The Effect of Opioid Abuse on Child Out-of-Home Placements

Scott Dallman*

November 2020
[click here for latest version]

Abstract

Opioid abuse has become a major public health issue in the US. While opioid misuse has direct consequences for addicts, children may also be affected. To prevent misuse of the prescription opiate OxyContin, Purdue Pharma released an abuse-deterrent version in 2010. Unintentionally, this reformulation caused many addicted to OxyContin to substitute more harmful opioids such as heroin and fentanyl in its place.

This study estimates the effect of opioid abuse on child out-of-home placements, the removal of a child from home due to maltreatment, using data on opioid abuse and OxyContin's reformulation. Using the reformulation as an instrumental variable for opioid abuse rates, I estimate that a 10% increase in the opioid abuse treatment admission rate caused an additional 2.4 foster care entries per 100,000 children due to drug abuse – equivalent to 1,778.4 child foster care out-of-home placements nationally. An average 27.21% increase in the opioid abuse treatment admission rate over the study period caused an estimated 4,840 additional drug-related child out-of-home placements or $26M in additional costs to the US foster care system from 2006-2016.

JEL Codes: I18, J13, K42
Keywords: Drug abuse, opioids, child maltreatment, child welfare, foster care, out-of-home placement, substance abuse

*University of Minnesota and Federal Reserve Bank of Minneapolis. Email: dallm031@umn.edu. Website: www.scottdallman.com. I am indebted to my advisors Elizabeth Davis and Joseph Ritter, as well as Anusha Nath, and Aaron Sojourner. I thank Terry Fitzgerald, Sarah Font, Donna Ginther, Paul Glewwe, Greg Leung, Ben Malin, Tom Tallerini for their thoughtful comments and constructive feedback. This paper also benefited from presentations at the 2018 Midwest Economic Association and 2018 Association for Public Policy and Management Annual Meetings as well as the Applied Economics Student Seminar Series. All views expressed and errors are solely my own.

1 Introduction

Opioid overprescription and misuse has created a public health epidemic in the US. While many adults suffer from opioid dependency, addiction also affects their children. More than half a million children are estimated to live with parents who have prescription opioid dependency, and 1.5 million children live away from a parent due to the opioid crisis (Bullinger and Wing, 2019; Buckles, Evans, and Lieber, 2020). Although the proportion of foster care cases due to parental drug abuse has grown by a factor of 2.5 since 2000, there is little evidence of opioid abuse's causal effect on foster care caseloads (Meinhofer and Angleró-Díaz, 2019; Buckles, Evans, and Lieber, 2020).

This study uses an exogeneous policy change to estimate the effect of opioid abuse on child out-of-home placements – the removal of a child from home due to maltreatment and placement in formal foster care or informal family living arrangements. A catalyst of the current opioid crisis was the introduction of the prescription opiate OxyContin in 1996. Widely-prescribed, individuals misused the original version of OxyContin by crushing it into a powder and ingesting the entire dose instantly to experience an euphoric high (Quinones, 2015; Powell, Pacula, and Taylor, 2020). In response, an abuse-deterrent reformulation of OxyContin was released in August 2010. While the reformulation deterred misuse of OxyContin, prior studies have shown that heroin and synthetic opioid-related overdoses increased due to their substitution in place of OxyContin (Alpert, Powell, and Pacula, 2018; Evans, Lieber, and Power, 2019).

Constructing a nationally representative panel using administrative data on child out-of-home placements merged with opioid abuse treatment entry rates, the supply of OxyContin, and demographics, I estimate the effect on child out-of-home placements using an instrumental variable for adult opioid abuse by modeling the reformulation of OxyContin with a

trend-break specification as done by Alpert, Powell, and Pacula (2018).[1] The measure of pre-intervention exposure to prescription opioids is variation in the 2010 state-level supply of oxycodone, the main ingredient in OxyContin. The identification assumption is that higher rates of opioid abuse increase child maltreatment and out-of-home placements. The exclusion restriction is that only opioid abuse rates are directly affected by variation in exposure to the supply of OxyContin and its reformulation.

I find that a 10% percent increase in opioid abuse treatment entries caused an additional 2.4 parental drug abuse related foster care entries per 100,000 children in the US over the study period 2006-2016. This is equivalent to a 10% percent increase in the national opioid abuse treatment admission rate on average causing 1,778.4 child foster care entries due to parental drug abuse. Due to under-identification of substance abuse as a reason for a child's removal from home, this is likely a lower bound estimate (Correia, 2013; Seay, 2015; Wiltz, 2016). For robustness, I replicate APP to show that the reformulation significantly increased opioid-related substance abuse treatment entry rates. I also find a lagged effect of the reformulation on child formal foster care out-of-home placements. Together, these findings suggest that higher rates of opioid abuse have significantly increased rates of drug-related out-of-home foster care placements.

However, I find that the overall rate of child out-of-home placements into foster care has remained unaffected by the opioid crisis indicating a decline in non-drug related entries. While, the opioid crisis has had no effect on the overall foster care entry rate, a growing number of children removed from home due to parental drug abuse is a concern if the cost of care for children of parents who abuse drugs is higher. Constructing a child-level longitudinal panel of foster care histories over the study period 2006-2016, I show that children who enter foster care due to parental drug abuse on average are more likely to recidivate to foster care and remain in foster care for an additional 2 months over their childhood. Given an average

[1] I will refer to this study as APP for the remainder of the paper

27.21% increase in opioid abuse treatment admission rates from 2006-2010 to 2011-2016, this is equivalent to approximately $26M in additional costs to the US foster care system over the study period.

This study makes two significant contributions. First, I present new findings on the effect of opioid abuse on children. Along with more children living in households affected by opioid addiction, more children are entering foster care due to parental drug abuse (Bullinger and Wing, 2019; Buckles, Evans, and Lieber, 2020; Meinhofer et al., 2020). Several studies have found increased rates of child out-of-home placements to be associated with greater rates of opioid prescription and overdose hospitalizations, and recent work by Gihleb, Giuntella, and Zhang (2019) estimate that greater opioid prescription oversight by mandatory prescription drug monitoring programs (PDMPs) decreased child removals by 10% (Ghertner et al., 2018; Quast, 2018; Quast, Bright, and Delcher, 2019). Other work by Buckles, Evans, and Lieber (2020) using the Current Population Survey (CPS) found no statistically significant effect of the opioid crisis on the population share of children in foster care. However, underreporting of foster children in national population surveys has been well documented (O'Hare, 2008). This study uses administrative data on the census of children who entered foster care to estimate the effect opioid abuse on the flow of child out-of-home placements into foster care.

Second, this study contributes to the economic literature on child out-of-home placements. Several economic studies have established a relation between child maltreatment and welfare program receipt (Paxson and Waldfogel, 2003), labor market conditions (Paxson and Waldfogel, 1999; Paxson and Waldfogel, 2002; Lindo, Schaller, and Hansen, 2018), and access to abortion (Bitler and Zavodny, 2002; Bitler and Zavodny, 2004). However the effect of drug abuse on child out-of-home placements in foster care has been less studied. In addition to recent work by Gihleb, Giuntella, and Zhang (2019) and Buckles, Evans, and Lieber (2020), Cunningham and Finlay (2013) examined the impact of federal restrictions for methamphetamine precursors on drug abuse related foster care entries by instrumenting local meth

price deviations from the national trend for meth-related treatment entries. I provide new evidence on the effect of opioid abuse on children and the US foster care system using a national opioid supply intervention.

2 The U.S. Opioid Crisis and Child Maltreatment

In 1898, the Bayer Pharmaceutical began marketing heroin as a non-addictive opiate medication to relieve respiratory disease. Heroin was later banned in 1924 in the US when discovered to be highly additive and susceptible to abuse (Sneader, 1998). Since the early 20th century, opiate-based medications such as morphine and codeine have been used restrictively for only severe cases of pain management. The recent proliferation of opioid prescription can be traced to a widely-cited study by Portenoy and Foley (1986) which found oxycodone, an opioid derivative, to be a non-addictive pain medication (Kolodny et al., 2015). In 1996, Purdue Pharma began promoting OxyContin, an extended-release oxycodone containing a large opiate dose per pill designed to be slowly released throughout the day. Aggressively marketed, OxyContin become one of the highest selling prescription drugs in the US (GAO, 2003; Alpert, Powell, and Pacula, 2018; Alpert et al., 2019).

Consequentially, widespread misuse of OxyContin has led to increased rates of opioid addiction and deaths (Kolodny et al., 2015; Compton, Jones, and Baldwin, 2016; Powell, Pacula, and Taylor, 2020). Since 2000, the number of opioid-related deaths in the U.S. has increased by a factor of 5 (See Figure 1). As well as overconsumption, individuals could misuse the original version of OxyContin by crushing it into a powder to ingest the entire dose instantly for an euphoric high (GAO, 2003). In response, Purdue Pharma released an abuse-deterrent reformulation of OxyContin which made the pill less soluable or crushable in August 2010. The year following this intervention, prescription opioid overdose deaths decreased for the first time since 1990 (Dart et al., 2015).

Although the 2010 reformulation of OxyContin reduced prescription opioid-related deaths, prior studies have shown that it unintentionally caused OxyContin abusers' to substitute heroin and synthetic opioids. APP estimate that nearly 80% of heroin-related deaths from 2010-2013 were due to the reformulation of OxyContin, and the increase in heroin-related deaths due to the reformulation has offset reductions in prescription opioid-related deaths (Evans, Lieber, and Power, 2019). Following OxyContin's reformulation in 2010, heroin and synthetic opioid-related deaths have increased by a factor of 5.8 and account for the majority of US opioid-related deaths (See Figure 1).

Opioid abuse has been cited as a major concern for public foster care systems (Wiltz, 2016; Radel et al., 2018). While the opioid crisis may have been more likely to affect children's in-home living arrangement than foster care placement, children removed from home due to opioid abuse and placed in foster care represent the most severe cases of child maltreatment (Buckles, Evans, and Lieber, 2020). Foster care is a state-provided temporary service for children who cannot live with their families due to maltreatment and are placed out-of-home most often with relatives or unrelated foster parents. More than 250,000 children enter the foster care system annually and by age 18 nearly 6% of all US children experience placement in foster care (Wildeman and Emanuel, 2014).

Among foster care placements, cases involving parental drug abuse, particularly opioid abuse, represent the most complex cases to resolve (Radel et al., 2018). While Buckles, Evans, and Lieber (2020) found no significant effect of the opioid crisis on overall foster care out-of-home placements using the CPS, national surveys have been shown to underestimate the population of foster care children due to misreporting, represent the stock rather than flow of children into foster care, and do not collect information on the reason for removing the child from home (O'Hare, 2008). Work by Meinhofer and others using administrative data has shown a national increase in the number of foster care entries related to parental drug abuse (Meinhofer and Angleró-Díaz, 2019; Meinhofer et al., 2020). Related work has

found a strong association between greater rates of opioid prescription and abuse and child foster care entries (Ghertner et al., 2018; Quast, Bright, and Delcher, 2019).

Foster care experiences and household instability can have long-term consequences for children. Studies by Doyle and co-authors as well as Bald et al. (2019) have found suggestive evidence that foster care experiences negatively impact children on the margin of foster care out-of-home placement (Doyle Jr, 2007b; Doyle Jr, 2008; Doyle Jr, 2013). Child maltreatment and foster care out-of-home placements also incur significant costs. Peterson, Florence, and Klevens (2018) estimate that the lifetime costs of child maltreatment per child not including productivity loss is $842,337 ($2016). In 2016, the estimated average cost to provide out-of-home foster care placement services per child was $33,210 and the average length of stay in foster care was 20.1 months (Crowley and Jones, 2017; US Department of Health and Human Services, 2017). The annual budget for the US foster care system was $5 billion.[2]

3 Data on Opioid Abuse and Foster Care

Directly estimating the effect of opioid abuse on child out-of-home placement rates using regression methods likely suffers from omitted variable bias (Swann and Sylvester, 2006). To correct for potential bias, I first predict opioid abuse rates using information on the supply of oxycodone and OxyContin's reformulation. Rates of opioid abuse should be highly correlated with the supply of OxyContin (oxycodone) and its reformulation in 2010. Then using the first-stage predicted opioid abuse rates, I estimate the effect on child out-of-home placements using instrumental variables. Greater rates of opioid abuse are predicted to cause higher rates of child out-of-home placements.

For the analysis, I construct a nationally representative panel at the age-state-year level

[2]HHS FY2016 Budget in Brief: ACF Budget Overview

of observation for children age 0-17 from 2006-2016. Information on child out-of-home placements and demographics are combined with data on the legal supply of oxycodone, opioid abuse rates, and demographics for age groups 25-34, 35-44, and 45-54 based on the mean age of parents. Overall, the dataset contains 9,882 observations.[3]

To quantify the effect of opioid misuse on out-of-home placements into foster care, I construct foster care entry rates per 10,000 children in the US using case-level information from the Adoption and Foster Care Analysis and Reporting System (AFCARS). Since 1995, the US Department of Health and Human Services has mandated states to annually submit information on all children served by public agencies to AFCARS. The sample used includes all children less than 18 years old who entered the foster care system available from the National Data Archive on Child Abuse and Neglect (NDACAN).[4] AFCARS data is reported on a fiscal year basis and merged to other data sources for the same calendar year i.e. fiscal year 2010 foster care entries are merged to other data sources reported for the 2010 calendar year.[5]

I construct three child out-of-home placement outcomes related to foster care. The first outcome is the overall foster care entry rate. AFCARS provides information on 15 non-mutually exclusive reasons for the child's removal from home including parental neglect, drug abuse, alcohol abuse, physical or sexual abuse, incarceration, and death. The second outcome is foster care entries where parental drug abuse was indicated as a reason for removal. Parental opioid abuse represents an unknown proportion of overall drug abuse related foster care entries since AFCARS does not provide detailed information on the specific drug abused. The third outcome is foster care entries where drug abuse, neglect, incarceration, or parental death were indicated as the reason for child out-of-home placement into foster care.

[3]The total number of adult (25-34, 35-44, and 45-54) and child (0-17) observations from 2006-2016 are 1,647, and 10,098. Due to missing TEDS data, the final dataset contains only 9,882 observations.

[4]A child was **served** by the foster care system if they passed through the foster care system at some point during the fiscal year. A child **enters** foster care if the child's date of most recent removal is between the beginning and the end of the fiscal year.

[5]The federal fiscal year begins Oct 1 and ends Sep 30 of the nominal fiscal year.

Although estimating the effect on drug-related foster care entries is most relevant to identifying the impact of opioid abuse on the foster care system, I examine multiple foster care entry outcomes due to widely-acknowledged underreporting of parental drug abuse as the reason why a child entered the foster care system. There is no standardized practice for how states report substance abuse (Wiltz, 2016). Case workers often only indicate child neglect as the reason for removal if neglect was the only substantiated reason for child removal at the time of allegation. This practice emphasizes reporting reasons for removal on a basis of behavior towards the child rather than underlying issues within the household (Dore, Doris, and Wright, 1995; Correia, 2013). Foster care entries due to parental neglect, incarceration, and death are included since parental drug abuse is likely correlated with these reasons for child out-of-home placement.

Lack of formal reporting guidelines likely accounts for large variation across counties in the number of drug-abuse related entries seen in the AFCARS data (Seay, 2015). For instance, of more than 3,600 foster care entry cases in Orange County, California from 2006-2007, none were attributed to parental drug abuse. However, in Bexlar county, Texas, approximately 68% of all foster care entries were attributed to parental drug abuse during the same period. The estimated effect of opioid abuse on parental drug abuse related child out-of-home placements into foster care therefore likely represents a lower bound estimate, and the effect on out-of-home placements due to parental drug abuse, neglect, incarceration, or parental death represents an upper bound.

Along with formal out-of-home foster care placements, I also estimate the effect of opioid abuse on the share of children cared for by a grandparent to measure informal out-of-home placements. A large increase in child maltreatment cases due to opioid addiction may create a shortage of foster homes for out-of-home care (Radel et al., 2018). One alternative to providing foster homes is to increase the use of informal kinship care. Child protective service caseworkers often prefer children to remain in the care of family members without

social services having to intervene (Child Welfare Information Gateway, 2016). As a proxy for informal out-of-home care with a grandparent, I construct the share of children living in households where a grandparent is the primary caregiver for a grandchild using the American Community Survey (ACS).

Greater rates of opioid abuse are strongly correlated with more foster care out-of-home placements (Radel et al., 2018; Quast, Bright, and Delcher, 2019). To measure parental opioid abuse, I collect drug treatment admission rates per 100,000 people for ages 25-34, 35-44, and 45-54 obtained from the Substance Abuse and Mental Health Services Administration's Treatment Episode Data Set Admissions (TEDS-A) dataset. TEDS-A reports all treatment admissions by facilities which receive public funding. For the main analysis, I use the treatment admission rate for any opioid – heroin or Oxycontin and other synthetic opioid – as the endogenous independent variable for estimating the effect on child out-of-home placements.[6] As robustness checks, I also construct drug treatment admission rates for heroin, Oxycontin, and non-opiate related entries separately. Non-opioid related drug treatment admission rates should be unaffected by OxyContin's 2010 reformulation.

Adults with greater exposure to OxyContin were more likely to abuse prescription opioids, and later substitute heroin and other synthetic opiates for OxyContin after its reformulation in 2010. To measure variation in the exposure to OxyContin across the US, I use the annual state-level supply of oxycodone in kilograms per 100,000 persons collected from the Drug Enforcement Agency's (DEA) Automation of Reports and Consolidated Orders System (ARCOS). ARCOS is the federal system which records the supply distribution of Schedule II-IV controlled substances by active ingredient as required by the Controlled Substance Act

[6]Other opiates and synthetics includes buprenorphine, codeine, hydrocodone, hydromorphone, meperidine, morphine, opium, oxycodone, pentazocine, propoxyphene, tramadol, and any other drug with morphine-like effects.

of 1970.[7]

Demographics are controlled for using the ACS available from IPUMS-USA. For both children and adults, I collect information on the total population, population shares by race and sex, and poverty rates. Additionally, for adults, I construct controls for level of education, marital status, per capita income, veteran status, unemployment rates. For children, I also include controls for household income, and whether the child lived in a single female-headed households. I also collect information on state policies which may affect either the supply of oxycodone or child out-of-home placements. PDMPs may reduce the supply of oxycodone and prescription opioid abuse if they provide greater oversight of opioid prescriptions.[8] For the opioid abuse rates, I collect information on the introduction of PDMPs by states using data collected by the PEW Charitable Trust. Variation in the amount of welfare assistance received by low-income families likely affects their ability to adequately provide care for a child (Paxson and Waldfogel, 2003). For child out-of-home placements, I control for state-level Supplemental Nutrition Assistance Program (SNAP) and Temporary Assistance for Needy Families (TANF) benefits for a family of three people obtained from the University of Kentucky Center for Poverty Research.

Summary statistics are presented in Tables 1 & 2 for children and adults by time period. The first column presents mean values for the entire study period, 2006-2016. The second and third columns decompose mean values by pre (2006-10) and post (2011-16) OxyContin reformulation (treatment) periods. The final column shows the difference in means between the pre (2006-10) and post (2011-16) periods. The fourth column shows the difference and column five shows the percentage change in means across periods. Although not controlled for in the model, I present demographic statistics for the population of children in foster care

[7]Prior work examining the effect of drug abuse on children has relied upon illicit drug price data collected through the Drug Enforcement Agency's System to Retrieve Information from Drug Evidence (STRIDE) (Cunningham and Finlay, 2013). STRIDE is a convenience sample and cannot address the overall stock of illicit substance available (Horowitz, 2001; Arkes et al., 2008).

[8]Prescription Drug Monitoring Programs: https://www.pewtrusts.org/-/media/assets/2016/12/prescription_drug_monitoring_programs.pdf

and adults in substance abuse treatment as a comparison to the general US population.

For children, the overall foster care entry rate per 10,000 children has decreased by 6.5% per annum. Since 2006, the foster care out-of-home placement rate related to parental drug abuse has steadily increased and largely accounts for an overall increase in the foster care entry rate beginning around 2010 (See Figure 2). Over the sample period, foster care entries due to parental drug abuse as well the combine drug abuse, neglect, incarceration, and death entry rates have increased by 27.5% and 8.9%. The share of children living in households where a grandparent is the primary caregiver for a child has also increased by 3.5%. Within the public foster care system, there are disproportionately more non-white and Hispanic children relative to the US population.

Although the entry rate for non-opioid related treatment has decreased since 2006, entries for prescription opiates (other opioids) and heroin-related addiction have remained constant or increased (See Figure 3). Drug abuse treatment entry rates related to opioids have increased by 26.8 to 37% while non-opioid related entry rates have decreased by 24%. Non-white, male, single, unemployed, and people with less education are disproportionately more represented among substance abuse treatment patients than in the general population. Across periods, the oxycodone supply increased on average by 7.67% or 1.34 kg per 100,000 persons. This is equivalent to an additional 0.7 20mg OxyContin pills per person in the US. The geographic dispersion of the supply of oxycodone in 2010 is shown in Figure 4. The North Pacific, Southwest and East Atlantic areas of the U.S. experienced higher exposure to OxyContin prior to its reformulation.

4 The Effect of Opioid Abuse on Children

To examine whether greater rates of opioid abuse increased child out-of-home placements, I first estimate the linear model:

$$Y_{ast} = \delta ln(Opioid\_Abuse_{ast}) + \beta X_{ast} + \eta_a + \alpha_s + \tau_t + \epsilon_{ast} \tag{1}$$

Here, Y_{ast} are child out-of-home placements expressed as the rate per 10,000 children. $ln(Opioid\_Abuse_{ast})$ is the natural log of the substance abuse treatment admission rate for any opiate (heroin or OxyContin and other synthetic opioids) per 100,000 persons. δ is the estimated effect of opioid abuse on child out-of home placements. X_{ast} is the vector of child demographic and state policy controls. η_a, α_s and τ_t are age cohort, state, and year fixed effects. All standard errors are clustered at the state-level.

Panel A of Table 3 shows the estimated effect of parental opioid abuse treatment entries on child out-of-home placements using OLS (1). Using OLS (1), I find a significant increase in the rate of parental drug-related child foster care entries (1.266) at the 10% significance level. Interpreting the coefficient δ for drug-related entries, a 10% percent increase in the parental substance abuse treatment entry rate is associated with an additional 1.2 child foster care entries per 100,000 children on average over the sample period. I find no significant effect of parental opioid abuse treatment admissions on total foster care entries, drug and other related entries, or the share of children cared for by a grandparent.

However, opioid abuse may be endogeneous to unobserved variation in the error term. Although less likely, greater rates of child out-of-home placements may cause an increase in adult opioid abuse. Studies have found states with greater rates of OxyContin abuse and access to oxycodone prior to the 2010 reformulation experienced higher rates of opioid addiction and heroin or fentanyl overdose deaths (Alpert, Powell, and Pacula, 2018; Evans,

Lieber, and Power, 2019). While variation in the supply of OxyContin and its 2010 reformulation directly affects the behavior of parents addicted to opioids, neither should affect child out-of-home placements other than through increased rates of parental opioid abuse. To correct for endogeneity bias, I also estimate the effect of opioid abuse on child out-of-home placements using two-stage least squares. In the first-stage, I model the 2010 OxyContin reformulation as done by APP to estimate opioid abuse rates:

$$\begin{aligned} ln(Opioid\_Abuse_{ast}) = \; & \delta_1[Post_t \times ln(Oxy\_Supply_s^{2010})] + \delta_2[t \times ln(Oxy\_Supply_s^{2010})] \\ & + \delta_3[Post_t \times (t - 2011) \times ln(Oxy\_Supply_s^{2010})] \\ & + \beta X_{ast} + \eta_a + \alpha_s + \tau_t + \epsilon_{ast} \end{aligned} \tag{2}$$

Here, $Opioid\_Abuse_{ast}$ are adult drug abuse treatment entry rates per 100,000 person in the population. $Post_t$ is an indicator for post-2010, the year OxyContin was reformulated, and $ln(Oxy\_Supply_s^{2010})$ is the 2010 retail supply of oxycodone in 2010.[9] t controls for pre-existing trends and a linear trend break beginning in 2012 (i.e. $t - 2011 = 0$ in 2011). δ_1 represents the initial effect of the reformulation in 2011. A common linear time trend is controlled for by δ_2, and the additive effect of the reformulation after 2011 is restricted to be linear by δ_3. X_{ast} is the vector of demographic and state policy controls. η_a, α_s and τ_t are age cohort, state and fiscal year fixed effects. All standard errors are clustered at the state-level. Then, opioid-related treatment admission rates predicted in the first-stage (2) are used to estimate the effect on child out-of-home placements in (1):

$$Y_{ast} = \delta ln(\widehat{Opioid\_Abuse}_{ast}) + \beta X_{ast} + \eta_a + \alpha_s + \tau_t + \epsilon_{ast} \tag{3}$$

If the 2010 OxyContin reformulation is a relevant and valid instrument for opioid abuse

[9]The 2010 opioid supply of oxycodone rate is preferred since it allows for a more contemporaneous measure of exposure to OxyContin immediately prior to the 2010 reformulation of OxyContin. Among the three measures oxycodone exposure: the 2006 oxycodone supply, the 2010 oxycodone supply and the mean pre-2010 oxycodone supply, the lowest coefficient of correlation is 0.87 suggesting little variation in estimated effects using any measure of OxyContin exposure. Correlation plots of the three measures of pre-2010 exposure are shown in the Appendix.

conditional on other covariates, then δ identifies the causal effect of opioid abuse on child out-of-home placements. Estimates using IV (3) are shown in Panel B of Table 3.

Using the reformulation of OxyContin as an instrumental variable for parental opioid abuse treatment admissions in equation (3), I find a statistically significant increase in the child foster care entry rate for both parental drug abuse (2.401), and drug abuse and related reasons (5.631), but no statistical effect on the overall foster care entry rate or share of children cared for by a grandparent. Interpreting the coefficient of $ln(\widehat{Opioid\_Abuse}_{ast})$ for drug abuse related foster care entries, a 10% percent increase in the treatment admission rate for opioid abuse caused an additional 2.4 foster care entries due to parental drug abuse per 100,000 children. This is statistically significant at the 1% level.

Alternative Parental Abuse Measures

For the main results, I use the supply of oxycodone as an instrument to estimate adult substance abuse treatment admission rates related to heroin or OxyContin and other synthetic opioids. Alternatively, I could use treatment admission rates for heroin, or OxyContin and other synthetic opioids separately. Results are shown in Tables 4 and 5. Using heroin-related adult treatment admissions, I estimate an increase in drug-related (2.613), and neglect child out-of-home placements (5.831) due to opioid abuse similar to the main results. I also find a significant effect on the overall foster care entry rate (3.770). However, I find no significant effect on child out-of-home placement outcomes using only OxyContin and other synthetic opioid-related adult drug treatment admissions.

Instrumenting with Contemporaneous Oxycodone Sales

As a further robustness check for the first-stage of the instrumental variable regression, I replace equation (2) with only the natural log of the contemporary oxycodone supply for opioid abuse treatment admission rates as an instrument along with demographic and fixed-effects,

$$ln(Opioid\_Abuse_{ast}) = \delta\ ln(Oxy\_Supply_{st}) + \beta X_{ast} + \eta_a + \alpha_s + \tau_t + \epsilon_{ast} \tag{4}$$

Results are shown in Table 6. Similar to results using equation (3) I find no effect on either the overall foster care entry rate (2.985) or share of children cared for by a grandparent (7.193) at 10% significant level. I find significant effects on both parental drug abuse related (2.281) and the combined drug and related reasons (5.378) child foster care entry rates similar to the main results at the 1% level.

The Effect of OxyContin's Reformulation

Thus far, I have shown that opioid abuse has increased drug-related child foster care out-of-home placements over the period 2006-2016. As done by APP, I also examine the causal effect of OxyContin's reformulation on adult opioid abuse as well as child out-of-home placement rates. Relaxing the linearity assumptions in equation (2), I first estimate the following generalized model as a baseline comparison to APP's model (2):

$$ln(Y_{ast}) = \delta[Post_t \times ln(Oxy\_Supply_s^{2010})] + \beta X_{ast} + \eta_a + \alpha_s + \tau_t + \epsilon_{ast} \tag{5}$$

To compare models, the joint significance test of the common linear time trend and post-2011 break coefficients in equation (2), $\delta_2 = \delta_3 = 0$, are also estimated. Rather than construct rates of opioid abuse and out-of-home placements, I measure outcomes as counts and estimate

a quasi-Poisson regression model.[10] I also assess the timing of the treatment effect with the generalized fixed-effects model used by APP:

$$ln(Y_{ast}) = \sum_{t=2006}^{2008} \delta_t[\mathbb{1}_t \times ln(Oxy\_Supply_s^{2010})] + \sum_{t=2010}^{2016} \delta_t[\mathbb{1}_t \times ln(Oxy\_Supply_s^{2010})] + \beta X_{ast} + \eta_a + \alpha_s + \tau_t + \epsilon_{ast} \quad (6)$$

$\mathbb{1}_t$ are a set of indicators for each year. Therefore the set of coefficients δ_t estimate the effect of the treatment exposure relative to the year prior to OxyContin's reformulation, 2009. If OxyContin's reformulation in 2010 was an exogeneous shock to the menu of opiates available to addicts, then equation (6) should estimate a significant effect for δ_t for $t \geq 2011$ and no significant effect prior to 2010. A significant effect for δ_t found prior to 2010 indicates a threat to the internal validity of causal estimates using equations (5) and (2) due to spurious correlation. Table 7 & 8 show the estimated effect of OxyContin's 2010 reformulation on adult substance abuse treatment entries and child out-of-home placements using the baseline (5) and APP's (2) model. Results using the fixed-effects model (6) are shown in Tables 9 and 10, and graphically presented in Figure 5 for adult (Panel A) and child (Panel B) outcomes.

Under the baseline model (5), Table 7 shows a statistically significant effect of the reformulation on adult substance abuse treatment entry rates for heroin (0.291) at the 10% level. Interpreting the coefficient for heroin entries in column (1), a one percent increase in the average 2010 supply of oxycodone increased the rate of heroin-related adult substance abuse treatment entries by 29.1 log points. I find no signficant effect on OxyContin related, or the overall opioid treatment entry rate.

Controlling for a pre-existing common trend using APP's model (2), there is a statistically significant initial effects on heroin (0.158), OxyContin (0.086), and overall opiate (0.133) related treatment entry rates in 2011. However, there is only a significant additive effect

[10] Estimates shown do not impose the population offset condition which constrains the population coefficient to be equal to 1, although effects are similar when the offset constraint is imposed.

for heroin (0.078) in the years following 2011. Interpreting the coefficients for heroin entries under (2), a one percent increase in the average 2010 supply of oxycodone had an initial effect of increasing heroin-related adult treatment entries by 15.8 log points in 2011 and an additive effect of 7.8 additional log points per annum. For the period 2011-2016, this is equivalent to a one percent increase in the 2010 oxycodone supply causing a 54.8 log point increase in the 2016 heroin-related treatment entry rate ($\delta_1 + 5 \times \delta_3$).

Panel A of Figure 5 graphical shows the estimated coefficient value for adult substance abuse treatment admissions using equation (6). Relative to 2009, there was a significant increase in heroin, OxyContin, and overall opiate related substance abuse treatment admissions after OxyContin's reformulation and no significant effect prior to 2009. As found by APP, OxyContin's reformulation increased opioid abuse rates largely through a significant increase in heroin-related substance abuse treatment entries. Interpreting the coefficient δ_{2016} from Table 9, a one percent increase in the mean amount of 2010 oxycodone supplied increased heroin-related treatment admissions in 2016 by 47.7 log points relative to 2009 at the 5% significance level. For non-opioid related treatment admissions, I find a significant negative effect (0.067) the year of the reformulation.

For child out-of-home placements, I find no statistically significant effect of OxyContin's reformulation using equation (5) shown in Panel A of Table 8. Using equation (2), while I find no initial effect of OxyContin's reformulation in 2011 on child out-of-home placements, there was a significant increase in total foster care out-of-home placements (0.027), and out-of-home placements for parental drug abuse or other related reasons for entry (0.042) following 2011. Interpreting the coefficient for total foster care out-of-home placements using linear trends in Panel B, a one percent increase in the average 2010 supply of oxycodone increased the overall foster care entry rate by an additional 2.7 log points annually after 2011 at the 5% significance level. I find no effect on the share of children cared for by a grandparent, entries due to drug abuse, or due to drug abuse and related reasons at the 10%

significance level.

Panel B of Figure 5 shows no strong relationship between child out-of-home placements and pre-2010 oxcodone misuse using equation (6). I find no significant increase in child out-of-home placements relative to 2009 due to OxyContin's reformulation except for a significant decrease in parental drug abuse and other related reasons for entry in 2008. Interpreting the coefficient δ_{2008} for column (3) of Table 10, a one percent increase in the mean 2010 supply of oxycodone significantly increased drug-related entries in 2008 by 6.4 log points relative to 2009 at the 5% confidence level.

Effect of Drug Abuse on Child Lifetime Foster Care Experiences

Although the overall rate of child out-of-home placements may have been unaffected by opioid abuse, a greater proportion of children entering foster care due to parental drug abuse is more costly if these children are more likely to stay in care longer or to recidivate to foster care. To estimate the effect of drug abuse on the children's total lifetime length of stay in foster care, I estimate the following model by constructing child-level observations for all children who entered foster care from 2006-2016 using child age, state, birthdate, and case identification number,

$$Y_i = \delta Drug\_Abuse_i + \beta X_{ist} + \alpha_s + \tau_t + \epsilon_{st} \tag{7}$$

Where Y_{ast}, is the total lifetime length of stay for each child from 2006-2016 measured in months, or an indicator for whether the child ever recidivated to the foster care system. $Drug\_Abuse_{ast}$ is an indicator for whether parental drug abuse was ever cited as a reason for child foster care out-of-home during child's lifetime. X_{ast}, is a set of controls for child age, gender, and race. α_s, *and* τ_t are state and year of first foster care out-of-home placement fixed effects. In total, more than 2.6 million children have entered the foster care system

from 2006-2016. Results are shown in Table 11.

Using OLS, Panel A shows that children who experienced any out-of-home placement in foster care due to parental drug abuse were associated with a longer average length of stay in the foster care system of an additional 1.97 months after controlling for state and year fixed effects. This is potentially due to child of parents who abuse drugs being more likely to recidivate to foster care. Using a logit model, Panel B of 11 shows that children of parents who abuse drugs are nearly 42.7 log points more likely to recidivate to the foster care system.

5 Additional Robustness Checks

Assessing Linearly Additive Dynamic Effects

In model (2), linearly additive dynamic effects of the reformulation over the post-2010 period are assumed. I assess this assumption using the following:

$$ln(Y_{ast}) = \sum_{T=2011}^{2016} \delta_T[Post_t \times ln(Oxy\_Supply_s^{2010}) \times \mathbb{1}_{t \leq T}] + \delta_2[t \times ln(Oxy\_Supply_s^{2010})] + \beta X_{ast} + \eta_a + \alpha_s + \tau_t + \epsilon_{ast} \tag{8}$$

Here, Y_{ast} are outcomes expressed as counts. The set of δ_T estimate the effect of the reformulation for years following the 2010 reformulation where $\mathbb{1}_{t \leq T}$ are indicators for observations up to year T. Relative to equation (2), equation (8) is a generalized specification which estimates the additive effect of the reformulation for each year separately. I can then test the assumption of linear effects:

$$\delta_{2012} = \delta_{2013} = \delta_{2014} = \delta_{2015} = \delta_{2016} \tag{9}$$

Results are shown in Tables 12 & 13. For adult drug treatment admission outcomes, the F-test reject linear effects for all drug abuse outcomes except overall opioid-related treatment admissions at the 10% significance level. For child outcomes, the F-test rejects the linearity assumption for all out-of-home placement outcomes except the share of children cared for by grandparents at the 10% significance level. Together with the F-test for joint significance of $\delta_2 = \delta_3 = 0$ presented in Tables 7 & 8, these results suggest mis-specification of APP's model (2) since the estimated effect of the reformulation was not linear following 2011. However, the F-test for statistically negligible coefficients on the common linear trend, δ_2, and the linear trend break post-2011, δ_3, fails to rejects that both are significant to estimating the effect of the reformulation on opioid abuse and out-of-home placement outcomes in equation (2).

Measuring Opioid Exposure using 2010 Prescription Rates

For the main results, I use the rate of adult opioid treatment admissions to identify pre-2010 exposure to OxyContin abuse. For robustness, I replicate the analysis using the natural log of the 2010 opioid prscription rate, $ln(Prescribe_s^{2010})$, as another measure of pre-2010 OxyContin exposure. Opioid prescription rates (per 100 persons) were collected from the Center for Diease Control's U.S. County Prescribing Rates Maps. This sample covers nearly 90% of all retail prescriptions in the US.[11] One prescription is defined as an initial or refill prescription dispensed at a retail pharmacy and does not include mail-order prescription.

For child out-of-home placements, I find a significant effect of opioid abuse on parental drug abuse related foster care entry rate (1.266) under OLS shown Panel A of Table 14. Using opioid prescription rates as an instrument for opioid abuse treatment admissions, Panel B shows estimated significant effects on drug (1.362) or neglect (3.710) related foster

[11] Estimates are based on a sample of approximately 50,000 retail (non-hospital) pharmacies collected by IQVIA Xponent.

care entries consistent with the main analysis. Interpreting the coefficient for on drug-related child out-of-home foster placements in Panel B, a 10% increase in the average opioid prescription rate increased the rate of drug-related out-of-home placements in foster care by 1.3 additional entries per 100,000 children. Slightly larger effects are estimated using only contemporaneous prescription rates as an instrument for opioid abuse on drug-related (2.461) or neglect (5.572) as well as significant effect on the overall foster care out-of-home placement rate (3.143) shown in Table 15.

Estimating the effect of OxyContin's reformulation directly on opioid abuse rates, I find an increase in heroin-related treatment admissions (0.352) and reductions in OxyContin and other synthetic (-0.344) and non-opioid (-0.299) related treatment admissions using equation (5) shown in Panel A of Table 16. Assuming linear trends under equation (2), only the effect on heroin-related drug treatment admissions (0.128) is estimated to be significant at the 10% significance level in Panel B. Relative to 2009, I find no significant correlation between adult opioid or non-opioid related treatment admission rates with opioid prescription rates prior to 2009 using the fixed effects model (6) shown in Table 17, but a highly significant association post 2010.

For child out-of-home placements, I find a significant effect of the 2010 reformulation on drug abuse related foster care entry rate (0.230) using the baseline model shown in Panel A of Table 18. However, I find no significant effect on any child out-of-home placement outcome after controlling for a linear trend shown in Panel B. Using the generalized fixed effects model (6), relative to 2009 I find a significant positive association between the overall child out-of-home foster care placement rate and pre-2010 opioid exposure using opioid prescription rates but find no significant association on drug-related child out-of-home placements (See Table 19)

State-level Analysis

As a final robustness check, I replicate the main analysis at the state-year level of observation. For child outcomes, the sample consists of 561 state-year observations. Due to missing data, for adult substance abuse, there are 549 state-year observations. Tables 20 and 21 show the state-level analysis estimates. Using ordinary least squares, I find no significant effect of opioid abuse on any child foster care out-of-home placement outcome. Under instrumental variables, I do find a significant decrease in the rate of children being cared for by a grandparent using either the reformulation (-47.871) or contemporary oxycodone retail distribution rates (-70.360) per 10,00 children in the US. However, I find no significant effect on any measure of child foster care out-of-home placements.

Examining the effect of OxyContin's reformulation separately on opioid abuse and out-of-home placement rates, for adult drug treatment admissions, I find an increase in heroin (0.322) and overall opioid-related (0.234) drug treatment admissions due to the reformulation using the baseline model shown in Panel A of Table 22. Controlling for linear trends, shown in Panel B, I find significant initial effects on OxyContin (0.116) and overall opioid-related (0.130) treatment admission rates, and only a significant effect after 2011 for heroin-related treatment admissions (0.088) at the 10% significance level. Looking at the estimated effect of the reformulation on treatment admission rates relative to 2009 in Table 23, I find a strong association between the 2010 opioid prescription rate and opioid-related drug abuse treatment admissions after 2010.

For child outcomes, I find no significant effect of OxyContin's reformulation using the baseline model in Panel A of Table 24. After controlling for a linear time trend, Panel B shows a significant effect of the reformulation on overall foster care entries (0.018) and drug or neglect related entries (0.029) after 2011. However, looking at the relative effect of OxyContin's reformulation on child out-of-home placements compared to 2009 in Table 25,

I find no significant effect after 2010.

6 Discussion & Limitations

This study estimated the effect of the recent US opioid abuse crisis on rates of child out-of-home placements. Using data collected on the national supply of oxycodone, adult drug abuse treatment admissions, and child out-of home placements from 2006-2016, I constructed an instrumental variable for opioid abuse rates by modeling the 2010 reformulation of OxyContin as done by APP. I find that a 10% percent increase in the national opioid abuse rate increased the rate of foster care entries due to parental drug abuse by 2.4 entries per 100,000 children. Including child foster care entries due to parental neglect, incarceration, death, or abandonment, a 10% increase in the national opioid abuse rate caused an estimated 5.6 additional entries per 100,000 children. However, I find no significant effect on the overall rate of children entering foster care or share of children cared for by a grandparent.

These effects are largely identified by a significant increase in heroin-related substance abuse rather than OxyContin abuse over the sample period. Replicating APP, I show that the 2010 reformulation significantly increased overall opioid abuse treatment admissions though an increase in heroin-related abuse. I also find evidence of a lagged effect on greater overall and neglect related foster care out-of-home placements beginning in 2012. These results suggest that a national increase in opioid abuse has significantly increased the proportion of children entering foster care due to drug-related reasons for entry. However, I estimate no significant effect on the overall rate of child foster care out-of-home placements indicating that non-drug related foster care entries have decreased over the study period.

Using 2010 opioid prescription rates as an alternative measure of OxyContin exposure, I find slightly larger effects on child out-of-home placements. Estimated effects at the state-

level of observation were largely consistent with the main results regarding the effect of OxyContin's reformulation on adult and child outcomes. However, I find no significant effect of opioid abuse on child out-of-home placements using instrumental variables at the state-level of analysis. One reason is that the 2010 oxycodone retail supply measure is a much weaker instrument for adult opioid abuse at the state-level. For the state-level first-stage instrumental variable regression, the F-statistic is only 4.69. Another reason for conflicting estimates is loss of statistical power due to a large reduction in sample size. Although I find an increase in the flow of child out-of-home placements due to drug abuse, the analysis does not account for foster care re-entries by a child within a given fiscal year and does not consider cases of foster care entry due to child drug abuse. Parental opioid abuse also represents an unknown proportion of overall drug abuse related foster care entries measured in this study since no detailed information on the specific drug abused is available.

While work by Buckles, Evans, and Lieber (2020) estimate that more children live in a household headed by a grandparent due to the opioid crisis, I find no significant effect of opioid abuse on the share of children cared for by grandparents over the period 2006-2016. One interpretation is that the opioid crisis has not affected the behavior of very risky households where both parents have severe drug abuse problems over a relative short-time period – children from households with severe drug abuse problems are being cared for by grandparents at a consistent rate regardless of the substance. On the other hand, no significant effect on the share of children cared for by grandparents also indicates that grandparents are a potentially under-utilized alternative care arrangement for children of severely opioid addicted adults.

A large influx of children who need foster care out-of-home placement due to opioid abuse poses significant additional costs for the child welfare system since cases related to opioid abuse are more complex and take a longer time to resolve (Radel et al., 2018). The average length of stay in foster care was 20.1 months in fiscal year 2016 (US Department of Health

and Human Services, 2017). However I find that children who have been placed out-of-home in the foster care system due to parental drug abuse stay in the system 2 months longer on average.

In 2016 estimated average cost to provide out-of-home foster care placement services per child was $33,210. As of the 2010 Census, 74.1 million children lived in the U.S.[12] I estimate that a 10% percent increase in the the opioid abuse treatment admission rate on average caused 1,778.4 child foster care entries due to opioid abuse nationally over the study period 2006-2016.[13] This is equivalent to an additional 289 child-years of out-of-home foster care, or approximately $9.6 million ($2016).[14] Given a 27.21% increase in the opioid abuse treatment admission rate from the period 2006-2010 to 2011-2016, this equals $26M in additional costs to the US foster care system over the study period. For comparision, the annual budget for the US foster care system was $5 billion in 2016.[15]

Policies which allow children of drug-addicted parents to live with other family members such as grandparents should receive greater consideration in order to reduce public foster caregiving costs. Providing higher financial assistance to adopt or provide foster caregiving has been shown to increase child out-of-home placement rates among kin (Doyle Jr, 2007a; Argys and Duncan, 2013; Buckles, 2013; Brehm, 2018). While potentially more costly, greater reimbursement rates for foster care assistance could also increase the supply of foster parents since state foster care payments cover only 35% - 45% of the estimated minimum adequare cost of child care (Ahn et al., 2018). For elderly or retired individuals, additional assistance should be provided to reduce the cost of care burden for a grandchild.

Interventions aimed at reducing parental drug abuse to improve household conditions may also be effective. One policy to reduce the number of children cared for by the foster system

[12] U.S. Census Bureau - Age and Sex Composition: 2010 https://www.census.gov/prod/cen2010/briefs/c2010br-03.pdf

[13] $\frac{2.4}{10{,}000} \times 74{,}100{,}000 = 1{,}778.4$ additional drug-related foster placements

[14] $1{,}778.4 \times \frac{1.95}{12} = 288.9$ ($\times 33{,}210 = \$9.59$ million)

[15] HHS FY2016 Budget in Brief: ACF Budget Overview

is to target in-home services towards children living in high risk households. The Family First Prevention Act of 2018 gave states increased controlled over how Title IV-E funding can be spent. Under the Act, states, territories, and tribes with an approved Title IV-E plan can use funding for in-home prevention services that would allow children who would otherwise enter the foster care system to stay with their parents or relatives.[16] Given the recent passage of the Family First Prevention Services Act, further evaluation of effective family support services is also necessary to ensure that those children who remain at home with parents are provided better care relative to the foster care system.

In the case of pharmaceutical drug abuse, opiate-based and other addictive medications should be more closely monitored and restrictively prescribed as a "last resort" after alternative pain medications and treatment methods have been exhausted (Powell, Pacula, and Jacobson, 2018). Greater regulation on how pharmaceutical companies are allowed to market their products should also be enforced. Future drug abuse interventions should also better coordinate efforts to reduce the supply of addictive substances with efforts to provide substance abuse recovery treatment – particularly for adults caring for children. Providing greater resources towards substance abuse recovery and prevention programs may be a cost-effective solution to reducing the underlying demand for illicit substances in comparision to the long-term consequences of parental drug abuse on children.

Children in the foster care system whose parents have substance abuse problems are a well-defined, high-risk population. Additional research on the benefits of narrowly-targeted interventions to assist them and their families should be a paramount concern to reduce the social costs associated with child maltreatment and foster care. Future work should further examine the long-term causal effects of parental opioid and other types of substance abuse on children using more detailed information on specific-types of substance abuse, accurate costs of care or prevention services, and later child outcomes which are currently unavailable

[16]NCSL: Family First Prevention Services Act https://www.ncsl.org/research/human-services/family-first-prevention-services-act-ffpsa.aspx

in nationally representative child foster care out-of-home placement data.

References

Ahn, Haksoon et al. (2018). "Estimating minimum adequate foster care costs for children in the United States". In: *Children and Youth Services Review* 84, pp. 55–67.

Alpert, Abby, David Powell, and Rosalie Liccardo Pacula (2018). "Supply-Side Drug Policy in the Presence of Substitutes: Evidence from the Introduction of Abuse-Deterrent Opioids". In: *American Economic Journal: Economic Policy* 10.4, pp. 1–35.

Alpert, Abby E et al. (2019). *Origins of the Opioid Crisis and Its Enduring Impacts*. Tech. rep. National Bureau of Economic Research.

Argys, Laura and Brian Duncan (2013). "Economic Incentives And Foster Child Adoption". In: *Demography* 50.3, pp. 933–954.

Arkes, Jeremy et al. (2008). *Why the DEA Stride Data Are Still Useful for Understanding Drug Markets*. Tech. rep. National Bureau of Economic Research.

Bald, Anthony et al. (2019). *The Causal Impact of Removing Children from Abusive and Neglectful Homes*. Tech. rep. National Bureau of Economic Research.

Bitler, Marianne and Madeline Zavodny (2002). "Child Abuse and Abortion Availability". In: *American Economic Review* 92.2, pp. 363–367.

Bitler, Marianne P and Madeline Zavodny (2004). "Child Maltreatment, Abortion Availability, and Economic Conditions". In: *Review of Economics of the Household* 2.2, pp. 119–141.

Brehm, Margaret E (2018). "The Effects of Federal Adoption Incentive Awards for Older Children on Adoptions From US Foster Care". In: *Journal of Policy Analysis and Management* 37.2, pp. 301–330.

Buckles, Kasey, William N Evans, and Ethan MJ Lieber (2020). *The Drug Crisis and the Living Arrangements of Children*. Tech. rep. National Bureau of Economic Research.

Buckles, Kasey S (2013). "Adoption subsidies and placement outcomes for children in foster care". In: *Journal of Human Resources* 48.3, pp. 596–627.

Bullinger, Lindsey Rose and Coady Wing (2019). "How Many Children Live With Adults With Opioid Use Disorder?" In: *Children and Youth Services Review*.

Child Welfare Information Gateway (2016). *Kinship Caregivers and the Child Welfare System*.

Compton, Wilson M, Christopher M Jones, and Grant T Baldwin (2016). "Relationship Between Nonmedical Prescription-opioid Use And Heroin Use". In: *New England Journal of Medicine* 2016.374, pp. 154–163.

Correia, Melissa (2013). "Substance Abuse Data in Child Welfare". In: *Casey Practice Digest: Substance Use Disorders in Families with Young Children* Case Family Programs.

Crowley, Max and Damon Jones (2017). "A framework for valuing investments in a nurturing society: Opportunities for prevention research". In: *Clinical child and family psychology review* 20.1, pp. 87–103.

Cunningham, Scott and Keith Finlay (2013). "Parental Substance Use and Foster Care: Evidence from Two Methamphetamine Supply Shocks". In: *Economic Inquiry* 51.1, pp. 764–782.

Dart, Richard C et al. (2015). "Trends In Opioid Analgesic Abuse And Mortality In The United States". In: 372.3, pp. 241–248.

Dore, Martha Morrison, Joan M Doris, and Pearl Wright (1995). "Identifying Substance Abuse in Maltreating Families: A Child Welfare Challenge". In: *Child Abuse & Neglect* 19.5, pp. 531–543.

Doyle Jr, Joseph J (2007a). "Can't Buy Me Love? Subsidizing The Care Of Related Children". In: *Journal of Public Economics* 91.1, pp. 281–304.

— (2007b). "Child Protection and Child Outcomes: Measuring the Effects of Foster Care". In: *American Economic Review* 97.5, pp. 1583–1610.

— (2008). "Child Protection And Adult Crime: Using Investigator Assignment To Estimate Causal Effects Of Foster Care". In: *Journal of Political Economy* 116.4, pp. 746–770.

— (2013). "Causal Effects Of Foster Care: An Instrumental-Variables Approach". In: *Children and Youth Services Review* 35.7, pp. 1143–1151.

Evans, William N, Ethan MJ Lieber, and Patrick Power (2019). "How the Reformulation of OxyContin Ignited the Heroin Epidemic". In: *Review of Economics and Statistics* 101.1, pp. 1–15.

GAO (2003). *Prescription Drugs: OxyContin Abuse and Diversion and Efforts to Address the Problem*. Tech. rep. United States Government Accountability Office.

Ghertner, Robin et al. (2018). "The role of substance use in child welfare caseloads". In: *Children and Youth Services Review* 90, pp. 83–93.

Gihleb, Rania, Osea Giuntella, and Ning Zhang (2019). "The Effect of Mandatory Access Prescription Drug Monitoring Programs on Foster Care Admissions". In: *Journal of Human Resources*, 0918–9729R2.

Horowitz, Joel L. (2001). "Should the DEA's STRIDE Data Be Used for Economic Analyses of Markets for Illegal Drugs?" In: *Journal of the American Statistical Association* 96.456, pp. 1254–1262.

Kolodny, Andrew et al. (2015). "The Prescription Opioid and Heroin Crisis: A Public Health Approach to an Epidemic of Addiction". In: *Annual Review Of Public Health* 36, pp. 559–574.

Lindo, Jason M, Jessamyn Schaller, and Benjamin Hansen (2018). "Caution! Men Not At Work: Gender-specific Labor Market Conditions and Child Maltreatment". In: *Journal of Public Economics* 163, pp. 77–98.

Meinhofer, Angélica and Yohanis Angleró-Díaz (2019). "Trends in Foster Care Entry Among Children Removed From Their Homes Because of Parental Drug Use, 2000 To 2017". In: *JAMA Pediatrics* 173.9, pp. 881–883.

Meinhofer, Angélica et al. (2020). "Parental drug use and racial and ethnic disproportionality in the US foster care system". In: *Children and youth services review* 118, p. 105336.

National Data Archive on Child Abuse and Neglect. *Adoption and Foster Care Analysis and Reporting System (AFCARS)*. [dataset]. URL: http://www.ndacan.cornell.edu.

— (2017). *Adoption and Foster Care Analysis and Reporting System (AFCARS): Data User's Guide*. Tech. rep. Bronfenbrenner Center for Translational Research, Cornell University.

O'Hare, William P (2008). "Data on children in foster care from the census bureau". In:
Paxson, Christina and Jane Waldfogel (1999). "Parental Resources and Child Abuse and Neglect". In: *American Economic Review* 89.2, pp. 239–244.
— (2002). "Work, Welfare, and Child Maltreatment". In: *Journal of Labor Economics* 20.3, pp. 435–474.
— (2003). "Welfare Reforms, Family Resources, and Child Maltreatment". In: *Journal of Policy Analysis and Management* 22.1, pp. 85–113.
Peterson, Cora, Curtis Florence, and Joanne Klevens (2018). "The Economic Burden Of Child Maltreatment in the United States, 2015". In: *Child Abuse & Neglect* 86, pp. 178–183.
Portenoy, Russell K and Kathleen M Foley (1986). "Chronic Use Of Opioid Analgesics In Non-Malignant Pain: Report Of 38 Cases". In: *Pain* 25.2, pp. 171–186.
Powell, David, Rosalie Liccardo Pacula, and Mireille Jacobson (2018). "Do medical marijuana laws reduce addictions and deaths related to pain killers?" In: *Journal of health economics* 58, pp. 29–42.
Powell, David, Rosalie Liccardo Pacula, and Erin Taylor (2020). "How Increasing Medical Access to Opioids Contributes to the Opioid Epidemic: Evidence from Medicare Part D". In: *Journal of Health Economics*, p. 102286.
Quast, Troy (2018). "State-level Variation In The Relationship Between Child Removals And Opioid Prescriptions". In: *Child Abuse & Neglect* 86, pp. 306–313.
Quast, Troy, Melissa A Bright, and Chris Delcher (2019). "The relationship between foster care entries and high-dose opioid prescribing in California". In: *Addictive Behaviors* 93, pp. 52–58.
Quinones, Sam (2015). *Dreamland: The True Tale of America's Opiate Epidemic*. Bloomsbury Publishing USA.
Radel, Laura et al. (2018). "Substance use, the opioid epidemic, and the child welfare system: Key findings from a mixed methods study". In: *Office of the Assistant Secretary for Planning and Evaluation*, pp. 1–9.
Seay, Kristen (2015). "How many families in child welfare services are affected by parental substance use disorders? A common question that remains unanswered". In: *Child welfare* 94.4, p. 19.
Sneader, Walter (1998). "The discovery of heroin". In: *The Lancet* 352.9141, pp. 1697–1699.
Steven Ruggles, Katie Genadek, Ronald Goeken, Josiah Grover and Matthew Sobek (2017). *Integrated Public Use Microdata Series: Version 7.0*. [dataset]. Minneapolis: University of Minnesota. URL: https://doi.org/10.18128/D010.V7.0.
Swann, Christopher A. and Michelle Sheran Sylvester (2006). "The Foster Care Crisis: What Caused Caseloads To Grow". In: *Demography* 43.2, pp. 309–335.
US Department of Health and Human Services (2017). *AFCARS Report # 24*.
Wildeman, Christopher and Natalia Emanuel (2014). "Cumulative Risks Of Foster Care Placement By Age 18 For Us Children, 2000–2011". In: *PloS one* 9.3, e92785.
Wiltz, Teresa (2016). "Drug-addiction epidemic creates crisis in foster care". In: *Stateline, The Pew Charitable Trusts, October* 7.
Wooldridge, Jeffrey M (2010). *Econometric Analysis of Cross Section and Panel Data*. MIT press.

Figures & Tables

Figure 1: National Overdose Deaths - National Institute of Drug Abuse

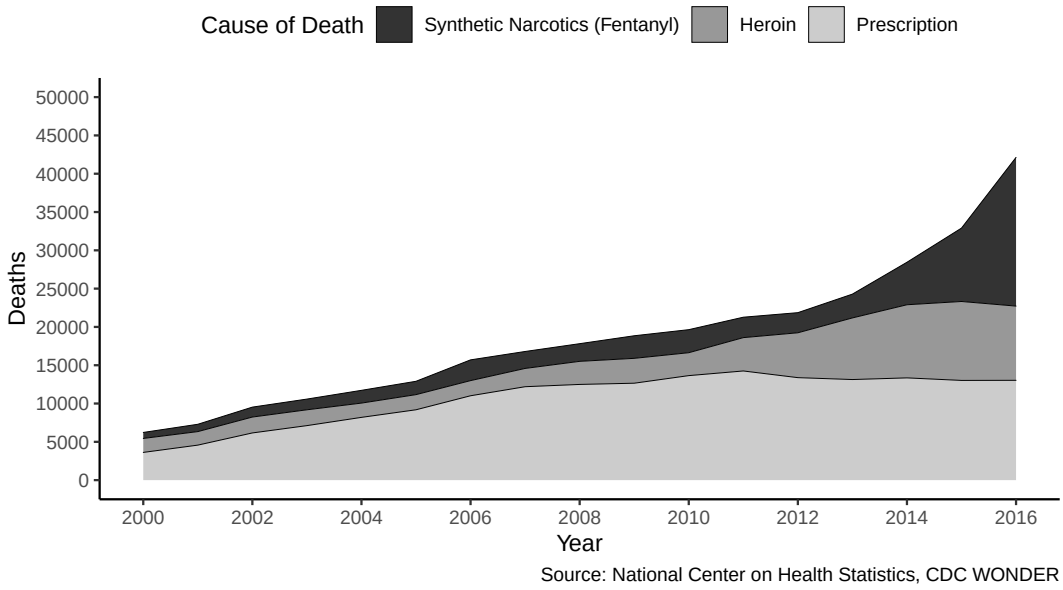


Figure 2: National Child Foster Care Entry Rates, 2006-2016

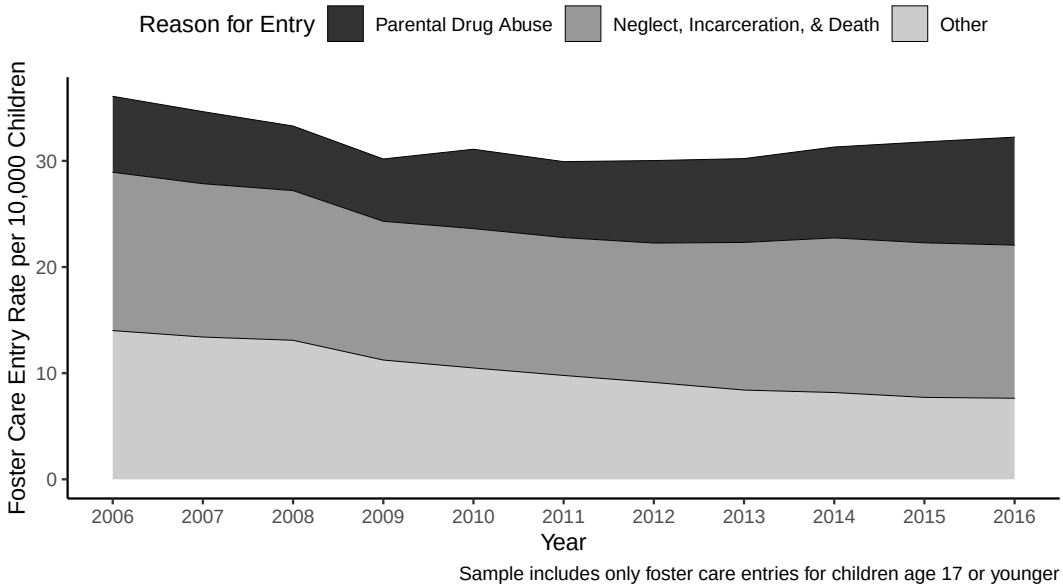


Figure 3: National Adult Drug Abuse Treatment Entry Rates, 2006-2016

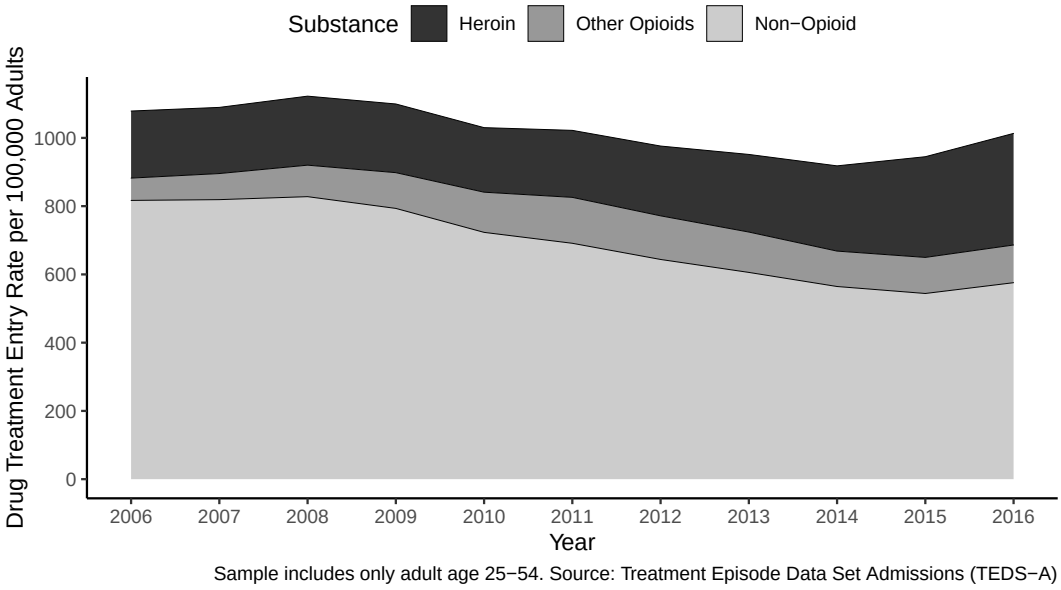


Figure 4: National Mean Oxycodone Supply Rates, 2010

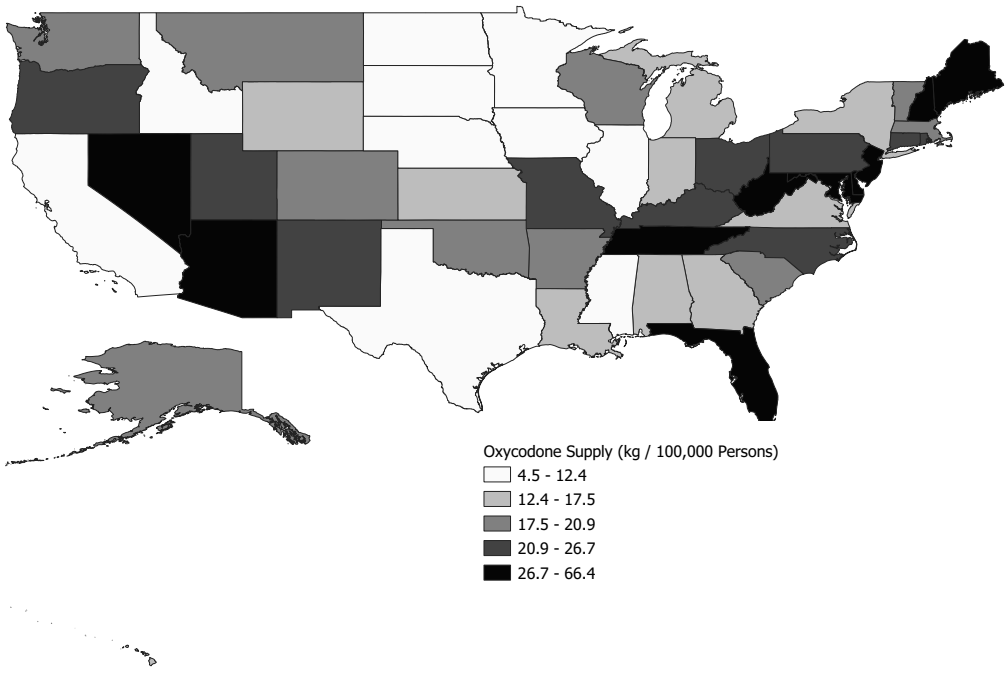
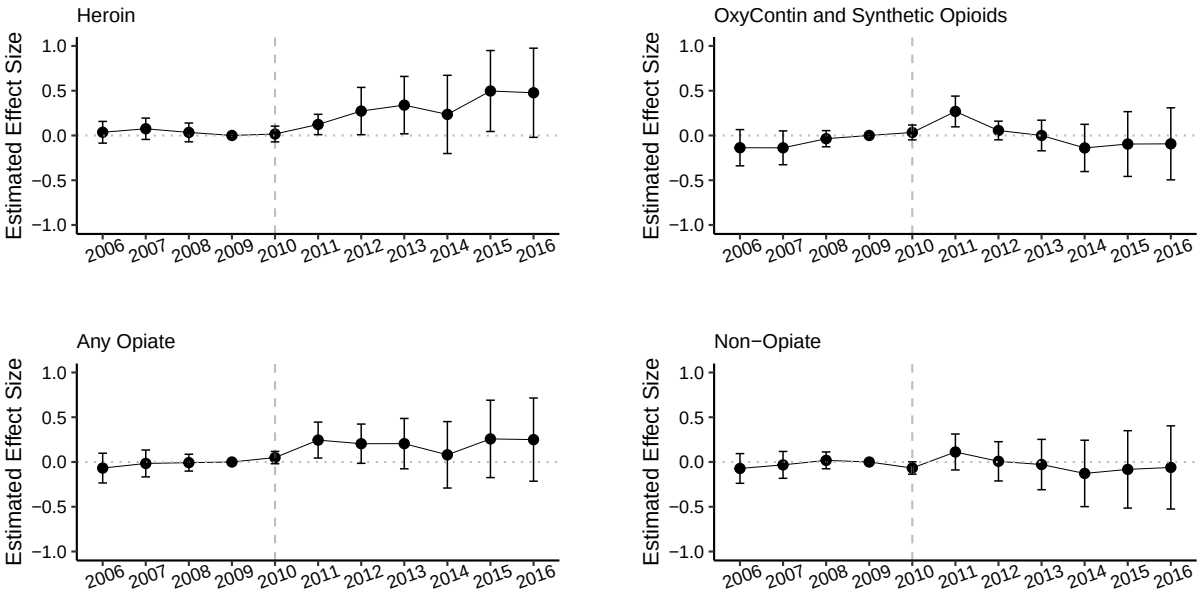
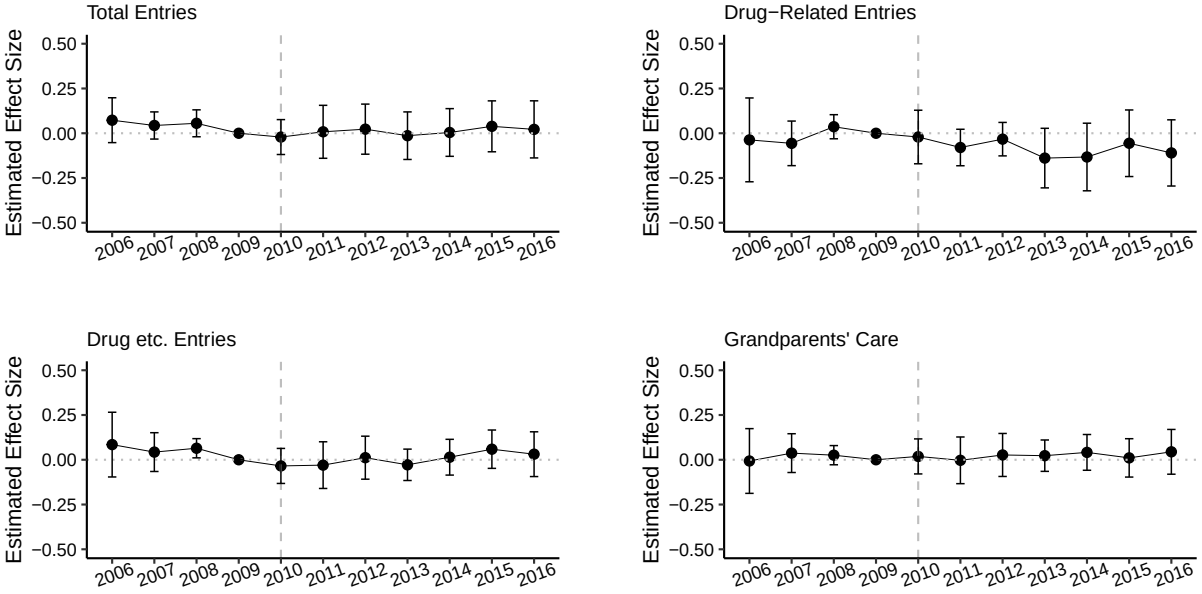


Figure 5: Fixed Effects Model Estimates of δ_t

Panel A: Adult Substance Abuse Treatment Admissions



Panel B: Child Out-of-Home Placements



Note: Each graph includes 95 percent confidence intervals using standard errors clustered at the state-level.

Table 1: Mean Annual Summary Statistics: Children Age 0-17

	All Years 2006–16	Pre–Treatment 2006–10	Post–Treatment 2011–16	Difference	% Change
Total Entry Rate Per 10,000	31.89	33.05	30.91	-2.13	-6.45
Drug-Related Entry Rate Per 10,000	7.67	6.67	8.51	1.83	27.48
Drugs, Neglect, etc. Entry Rate Per 10,000	21.60	20.60	22.44	1.84	8.91
% Cared for by Grandparent	497.76	488.42	505.59	17.16	3.51
% White in Foster Care	43.05	42.99	43.11	0.11	0.27
% Black in Foster Care	26.31	28.20	24.72	-3.48	-12.35
% Hispanic in Foster Care	20.44	19.73	21.03	1.30	6.59
% Other Race in Foster Care	10.20	9.07	11.14	2.07	22.79
% Female in Foster Care	49.08	49.22	48.97	-0.25	-0.51
% White (Population)	53.75	55.78	52.05	-3.72	-6.68
% Black (Population)	13.81	14.03	13.62	-0.41	-2.95
% Hispanic (Population)	23.05	21.66	24.22	2.55	11.79
% Other Race (Population)	9.39	8.53	10.11	1.58	18.56
% Female (Population)	48.85	48.84	48.86	0.02	0.04
Unemployment Rate (Population)	5.84	5.89	5.80	-0.10	-1.65
Household Income (000's $2010)	76.82	77.36	76.37	-0.99	-1.28
Mean Parent's Age (Population)	38.54	38.31	38.73	0.42	1.10
% Less than H.S. Educ. (Population)	12.67	13.25	12.19	-1.06	-8.02
% H.S. Educ. (Population)	21.41	22.93	20.15	-2.78	-12.14
% Some College (Population)	30.03	29.88	30.16	0.29	0.96
% Bachelor or More (Population)	35.88	33.94	37.50	3.56	10.50
% Single Female Head of Household (Population)	21.45	21.27	21.60	0.34	1.58
Poverty Rate (Population)	21.10	19.88	22.13	2.25	11.30
Oxycodone Supply (kg/100,000 persons)	17.95	17.13	18.63	1.50	8.75
Total Population (10,000's)	80.14	80.40	79.93	-0.46	-0.57

Notes: Sample includes chilren less than 18. Foster care and adoption statistics were obtained from the Adoption and Foster Care Analysis and Report System (AFCARS). Population demographics were obtained from the 1-year American Community Survey (ACS). Unemployment rates were obtained from the Bureau of Labor Statistics. Oxycodone supply data was obtained from the DEA's Automated Reports and Consolidated Ordering System (ARCOS).

Table 2: Mean Annual Summary Statistics: Adults Age 25-54

	All Years 2006–16	Pre–Treatment 2006–10	Post–Treatment 2011–16	Difference	% Change
Heroin Entry Rate Per 100,000	225.30	196.58	249.34	52.76	26.84
OxyContin/Synthetic Entry Rate Per 100,000	132.14	109.98	150.69	40.71	37.02
Any Opiate Entry Rate Per 100,000	330.52	287.89	366.21	78.32	27.21
Non-Opiate Entry Rate Per 100,000	691.89	796.09	604.68	-191.41	-24.04
% White in Drug Treatment	61.47	60.09	62.63	2.54	4.22
% Black in Drug Treatment	20.91	22.88	19.26	-3.62	-15.82
% Hispanic in Drug Treatment	15.56	15.67	15.46	-0.21	-1.36
% Other Race in Drug Treatment	4.52	4.18	4.80	0.62	14.73
% Female in Drug Treatment	35.66	35.04	36.18	1.14	3.26
% Military Veteran in Drug Treatment	4.30	5.20	3.57	-1.63	-31.40
% Married in Drug Treatment	18.04	19.38	16.92	-2.45	-12.66
% Less than H.S. Educ. in Drug Treatment	31.42	32.12	30.83	-1.28	-3.99
% H.S. Educ. in Drug Treatment	44.93	44.49	45.30	0.82	1.83
% Some College in Drug Treatment	20.25	19.69	20.71	1.03	5.22
% Bachelor or More in Drug Treatment	5.75	5.46	5.99	0.53	9.71
Unemployment Rate among Drug Treatment Patients	62.11	58.69	64.98	6.29	10.72
% White (Population)	62.43	64.54	60.67	-3.88	-6.01
% Black (Population)	12.28	12.05	12.47	0.42	3.51
% Hispanic (Population)	17.09	15.92	18.08	2.16	13.56
% Other Race (Population)	8.19	7.49	8.78	1.29	17.29
% Female (Population)	50.13	50.04	50.20	0.17	0.33
% Military Veteran (Population)	5.29	5.79	4.86	-0.93	-16.05
% Married (Population)	56.44	58.36	54.83	-3.53	-6.04
% Less than H.S. Educ. (Population)	12.26	12.77	11.83	-0.94	-7.37
% H.S. Educ. (Population)	26.55	27.67	25.61	-2.06	-7.43
% Some College (Population)	30.29	30.03	30.51	0.48	1.60
% Bachelor or More (Population)	30.90	29.53	32.05	2.52	8.52
Unemployment Rate (Population)	5.87	5.85	5.88	0.04	0.61
Per Capita Income (000's $2010)	37.31	37.79	36.91	-0.88	-2.34
Poverty Rate (Population)	12.43	11.38	13.30	1.92	16.83
Oxycodone Supply (kg/100,000 persons)	18.19	17.46	18.80	1.34	7.67
Total Population (100,000's)	8.40	8.48	8.34	-0.13	-1.56

Notes: Sample includes adults age 25-54. Adult Substance Abuse Treatment Admissions were obtained from the Substance Abuse and Mental Health Services Administration's Treatment Episode Data Set Admissions (TEDS-A) dataset. Population demographics were obtained from the 1-year American Community Survey (ACS). Unemployment rates were obtained from the Bureau of Labor Statistics. Oxycodone supply data was obtained from the DEA's Automated Reports and Consolidated Ordering System (ARCOS).

Table 3: Effect of Opioid Abuse on Out-of-Home Placements

	Total Entries (1)	Drug-Related Entries (2)	Drugs, Neglect, etc. (3)	Grandchildren (4)
Panel A: Ordinary Least Squares				
$ln(Opioid\_Abuse_{ast})$	−0.116	1.266*	1.538	0.321
	(1.231)	(0.694)	(1.061)	(6.934)
R^2	0.621	0.664	0.753	0.544
Age Fixed–Effects	Yes	Yes	Yes	Yes
Year Fixed–Effects	Yes	Yes	Yes	Yes
State Fixed–Effects	Yes	Yes	Yes	Yes
Panel B: Instrumental Variables				
$ln(\widehat{Opioid\_Abuse}_{ast})$	3.268	2.401***	5.631***	9.294
	(2.277)	(0.784)	(1.430)	(11.319)
First-Stage F-Statistic	244.751	244.751	244.751	244.751
R^2	0.618	0.662	0.746	0.544
Age Fixed–Effects	Yes	Yes	Yes	Yes
Year Fixed–Effects	Yes	Yes	Yes	Yes
State Fixed–Effects	Yes	Yes	Yes	Yes
Mean of Dependent Variable	31.887	7.672	21.600	497.760
Observations	9,882	9,882	9,882	9,882

Notes: *** Denotes significance at 1%, ** at 5%, and * at 10%. Results from ordinary least squares and instrumental variable regressions with standard errors clustered at the state-level are reported in parentheses. The unit of observation are child age-state-year cells from 2006 to 2016. All estimates control for age, year, and state fixed-effects. For instrumental variables (Panel B), the first stage regression estimate the effect of Oxy-Contin's reformulation on opioid abuse rates controlling for a common linear trend, post-2010 trend break, and the following adult demographic population shares: non-Hispanic black, non-Hispanic other race and Hispanic, female, with a high school degree, some college or associates degree, bachelors degree or more, military veteran, married, and living below 100% of the poverty line. Also included are the average per capita income, unemployment rates, whether a state PDMP program was active, and the natural log of the total population. Other race non-Hispanic includes Asian, Pacific Islander, American Indian, and other racial groups as well as multi-racial individuals. Omitted categorical variables were the share of the non-Hispanic white, males, and less than high school education. The second stage and ordinary least squares regressions estimate the effect of opioid abuse on child out-of-home placements controlling for the following child demographics: share of the population non-Hispanic black, non-Hispanic other race and Hispanic, female, parent's with a high school degree, parent's with a some college or associates degree, parent's with a bachelors degree or more, living in single female households, and living below 100% of the poverty line. Also included are the average household income, mean parent's age, parent's unemployment rates, whether a state PDMP program was active, average receipt from state SNAP and TANF programs for a family of three, and the natural log of the total population. Omitted categorical variables were the share of the non-Hispanic white, males, and mother's education less than high school education.

Table 4: Effect of Heroin Abuse on Out-of-Home Placements

	Total Entries (1)	Drug-Related Entries (2)	Drugs, Neglect, etc. (3)	Grandchildren (4)
Panel A: Ordinary Least Squares				
$ln(Heroin\_Abuse_{ast})$	1.464	2.081***	2.755***	1.802
	(0.908)	(0.551)	(0.839)	(5.356)
R^2	0.623	0.672	0.757	0.543
Age Fixed–Effects	Yes	Yes	Yes	Yes
Year Fixed–Effects	Yes	Yes	Yes	Yes
State Fixed–Effects	Yes	Yes	Yes	Yes
Panel B: Instrumental Variables				
$ln(\widehat{Heroin\_Abuse}_{ast})$	3.770*	2.613***	5.831***	8.141
	(2.148)	(0.732)	(1.341)	(10.901)
First-Stage F-Statistic	223.126	223.126	223.126	223.126
R^2	0.621	0.672	0.751	0.543
Age Fixed–Effects	Yes	Yes	Yes	Yes
Year Fixed–Effects	Yes	Yes	Yes	Yes
State Fixed–Effects	Yes	Yes	Yes	Yes
Mean of Dependent Variable	31.887	7.672	21.600	497.760
Observations	9,809	9,809	9,809	9,809

Notes: *** Denotes significance at 1%, ** at 5%, and * at 10%. Results from ordinary least squares and instrumental variable regressions with standard errors clustered at the state-level are reported in parentheses. The unit of observation are child age-state-year cells from 2006 to 2016. All estimates control for age, year, and state fixed-effects. For instrumental variables (Panel B), the first stage regression estimate the effect of OxyContin's reformulation on heroin abuse rates controlling for a common linear trend, post-2010 trend break, and the following adult demographic population shares: non-Hispanic black, non-Hispanic other race and Hispanic, female, with a high school degree, some college or associates degree, bachelors degree or more, military veteran, married, and living below 100% of the poverty line. Also included are the average per capita income, unemployment rates, whether a state PDMP program was active, and the natural log of the total population. Other race non-Hispanic includes Asian, Pacific Islander, American Indian, and other racial groups as well as multi-racial individuals. Omitted categorical variables were the share of the non-Hispanic white, males, and less than high school education. The second stage and ordinary least squares regressions estimate the effect of heroin abuse on child out-of-home placements controlling for the following child demographics: share of the population non-Hispanic black, non-Hispanic other race and Hispanic, female, parent's with a high school degree, parent's with a some college or associates degree, parent's with a bachelors degree or more, living in single female households, and living below 100% of the poverty line. Also included are the average household income, mean parent's age, parent's unemployment rates, whether a state PDMP program was active, average receipt from state SNAP and TANF programs for a family of three, and the natural log of the total population. Omitted categorical variables were the share of the non-Hispanic white, males, and mother's education less than high school education.

Table 5: Effect of OxyContin Abuse on Out-of-Home Placements

	Total Entries (1)	Drug-Related Entries (2)	Drugs, Neglect, etc. (3)	Grandchildren (4)
Panel A: Ordinary Least Squares				
$ln(OxyContin\_Abuse_{ast})$	−1.785	0.060	−0.917	3.642
	(1.660)	(0.655)	(1.218)	(7.328)
R^2	0.621	0.662	0.753	0.545
Age Fixed–Effects	Yes	Yes	Yes	Yes
Year Fixed–Effects	Yes	Yes	Yes	Yes
State Fixed–Effects	Yes	Yes	Yes	Yes
Panel B: Instrumental Variables				
$ln(\widehat{OxyContin\_Abuse}_{ast})$	−0.504	0.929	2.016	0.265
	(2.002)	(0.824)	(1.253)	(10.047)
First-Stage F-Statistic	202.431	202.431	202.431	202.431
R^2	0.621	0.661	0.749	0.545
Age Fixed–Effects	Yes	Yes	Yes	Yes
Year Fixed–Effects	Yes	Yes	Yes	Yes
State Fixed–Effects	Yes	Yes	Yes	Yes
Mean of Dependent Variable	31.887	7.672	21.600	497.760
Observations	9,864	9,864	9,864	9,864

Notes: *** Denotes significance at 1%, ** at 5%, and * at 10%. Results from ordinary least squares and instrumental variable regressions with standard errors clustered at the state-level are reported in parentheses. The unit of observation are child age-state-year cells from 2006 to 2016. All estimates control for age, year, and state fixed-effects. For instrumental variables (Panel B), the first stage regression estimate the effect of OxyContin's reformulation on OxyContin abuse rates controlling for a common linear trend, post-2010 trend break, and the following adult demographic population shares: non-Hispanic black, non-Hispanic other race and Hispanic, female, with a high school degree, some college or associates degree, bachelors degree or more, military veteran, married, and living below 100% of the poverty line. Also included are the average per capita income, unemployment rates, whether a state PDMP program was active, and the natural log of the total population. Other race non-Hispanic includes Asian, Pacific Islander, American Indian, and other racial groups as well as multi-racial individuals. Omitted categorical variables were the share of the non-Hispanic white, males, and less than high school education. The second stage and ordinary least squares regressions estimate the effect of opioid abuse on child out-of-home placements controlling for the following child demographics: share of the population non-Hispanic black, non-Hispanic other race and Hispanic, female, parent's with a high school degree, parent's with a some college or associates degree, parent's with a bachelors degree or more, living in single female households, and living below 100% of the poverty line. Also included are the average household income, mean parent's age, parent's unemployment rates, whether a state PDMP program was active, average receipt from state SNAP and TANF programs for a family of three, and the natural log of the total population. Omitted categorical variables were the share of the non-Hispanic white, males, and mother's education less than high school education.

Table 6: Effect of Opioid Abuse on Out-of-Home Placements using Only Contemporaneous Oxycodone Sales

	Total Entries (1)	Drug-Related Entries (2)	Drugs, Neglect, etc. (3)	Grandchildren (4)
$ln(\widehat{Opioid\_Abuse}_{ast})$	2.985	2.281***	5.378***	7.193
	(2.277)	(0.784)	(1.430)	(11.319)
Mean of Dependent Variable	31.887	7.672	21.600	497.760
Age Fixed–Effects	Yes	Yes	Yes	Yes
Year Fixed–Effects	Yes	Yes	Yes	Yes
State Fixed–Effects	Yes	Yes	Yes	Yes
First-Stage F-Statistic	277.583	277.583	277.583	277.583
R^2	0.618	0.663	0.747	0.544
Observations	9,882	9,882	9,882	9,882

Notes: *** Denotes significance at 1%, ** at 5%, and * at 10%. Results from ordinary least squares and instrumental variable regressions with standard errors clustered at the state-level are reported in parentheses. The unit of observation are child age-state-year cells from 2006 to 2016. All estimates control for age, year, and state fixed-effects. The first stage regression estimate the effect of OxyContin's reformulation on opioid abuse rates using only contemporaneous oxycodone supply rates, and the following adult demographic population shares: non-Hispanic black, non-Hispanic other race and Hispanic, female, with a high school degree, some college or associates degree, bachelors degree or more, military veteran, married, and living below 100% of the poverty line. Also included are the average per capita income, unemployment rates, whether a state PDMP program was active, and the natural log of the total population. Other race non-Hispanic includes Asian, Pacific Islander, American Indian, and other racial groups as well as multi-racial individuals. Omitted categorical variables were the share of the non-Hispanic white, males, and less than high school education. The second stage and ordinary least squares regressions estimate the effect of opioid abuse on child out-of-home placements controlling for the following child demographics: share of the population non-Hispanic black, non-Hispanic other race and Hispanic, female, parent's with a high school degree, parent's with a some college or associates degree, parent's with a bachelors degree or more, living in single female households, and living below 100% of the poverty line. Also included are the average household income, mean parent's age, parent's unemployment rates, whether a state PDMP program was active, average receipt from state SNAP and TANF programs for a family of three, and the natural log of the total population. Omitted categorical variables were the share of the non-Hispanic white, males, and mother's education less than high school education.

Table 7: Effect of Oxycontin's Reformulation on Adults

	Heroin (1)	OxyContin Synthetic (2)	Any Opiate (3)	Not Opiate (4)
Panel A: Baseline Model				
$Post \times ln(Oxy\_Supply_s^{2010})$	0.291*	0.061	0.215	0.008
	(0.174)	(0.063)	(0.135)	(0.135)
Age Fixed–Effects	Yes	Yes	Yes	Yes
Year Fixed–Effects	Yes	Yes	Yes	Yes
State Fixed–Effects	Yes	Yes	Yes	Yes
Panel B: Controlling for Linear Trends				
$Post \times ln(Oxy\_Supply_s^{2010})$	0.158*	0.086**	0.133**	0.074
	(0.087)	(0.042)	(0.062)	(0.047)
$Post \times (t-2011) \times ln(Oxy\_Supply_s^{2010})$	0.078*	−0.115	−0.021	−0.041
	(0.047)	(0.074)	(0.072)	(0.046)
F-statistic: $\delta_2 = \delta_3 = 0$	1.399	1.627	0.892	0.428
Pr(>F)	0.247	0.197	0.410	0.652
Age Fixed–Effects	Yes	Yes	Yes	Yes
Year Fixed–Effects	Yes	Yes	Yes	Yes
State Fixed–Effects	Yes	Yes	Yes	Yes
Linear Trends	Yes	Yes	Yes	Yes
Mean of Dependent Variable	225.298	132.138	330.524	691.891
Observations	1,647	1,647	1,647	1,647

Notes: *** Denotes significance at 1%, ** at 5%, and * at 10%. Results from Quasi-Poisson regressions with standard errors clustered at the state-level are reported in parentheses. The unit of observation are adult age-state-year cells from fiscal year 2006 to 2016. Panel A estimates the effect of OxyContin's reformulation on adult drug abuse rates as an averaged effect over the post-reformulation period. Panel B shows estimates when also controlling for a common linear trend, post-2010 trend break. All estimates control for age, year, and state fixed-effects and the following adult demographic population shares: non-Hispanic black, non-Hispanic other race and Hispanic, female, with a high school degree, some college or associates degree, bachelors degree or more, military veteran, married, and living below 100% of the poverty line. Also included are the average per capita income, unemployment rates, whether a state PDMP program was active, and the natural log of the total population. Other race non-Hispanic includes Asian, Pacific Islander, American Indian, and other racial groups as well as multi-racial individuals. Omitted categorical variables were the share of the non-Hispanic white, males, and less than high school education.

Table 8: Effect of Oxycontin's Reformulation on Children

	Total Entries (1)	Drug-Related Entries (2)	Drugs, Neglect, etc. (3)	Grandchildren (4)
Panel A: Baseline Model				
$Post \times ln(Oxy\_Supply_s^{2010})$	−0.017	−0.075	−0.021	0.007
	(0.047)	(0.075)	(0.030)	(0.030)
Age Fixed–Effects	Yes	Yes	Yes	Yes
Year Fixed–Effects	Yes	Yes	Yes	Yes
State Fixed–Effects	Yes	Yes	Yes	Yes
Panel B: Controlling for Linear Trends				
$Post \times ln(Oxy\_Supply_s^{2010})$	0.043	−0.085	0.028	−0.009
	(0.069)	(0.099)	(0.070)	(0.016)
$Post \times (t-2011) \times ln(Oxy\_Supply_s^{2010})$	0.027**	−0.014	0.042*	0.005
	(0.013)	(0.039)	(0.024)	(0.005)
F-statistic: $\delta_2 = \delta_3 = 0$	2.142	0.078	2.743	0.463
Pr(>F)	0.118	0.925	0.064	0.630
Age Fixed–Effects	Yes	Yes	Yes	Yes
Year Fixed–Effects	Yes	Yes	Yes	Yes
State Fixed–Effects	Yes	Yes	Yes	Yes
Linear Trends	Yes	Yes	Yes	Yes
Mean of Dependent Variable	31.887	7.672	21.600	497.760
Observations	10,098	10,098	10,098	10,098

Notes: *** Denotes significance at 1%, ** at 5%, and * at 10%. Results from Quasi-Poisson regressions with standard errors clustered at the state-level are reported in parentheses. The unit of observation are child age-state-year cells from fiscal year 2006 to 2016. Panel A estimates the effect of OxyContin's reformulation on child out-of-home placement rates as an averaged effect over the post-reformulation period. Panel B shows estimates when also controlling for a common linear trend, post-2010 trend break. All estimates control for age, year, and state fixed-effects and the following child demographic population shares: non-Hispanic black, non-Hispanic other race and Hispanic, female, parent's with a high school degree, parent's with a some college or associates degree, parent's with a bachelors degree or more, living in single female households, and living below 100% of the poverty line. Also included are the average household income, mean parent's age, parent's unemployment rates, whether a state PDMP program was active, average receipt from state SNAP and TANF programs for a family of three, and the natural log of the total population. Omitted categorical variables were the share of the non-Hispanic white, males, and mother's education less than high school education.

Table 9: Effect of Oxycontin's Reformulation on Adults using Fixed Effects

	Heroin (1)	OxyContin Synthetic (2)	Any Opiate (3)	Not Opiate (4)
$\mathbb{1}_{2006} \times ln(Oxy\_Supply_s^{2010})$	0.036	−0.137	−0.068	−0.072
	(0.062)	(0.103)	(0.085)	(0.085)
$\mathbb{1}_{2007} \times ln(Oxy\_Supply_s^{2010})$	0.075	−0.138	−0.016	−0.032
	(0.061)	(0.096)	(0.077)	(0.077)
$\mathbb{1}_{2008} \times ln(Oxy\_Supply_s^{2010})$	0.034	−0.036	−0.007	0.018
	(0.054)	(0.046)	(0.048)	(0.048)
$\mathbb{1}_{2010} \times ln(Oxy\_Supply_s^{2010})$	0.017	0.034	0.050	−0.067*
	(0.045)	(0.042)	(0.035)	(0.035)
$\mathbb{1}_{2011} \times ln(Oxy\_Supply_s^{2010})$	0.123**	0.268***	0.245**	0.112
	(0.058)	(0.088)	(0.102)	(0.102)
$\mathbb{1}_{2012} \times ln(Oxy\_Supply_s^{2010})$	0.273**	0.056	0.204*	0.008
	(0.135)	(0.053)	(0.112)	(0.112)
$\mathbb{1}_{2013} \times ln(Oxy\_Supply_s^{2010})$	0.339**	−0.000	0.205	−0.028
	(0.164)	(0.087)	(0.143)	(0.143)
$\mathbb{1}_{2014} \times ln(Oxy\_Supply_s^{2010})$	0.235	−0.139	0.080	−0.128
	(0.223)	(0.135)	(0.189)	(0.189)
$\mathbb{1}_{2015} \times ln(Oxy\_Supply_s^{2010})$	0.497**	−0.096	0.258	−0.082
	(0.231)	(0.185)	(0.220)	(0.220)
$\mathbb{1}_{2016} \times ln(Oxy\_Supply_s^{2010})$	0.477*	−0.093	0.250	−0.061
	(0.254)	(0.205)	(0.237)	(0.237)
Mean of Dependent Variable	225.298	132.138	330.524	691.891
Age Fixed–Effects	Yes	Yes	Yes	Yes
Year Fixed–Effects	Yes	Yes	Yes	Yes
State Fixed–Effects	Yes	Yes	Yes	Yes
Observations	1,647	1,647	1,647	1,647

Notes: *** Denotes significance at 1%, ** at 5%, and * at 10%. Results from Quasi-Poisson regressions with standard errors clustered at the state-level are reported in parentheses. The unit of observation are adult age-state-year cells from fiscal year 2006 to 2016. All estimates control for age, year, and state fixed-effects and the following demographic population shares: non-Hispanic black, non-Hispanic other race and Hispanic, female, with a high school degree, some college or associates degree, bachelors degree or more, military veteran, married, and living below 100% of the poverty line. Also included are the average per capita income, unemployment rates, whether a state PDMP program was active, and the natural log of the total population. Other race non-Hispanic includes Asian, Pacific Islander, American Indian, and other racial groups as well as multi-racial individuals. Omitted categorical variables were the share of the non-Hispanic white, males, and less than high school education.

Table 10: Effect of Oxycontin's Reformulation on Children using Fixed Effects

	Total Entries (1)	Drug-Related Entries (2)	Drugs, Neglect, etc. (3)	Grandchildren (4)
$\mathbb{1}_{2006} \times ln(Oxy\_Supply_s^{2010})$	0.073	−0.037	0.085	−0.007
	(0.064)	(0.119)	(0.092)	(0.092)
$\mathbb{1}_{2007} \times ln(Oxy\_Supply_s^{2010})$	0.043	−0.056	0.043	0.037
	(0.039)	(0.064)	(0.055)	(0.055)
$\mathbb{1}_{2008} \times ln(Oxy\_Supply_s^{2010})$	0.056	0.036	0.064**	0.026
	(0.038)	(0.034)	(0.027)	(0.027)
$\mathbb{1}_{2010} \times ln(Oxy\_Supply_s^{2010})$	−0.021	−0.021	−0.034	0.019
	(0.050)	(0.076)	(0.050)	(0.050)
$\mathbb{1}_{2011} \times ln(Oxy\_Supply_s^{2010})$	0.008	−0.080	−0.030	−0.003
	(0.075)	(0.052)	(0.067)	(0.067)
$\mathbb{1}_{2012} \times ln(Oxy\_Supply_s^{2010})$	0.023	−0.033	0.012	0.027
	(0.071)	(0.048)	(0.061)	(0.061)
$\mathbb{1}_{2013} \times ln(Oxy\_Supply_s^{2010})$	−0.014	−0.139	−0.028	0.023
	(0.068)	(0.085)	(0.045)	(0.045)
$\mathbb{1}_{2014} \times ln(Oxy\_Supply_s^{2010})$	0.004	−0.133	0.014	0.041
	(0.068)	(0.096)	(0.051)	(0.051)
$\mathbb{1}_{2015} \times ln(Oxy\_Supply_s^{2010})$	0.039	−0.056	0.059	0.011
	(0.073)	(0.095)	(0.055)	(0.055)
$\mathbb{1}_{2016} \times ln(Oxy\_Supply_s^{2010})$	0.022	−0.110	0.031	0.044
	(0.081)	(0.094)	(0.064)	(0.064)
Mean of Dependent Variable	31.887	7.672	21.600	497.760
Age Fixed–Effects	Yes	Yes	Yes	Yes
Year Fixed–Effects	Yes	Yes	Yes	Yes
State Fixed–Effects	Yes	Yes	Yes	Yes
Observations	10,098	10,098	10,098	10,098

Notes: *** Denotes significance at 1%, ** at 5%, and * at 10%. Results from Quasi-Poisson regressions with standard errors clustered at the state-level are reported in parentheses. The unit of observation are child age-state-year cells from fiscal year 2006 to 2016. All estimates control for age, year, and state fixed-effects and the following demographic population shares: non-Hispanic black, non-Hispanic other race and Hispanic, female, parent's with a high school degree, parent's with a some college or associates degree, parent's with a bachelors degree or more, living in single female households, and living below 100% of the poverty line. Also included are the average household income, mean parent's age, parent's unemployment rates, whether a state PDMP program was active, average receipt from state SNAP and TANF programs for a family of three, and the natural log of the total population. Omitted categorical variables were the share of the non-Hispanic white, males, and mother's education less than high school education.

Table 11: Effect of Drug Abuse on Child Lifetime Foster Care Experiences

	(1)	(2)	(3)
Panel A: Effect on Total Length of Stay (OLS)			
Drug Abuse	0.662	1.358**	1.953***
	(0.737)	(0.412)	(0.373)
Demographic Controls	Yes	Yes	Yes
State Fixed-Effects		Yes	Yes
Year Fixed-Effects			Yes
Observations	2,604,836	2,604,836	2604,836
Panel B: Effect on Likelihood of Foster Care Recidivism (Logit)			
Drug Abuse	1.229**	1.311***	1.427***
	(0.0913)	(0.0386)	(0.0422)
Demographic Controls	Yes	Yes	Yes
State Fixed-Effects		Yes	Yes
Year Fixed-Effects			Yes
Observations	2,662,332	2,662,332	2,662,332

Notes: *** Denotes significance at 1%, ** at 5%, and * at 10%. Results from regressions with standard errors clustered at the state-level are reported in parentheses. The unit of observation are children who entered foster care from fiscal year 2006 to 2016. All estimates control for age of first entry, year, and state fixed-effects, the following demographics: sex, race. Omitted categorical variables were non-Hispanic white, and males.

Table 12: Linear Additive Effect of the Reformulation on Adults

	Heroin (1)	OxyContin Synthetic (2)	Any Opiate (3)	Not Opiate (4)
$\mathbb{1}_{2011} \times ln(Oxy\_Supply_s^{2010})$	0.125*	0.180***	0.178**	0.126**
	(0.071)	(0.069)	(0.081)	(0.062)
$\mathbb{1}_{2012} \times ln(Oxy\_Supply_s^{2010})$	0.162	−0.260*	−0.065	−0.110
	(0.104)	(0.136)	(0.172)	(0.122)
$\mathbb{1}_{2013} \times ln(Oxy\_Supply_s^{2010})$	0.078*	−0.103	−0.024	−0.041
	(0.042)	(0.064)	(0.065)	(0.034)
$\mathbb{1}_{2014} \times ln(Oxy\_Supply_s^{2010})$	−0.092	−0.187**	−0.150*	−0.105**
	(0.091)	(0.077)	(0.078)	(0.048)
$\mathbb{1}_{2015} \times ln(Oxy\_Supply_s^{2010})$	0.273	−0.004	0.153	0.040
	(0.185)	(0.119)	(0.162)	(0.057)
$\mathbb{1}_{2016} \times ln(Oxy\_Supply_s^{2010})$	−0.008	−0.045	−0.033	0.016
	(0.088)	(0.055)	(0.064)	(0.051)
Mean of Dependent Variable	225.298	132.138	330.524	691.891
Age Fixed–Effects	Yes	Yes	Yes	Yes
Year Fixed–Effects	Yes	Yes	Yes	Yes
State Fixed–Effects	Yes	Yes	Yes	Yes
Linear Trends	Yes	Yes	Yes	Yes
F-statistic	2.094	2.232	1.419	2.535
Pr(>F)	0.079	0.063	0.225	0.039
Observations	1,647	1,647	1,647	1,647

Notes: *** Denotes significance at 1%, ** at 5%, and * at 10%. Results from Quasi-Poisson regressions with standard errors clustered at the state-level are reported in parentheses. The unit of observation are adult age-state-year cells from fiscal year 2006 to 2016. All estimates control for age, year, and state fixed-effects, a common linear trend, post-2010 trend break, and the following demographic population shares: non-Hispanic black, non-Hispanic other race and Hispanic, female, with a high school degree, some college or associates degree, bachelors degree or more, military veteran, married, and living below 100% of the poverty line. Also included are the average per capita income, unemployment rates, whether a state PDMP program was active, and the natural log of the total population. Other race non-Hispanic includes Asian, Pacific Islander, American Indian, and other racial groups as well as multi-racial individuals. Omitted categorical variables were the share of the non-Hispanic white, males, and less than high school education.

Table 13: Linear Additive Effects of the Reformulation on Children

	Total Entries (1)	Drug-Related Entries (2)	Drugs, Neglect, etc. (3)	Grandchildren (4)
$\mathbb{1}_{2011} \times ln(Oxy\_Supply_s^{2010})$	0.047	−0.087	0.023	−0.021
	(0.077)	(0.103)	(0.083)	(0.018)
$\mathbb{1}_{2012} \times ln(Oxy\_Supply_s^{2010})$	0.038**	0.038	0.070***	0.029
	(0.019)	(0.044)	(0.024)	(0.019)
$\mathbb{1}_{2013} \times ln(Oxy\_Supply_s^{2010})$	−0.013	−0.114	−0.012	−0.005
	(0.013)	(0.073)	(0.020)	(0.020)
$\mathbb{1}_{2014} \times ln(Oxy\_Supply_s^{2010})$	0.041*	−0.002	0.071	0.017
	(0.024)	(0.030)	(0.043)	(0.024)
$\mathbb{1}_{2015} \times ln(Oxy\_Supply_s^{2010})$	0.057**	0.069*	0.073**	−0.032*
	(0.027)	(0.039)	(0.030)	(0.017)
$\mathbb{1}_{2016} \times ln(Oxy\_Supply_s^{2010})$	0.006	−0.062	0.000	0.033*
	(0.023)	(0.068)	(0.036)	(0.017)
Mean of Dependent Variable	31.887	7.672	21.600	497.760
Age Fixed–Effects	Yes	Yes	Yes	Yes
Year Fixed–Effects	Yes	Yes	Yes	Yes
State Fixed–Effects	Yes	Yes	Yes	Yes
Linear Trends	Yes	Yes	Yes	Yes
F-statistic	4.169	3.492	4.505	1.817
Pr(>F)	0.002	0.007	0.001	0.123
Observations	10,098	10,098	10,098	10,098

Notes: *** Denotes significance at 1%, ** at 5%, and * at 10%. Results from Quasi-Poisson regressions with standard errors clustered at the state-level are reported in parentheses. The unit of observation are adult age-state-year cells from fiscal year 2006 to 2016. All estimates control for age, year, and state fixed-effects, a common linear trend, post-2010 trend break, and the following demographic population shares: non-Hispanic black, non-Hispanic other race and Hispanic, female, parent's with a high school degree, parent's with a some college or associates degree, parent's with a bachelors degree or more, living in single female households, and living below 100% of the poverty line. Also included are the average household income, mean parent's age, parent's unemployment rates, whether a state PDMP program was active, average receipt from state SNAP and TANF programs for a family of three, and the natural log of the total population. Omitted categorical variables were the share of the non-Hispanic white, males, and mother's education less than high school education.

Figure 6: National Opioid Prescription Rates, 2010

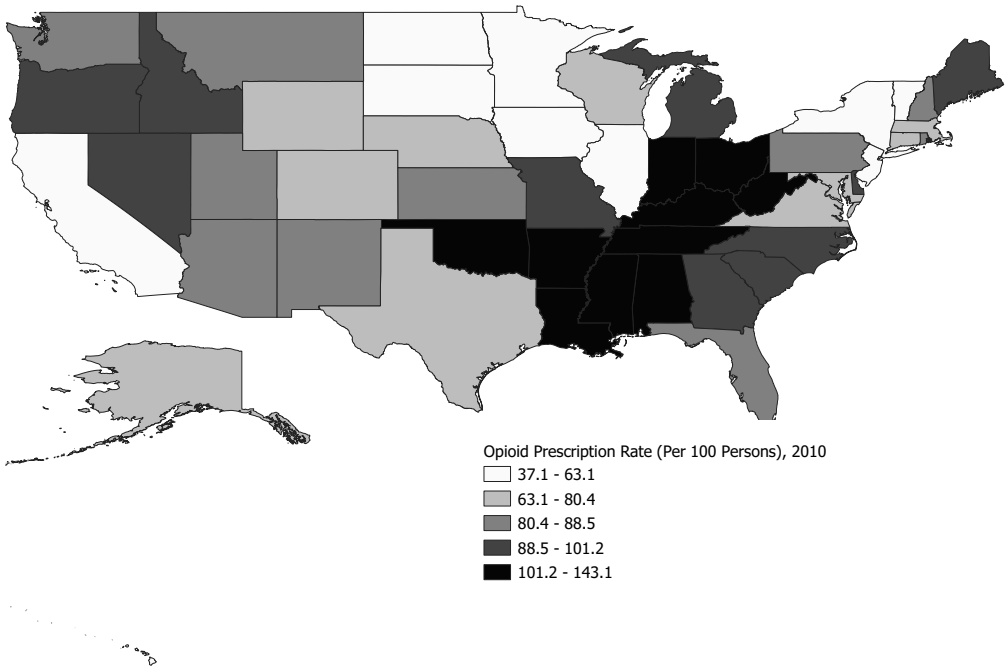
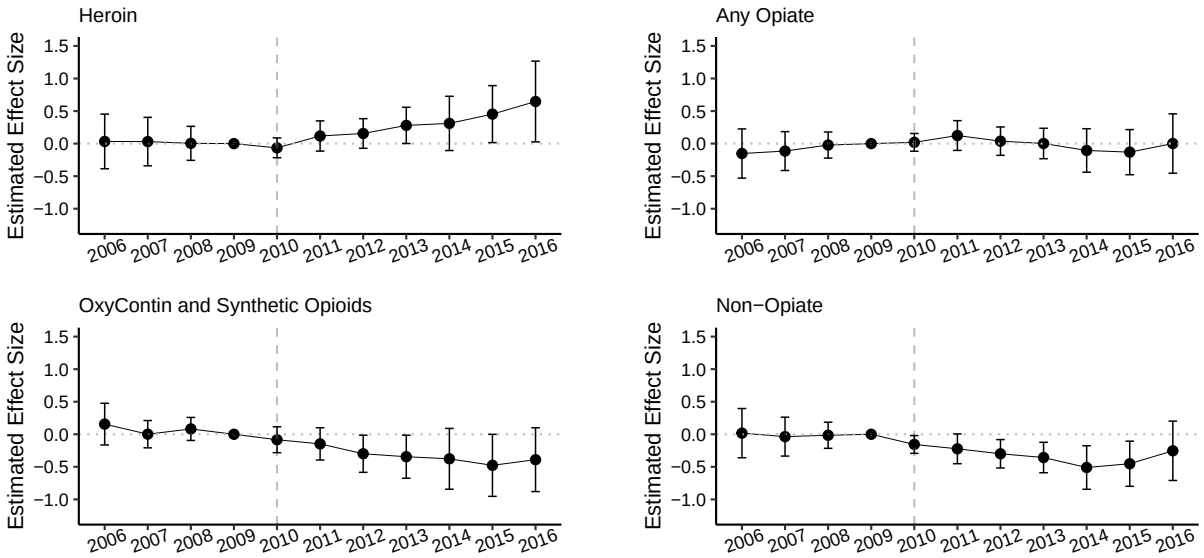
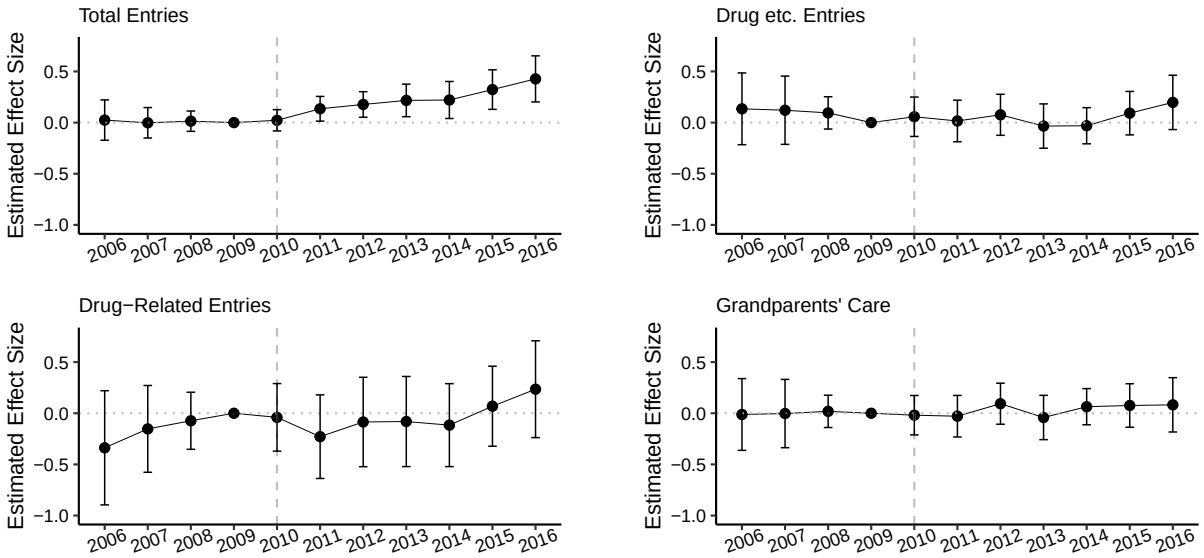


Figure 7: Fixed Effects Model Estimates of δ_t using Prescription Rates

Panel A: Adult Substance Abuse Treatment Admissions



Panel B: Child Out-of-Home Placements



Note: Each graph includes 95 percent confidence intervals using standard errors clustered at the state-level.

Table 14: Effect of Opioid Abuse on Out-of-Home Placements using Prescription Rates

	Total Entries (1)	Drug-Related Entries (2)	Drugs, Neglect, etc. (3)	Grandchildren (4)
Panel A: Ordinary Least Squares				
$ln(Opioid\_Abuse_{ast})$	−0.116	1.266*	1.538	0.321
	(1.231)	(0.694)	(1.061)	(6.934)
R^2	0.621	0.664	0.753	0.544
Age Fixed–Effects	Yes	Yes	Yes	Yes
Year Fixed–Effects	Yes	Yes	Yes	Yes
State Fixed–Effects	Yes	Yes	Yes	Yes
Panel B: Instrumental Variables				
$ln(\widehat{Opioid\_Abuse}_{ast})$	0.494	1.362**	3.710***	3.951
	(1.753)	(0.672)	(1.027)	(9.723)
First-Stage F-Statistic	273.707	273.707	273.707	273.707
R^2	0.620	0.664	0.751	0.544
Age Fixed–Effects	Yes	Yes	Yes	Yes
Year Fixed–Effects	Yes	Yes	Yes	Yes
State Fixed–Effects	Yes	Yes	Yes	Yes
Mean of Dependent Variable	31.887	7.672	21.600	497.760
Observations	9,882	9,882	9,882	9,882

Notes: *** Denotes significance at 1%, ** at 5%, and * at 10%. Results from ordinary least squares and instrumental variable regressions with standard errors clustered at the state-level are reported in parentheses. The unit of observation are child age-state-year cells from 2006 to 2016. All estimates control for age, year, and state fixed-effects. For instrumental variables (Panel B), the first stage regression estimate the effect of OxyContin's reformulation on opioid abuse rates controlling for a common linear trend, post-2010 trend break, and the following adult demographic population shares: non-Hispanic black, non-Hispanic other race and Hispanic, female, with a high school degree, some college or associates degree, bachelors degree or more, military veteran, married, and living below 100% of the poverty line. Also included are the average per capita income, unemployment rates, whether a state PDMP program was active, and the natural log of the total population. Other race non-Hispanic includes Asian, Pacific Islander, American Indian, and other racial groups as well as multi-racial individuals. Omitted categorical variables were the share of the non-Hispanic white, males, and less than high school education. The second stage and ordinary least squares regressions estimate the effect of opioid abuse on child out-of-home placements controlling for the following child demographics: share of the population non-Hispanic black, non-Hispanic other race and Hispanic, female, parent's with a high school degree, parent's with a some college or associates degree, parent's with a bachelors degree or more, living in single female households, and living below 100% of the poverty line. Also included are the average household income, mean parent's age, parent's unemployment rates, whether a state PDMP program was active, average receipt from state SNAP and TANF programs for a family of three, and the natural log of the total population. Omitted categorical variables were the share of the non-Hispanic white, males, and mother's education less than high school education.

Table 15: Effect of Opioid Abuse on Out-of-Home Placements using Only Contemporary Opioid Prescription Rates

	Total Entries (1)	Drug-Related Entries (2)	Drugs, Neglect, etc. (3)	Grandchildren (4)
$ln(\widehat{Opioid\_Abuse}_{ast})$	3.143*	2.461***	5.572***	8.570
	(1.753)	(0.672)	(1.027)	(9.723)
Mean of Dependent Variable	31.887	7.672	21.600	497.760
Age Fixed–Effects	Yes	Yes	Yes	Yes
Year Fixed–Effects	Yes	Yes	Yes	Yes
State Fixed–Effects	Yes	Yes	Yes	Yes
First-Stage F-Statistic	275.673	275.673	275.673	275.673
R^2	0.618	0.662	0.746	0.544
Observations	9,882	9,882	9,882	9,882

Notes: *** Denotes significance at 1%, ** at 5%, and * at 10%. Results from ordinary least squares and instrumental variable regressions with standard errors clustered at the state-level are reported in parentheses. The unit of observation are child age-state-year cells from 2006 to 2016. All estimates control for age, year, and state fixed-effects. The first stage regression estimate the effect of OxyContin's reformulation on opioid abuse rates using only contemporaneous opioid prescription rates, and the following adult demographic population shares: non-Hispanic black, non-Hispanic other race and Hispanic, female, with a high school degree, some college or associates degree, bachelors degree or more, military veteran, married, and living below 100% of the poverty line. Also included are the average per capita income, unemployment rates, whether a state PDMP program was active, and the natural log of the total population. Other race non-Hispanic includes Asian, Pacific Islander, American Indian, and other racial groups as well as multi-racial individuals. Omitted categorical variables were the share of the non-Hispanic white, males, and less than high school education. The second stage and ordinary least squares regressions estimate the effect of opioid abuse on child out-of-home placements controlling for the following child demographics: share of the population non-Hispanic black, non-Hispanic other race and Hispanic, female, parent's with a high school degree, parent's with a some college or associates degree, parent's with a bachelors degree or more, living in single female households, and living below 100% of the poverty line. Also included are the average household income, mean parent's age, parent's unemployment rates, whether a state PDMP program was active, average receipt from state SNAP and TANF programs for a family of three, and the natural log of the total population. Omitted categorical variables were the share of the non-Hispanic white, males, and mother's education less than high school education.

Table 16: Effect of Oxycontin's Reformulation on Adults (Opioid Prescription Rates)

	Heroin (1)	OxyContin Synthetic (2)	Any Opiate (3)	Not Opiate (4)
Panel A: Baseline Model				
$Post \times ln(Prescribe_s^{2010})$	0.352*	−0.344**	0.035	−0.299**
	(0.182)	(0.163)	(0.122)	(0.122)
Age Fixed–Effects	Yes	Yes	Yes	Yes
Year Fixed–Effects	Yes	Yes	Yes	Yes
State Fixed–Effects	Yes	Yes	Yes	Yes
Panel B: Controlling for Linear Trends				
$Post \times ln(Prescribe_s^{2010})$	0.135	−0.093	−0.006	−0.155
	(0.148)	(0.104)	(0.133)	(0.117)
$Post \times (t-2011) \times ln(Prescribe_s^{2010})$	0.128*	−0.002	−0.078	0.006
	(0.073)	(0.061)	(0.075)	(0.065)
Age Fixed–Effects	Yes	Yes	Yes	Yes
Year Fixed–Effects	Yes	Yes	Yes	Yes
State Fixed–Effects	Yes	Yes	Yes	Yes
Linear Trends	Yes	Yes	Yes	Yes
Mean of Dependent Variable	31.887	7.672	21.600	497.760
Observations	1,647	1,647	1,647	1,647

Notes: *** Denotes significance at 1%, ** at 5%, and * at 10%. Results from Quasi-Poisson regressions with standard errors clustered at the state-level are reported in parentheses. The unit of observation are adult age-state-year cells from fiscal year 2006 to 2016. Panel A estimates the effect of OxyContin's reformulation on adult drug abuse rates as an averaged effect over the post-reformulation period. Panel B shows estimates when also controlling for a common linear trend, post-2010 trend break. All estimates control for age, year, and state fixed-effects and the following adult demographic population shares: non-Hispanic black, non-Hispanic other race and Hispanic, female, with a high school degree, some college or associates degree, bachelors degree or more, military veteran, married, and living below 100% of the poverty line. Also included are the average per capita income, unemployment rates, whether a state PDMP program was active, and the natural log of the total population. Other race non-Hispanic includes Asian, Pacific Islander, American Indian, and other racial groups as well as multi-racial individuals. Omitted categorical variables were the share of the non-Hispanic white, males, and less than high school education.

Table 17: Effect of Oxycontin's Reformulation on Adults using Fixed Effects (Opioid Prescription Rates)

	Heroin (1)	OxyContin Synthetic (2)	Any Opiate (3)	Not Opiate (4)
$\mathbb{1}_{2006} \times ln(Prescribe_s^{2010})$	0.033	0.156	−0.152	0.018
	(0.214)	(0.163)	(0.193)	(0.193)
$\mathbb{1}_{2007} \times ln(Prescribe_s^{2010})$	0.031	0.001	−0.114	−0.036
	(0.190)	(0.107)	(0.152)	(0.152)
$\mathbb{1}_{2008} \times ln(Prescribe_s^{2010})$	0.004	0.082	−0.022	−0.015
	(0.133)	(0.090)	(0.102)	(0.102)
$\mathbb{1}_{2010} \times ln(Prescribe_s^{2010})$	−0.065	−0.084	0.019	−0.156**
	(0.077)	(0.102)	(0.070)	(0.070)
$\mathbb{1}_{2011} \times ln(Prescribe_s^{2010})$	0.117	−0.148	0.124	−0.223*
	(0.118)	(0.127)	(0.117)	(0.117)
$\mathbb{1}_{2012} \times ln(Prescribe_s^{2010})$	0.156	−0.299**	0.038	−0.300***
	(0.116)	(0.146)	(0.111)	(0.111)
$\mathbb{1}_{2013} \times ln(Prescribe_s^{2010})$	0.280**	−0.345**	0.002	−0.357***
	(0.142)	(0.169)	(0.119)	(0.119)
$\mathbb{1}_{2014} \times ln(Prescribe_s^{2010})$	0.311	−0.377	−0.105	−0.510***
	(0.213)	(0.238)	(0.171)	(0.171)
$\mathbb{1}_{2015} \times ln(Prescribe_s^{2010})$	0.453**	−0.477**	−0.131	−0.453**
	(0.223)	(0.243)	(0.177)	(0.177)
$\mathbb{1}_{2016} \times ln(Prescribe_s^{2010})$	0.647**	−0.390	0.001	−0.254
	(0.316)	(0.250)	(0.233)	(0.233)
Mean of Dependent Variable	31.887	7.672	21.600	497.760
Age Fixed–Effects	Yes	Yes	Yes	Yes
Year Fixed–Effects	Yes	Yes	Yes	Yes
State Fixed–Effects	Yes	Yes	Yes	Yes
Observations	1,647	1,647	1,647	1,647

Notes: *** Denotes significance at 1%, ** at 5%, and * at 10%. Results from Quasi-Poisson regressions with standard errors clustered at the state-level are reported in parentheses. The unit of observation are adult age-state-year cells from fiscal year 2006 to 2016. All estimates control for age, year, and state fixed-effects and the following demographic population shares: non-Hispanic black, non-Hispanic other race and Hispanic, female, with a high school degree, some college or associates degree, bachelors degree or more, military veteran, married, and living below 100% of the poverty line. Also included are the average per capita income, unemployment rates, whether a state PDMP program was active, and the natural log of the total population. Other race non-Hispanic includes Asian, Pacific Islander, American Indian, and other racial groups as well as multi-racial individuals. Omitted categorical variables were the share of the non-Hispanic white, males, and less than high school education.

Table 18: Effect of Oxycontin's Reformulation on Children (Opioid Prescription Rates)

	Total Entries (1)	Drug-Related Entries (2)	Drugs, Neglect, etc. (3)	Grandchildren (4)
Panel A: Baseline Model				
$Post \times ln(Prescribe_s^{2010})$	0.230***	0.091	−0.036	0.039
	(0.048)	(0.212)	(0.097)	(0.097)
Age Fixed–Effects	Yes	Yes	Yes	Yes
Year Fixed–Effects	Yes	Yes	Yes	Yes
State Fixed–Effects	Yes	Yes	Yes	Yes
Panel B: Controlling for Linear Trends				
$Post \times ln(Prescribe_s^{2010})$	0.102	−0.331	−0.023	0.005
	(0.090)	(0.229)	(0.121)	(0.046)
$Post \times (t-2011) \times ln(Prescribe_s^{2010})$	0.055	0.007	0.056	0.019
	(0.034)	(0.091)	(0.043)	(0.022)
Age Fixed–Effects	Yes	Yes	Yes	Yes
Year Fixed–Effects	Yes	Yes	Yes	Yes
State Fixed–Effects	Yes	Yes	Yes	Yes
Linear Trends	Yes	Yes	Yes	Yes
Mean of Dependent Variable	31.887	7.672	21.600	497.760
Observations	10,098	10,098	10,098	10,098

Notes: *** Denotes significance at 1%, ** at 5%, and * at 10%. Results from Quasi-Poisson regressions with standard errors clustered at the state-level are reported in parentheses. The unit of observation are child age-state-year cells from fiscal year 2006 to 2016. Panel A estimates the effect of OxyContin's reformulation on child out-of-home placement rates as an averaged effect over the post-reformulation period. Panel B shows estimates when also controlling for a common linear trend, post-2010 trend break. All estimates control for age, year, and state fixed-effects and the following child demographic population shares: non-Hispanic black, non-Hispanic other race and Hispanic, female, parent's with a high school degree, parent's with a some college or associates degree, parent's with a bachelors degree or more, living in single female households, and living below 100% of the poverty line. Also included are the average household income, mean parent's age, parent's unemployment rates, whether a state PDMP program was active, average receipt from state SNAP and TANF programs for a family of three, and the natural log of the total population. Omitted categorical variables were the share of the non-Hispanic white, males, and mother's education less than high school education.

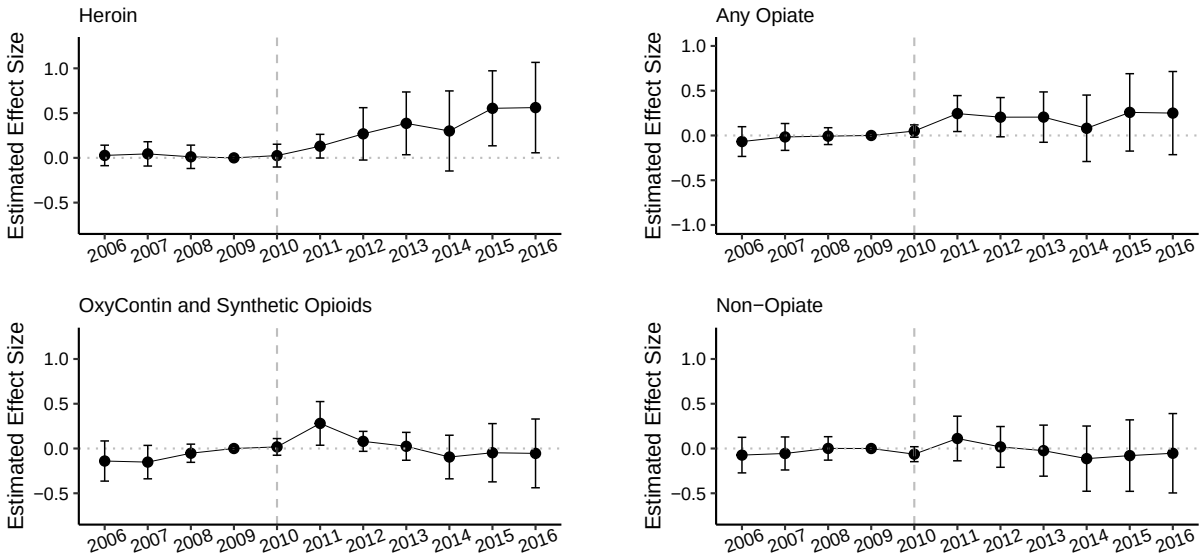
Table 19: Effect of Oxycontin's Reformulation on Children using Fixed Effects (Opioid Prescription Rates)

	Total Entries (1)	Drug-Related Entries (2)	Drugs, Neglect, etc. (3)	Grandchildren (4)
$\mathbb{1}_{2006} \times ln(Prescribe_s^{2010})$	0.025	−0.338	0.135	−0.012
	(0.101)	(0.285)	(0.179)	(0.179)
$\mathbb{1}_{2007} \times ln(Prescribe_s^{2010})$	−0.002	−0.153	0.121	−0.003
	(0.076)	(0.216)	(0.170)	(0.170)
$\mathbb{1}_{2008} \times ln(Prescribe_s^{2010})$	0.014	−0.073	0.095	0.019
	(0.051)	(0.142)	(0.081)	(0.081)
$\mathbb{1}_{2010} \times ln(Prescribe_s^{2010})$	0.022	−0.040	0.057	−0.019
	(0.053)	(0.169)	(0.098)	(0.098)
$\mathbb{1}_{2011} \times ln(Prescribe_s^{2010})$	0.135**	−0.229	0.016	−0.029
	(0.062)	(0.208)	(0.104)	(0.104)
$\mathbb{1}_{2012} \times ln(Prescribe_s^{2010})$	0.177***	−0.085	0.076	0.093
	(0.064)	(0.223)	(0.102)	(0.102)
$\mathbb{1}_{2013} \times ln(Prescribe_s^{2010})$	0.217***	−0.081	−0.034	−0.041
	(0.081)	(0.225)	(0.110)	(0.110)
$\mathbb{1}_{2014} \times ln(Prescribe_s^{2010})$	0.221**	−0.116	−0.031	0.064
	(0.092)	(0.207)	(0.090)	(0.090)
$\mathbb{1}_{2015} \times ln(Prescribe_s^{2010})$	0.323***	0.069	0.092	0.076
	(0.099)	(0.200)	(0.108)	(0.108)
$\mathbb{1}_{2016} \times ln(Prescribe_s^{2010})$	0.427***	0.235	0.198	0.082
	(0.115)	(0.241)	(0.135)	(0.135)
Mean of Dependent Variable	31.887	7.672	21.600	497.760
Age Fixed–Effects	Yes	Yes	Yes	Yes
Year Fixed–Effects	Yes	Yes	Yes	Yes
State Fixed–Effects	Yes	Yes	Yes	Yes
Observations	10,098	10,098	10,098	10,098

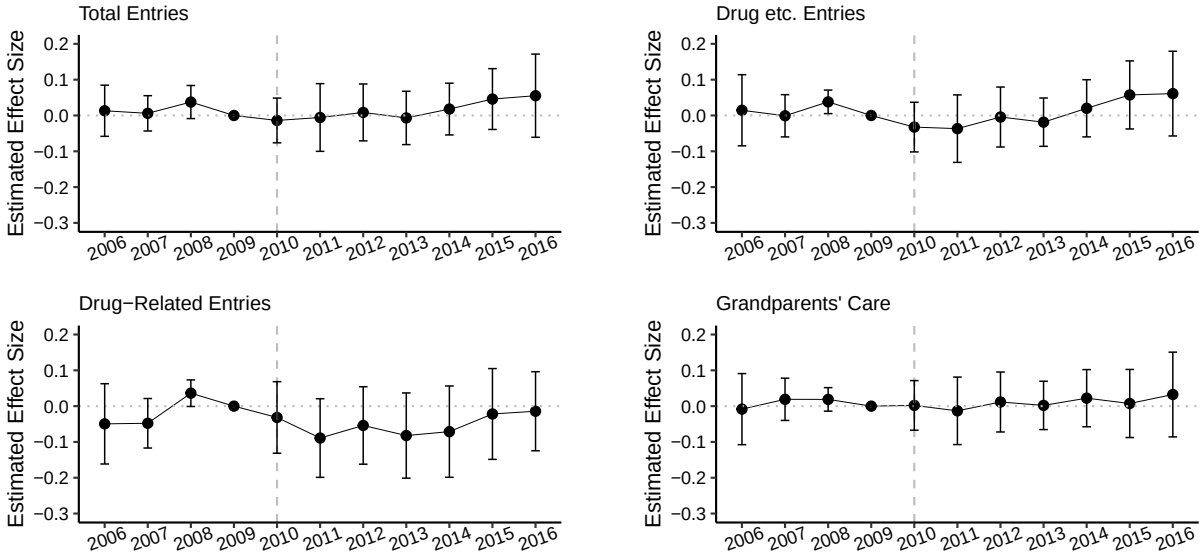
Notes: *** Denotes significance at 1%, ** at 5%, and * at 10%. Results from Quasi-Poisson regressions with standard errors clustered at the state-level are reported in parentheses. The unit of observation are child age-state-year cells from fiscal year 2006 to 2016. All estimates control for age, year, and state fixed-effects and the following demographic population shares: non-Hispanic black, non-Hispanic other race and Hispanic, female, parent's with a high school degree, parent's with a some college or associates degree, parent's with a bachelors degree or more, living in single female households, and living below 100% of the poverty line. Also included are the average household income, mean parent's age, parent's unemployment rates, whether a state PDMP program was active, average receipt from state SNAP and TANF programs for a family of three, and the natural log of the total population. Omitted categorical variables were the share of the non-Hispanic white, males, and mother's education less than high school education.

Figure 8: State Analysis: Fixed Effects Model Estimates of δ_t

Panel A: Adult Substance Abuse Treatment Admissions



Panel B: Child Out-of-Home Placements



Note: Each graph includes 95 percent confidence intervals using standard errors clustered at the state-level.

Table 20: State Analysis: Effect of Opioid Abuse on Out-of-Home Placements

	Total Entries (1)	Drug-Related Entries (2)	Drugs, Neglect, etc. (3)	Grandchildren (4)
Panel A: Ordinary Least Squares				
$ln(Opioid\_Abuse_{st})$	−1.064	0.731	−0.007	−5.201
	(2.035)	(0.964)	(1.687)	(12.938)
R^2	0.896	0.768	0.848	0.907
Year Fixed–Effects	Yes	Yes	Yes	Yes
State Fixed–Effects	Yes	Yes	Yes	Yes
Panel B: Instrumental Variables				
$ln(\widehat{Opioid\_Abuse}_{st})$	−1.196	0.742	0.157	−47.871*
	(3.313)	(1.937)	(2.613)	(27.711)
First-Stage F-Statistic	4.687	4.687	4.687	4.687
R^2	0.896	0.768	0.848	0.903
Year Fixed–Effects	Yes	Yes	Yes	Yes
State Fixed–Effects	Yes	Yes	Yes	Yes
Mean of Dependent Variable	31.887	7.672	21.600	497.760
Observations	549	549	549	549

Notes: *** Denotes significance at 1%, ** at 5%, and * at 10%. Results from ordinary least squares and instrumental variable regressions with standard errors clustered at the state-level are reported in parentheses. The unit of observation are state-year cells from 2006 to 2016. All estimates control for year and state fixed-effects. For instrumental variables (Panel B), the first stage regression estimate the effect of OxyContin's reformulation on opioid abuse rates controlling for a common linear trend, post-2010 trend break, and the following adult demographic population shares: share of the population age 25-34, 35-44, and 44-54 years old, non-Hispanic black, non-Hispanic other race and Hispanic, female, with a high school degree, some college or associates degree, bachelors degree or more, military veteran, married, and living below 100% of the poverty line. Also included are the average per capita income, unemployment rates, whether a state PDMP program was active, and the natural log of the total population. Other race non-Hispanic includes Asian, Pacific Islander, American Indian, and other racial groups as well as multi-racial individuals. Omitted categorical variables were the share of the non-Hispanic white, males, and less than high school education. The second stage and ordinary least squares regressions estimate the effect of opioid abuse on child out-of-home placements controlling for the following child demographics: share of the population age less than 2, 2-5, 6-11, and 12-17 years old, non-Hispanic black, non-Hispanic other race and Hispanic, female, parent's with a high school degree, parent's with a some college or associates degree, parent's with a bachelors degree or more, living in single female households, and living below 100% of the poverty line. Also included are the average household income, mean parent's age, parent's unemployment rates, whether a state PDMP program was active, average receipt from state SNAP and TANF programs for a family of three, and the natural log of the total population. Other race non-Hispanic includes Asian, Pacific Islander, American Indian, and other racial groups as well as multi-racial individuals. Omitted categorical variables were the share of the non-Hispanic white, males, and less than high school education.

Table 21: State Analysis: Effect of Opioid Abuse on Out-of-Home Placements using Only Contemporaneous Oxycodone Sales

	Total Entries (1)	Drug-Related Entries (2)	Drugs, Neglect, etc. (3)	Grandchildren (4)
$ln(\widehat{Opioid\_Abuse}_{st})$	−3.593	0.277	−1.830	−70.360**
	(3.313)	(1.937)	(2.613)	(27.711)
Mean of Dependent Variable	31.887	7.672	21.600	497.760
Age Fixed–Effects	Yes	Yes	Yes	Yes
Year Fixed–Effects	Yes	Yes	Yes	Yes
State Fixed–Effects	Yes	Yes	Yes	Yes
First-Stage F-Statistic	4.698	4.698	4.698	4.698
R^2	0.894	0.767	0.847	0.898
Observations	549	549	549	549

Notes: *** Denotes significance at 1%, ** at 5%, and * at 10%. Results from ordinary least squares and instrumental variable regressions with standard errors clustered at the state-level are reported in parentheses. The unit of observation are state-year cells from 2006 to 2016. All estimates control for year, and state fixed-effects. The first stage regression estimate the effect of OxyContin's reformulation on opioid abuse rates using only contemporaneous oxycodone supply rates, and the following adult demographic population shares: 25-34, 35-44, and 44-54 years old, non-Hispanic black, non-Hispanic other race and Hispanic, female, with a high school degree, some college or associates degree, bachelors degree or more, military veteran, married, and living below 100% of the poverty line. Also included are the average per capita income, unemployment rates, whether a state PDMP program was active, and the natural log of the total population. Other race non-Hispanic includes Asian, Pacific Islander, American Indian, and other racial groups as well as multi-racial individuals. Omitted categorical variables were the share of the non-Hispanic white, males, and less than high school education. The second stage regression contains the following child demographic controls: share of the population age less than 2, 2-5, 6-11, and 12-17 years old, non-Hispanic black, non-Hispanic other race and Hispanic, female, parent's with a high school degree, parent's with a some college or associates degree, parent's with a bachelors degree or more, living in single female households, and living below 100% of the poverty line. Also included are the average household income, mean parent's age, parent's unemployment rates, whether a state PDMP program was active, average receipt from state SNAP and TANF programs for a family of three, and the natural log of the total population. Other race non-Hispanic includes Asian, Pacific Islander, American Indian, and other racial groups as well as multi-racial individuals. Omitted categorical variables were the share of the non-Hispanic white, males, and less than high school education.

Table 22: State Analysis: Effect of Oxycontin's Reformulation on Adults

	Heroin (1)	OxyContin Synthetic (2)	Any Opiate (3)	Not Opiate (4)
Panel A: Baseline Model				
$Post \times ln(Oxy\_Supply_s^{2010})$	0.322**	0.116	0.234**	0.029
	(0.145)	(0.076)	(0.117)	(0.117)
Year Fixed–Effects	Yes	Yes	Yes	Yes
State Fixed–Effects	Yes	Yes	Yes	Yes
Panel B: Controlling for Linear Trends				
$Post \times ln(Oxy\_Supply_s^{2010})$	0.151	0.116*	0.130*	0.078
	(0.098)	(0.069)	(0.075)	(0.053)
$Post \times (t-2011) \times ln(Oxy\_Supply_s^{2010})$	0.088**	−0.108	−0.015	−0.044
	(0.043)	(0.076)	(0.076)	(0.047)
Year Fixed–Effects	Yes	Yes	Yes	Yes
State Fixed–Effects	Yes	Yes	Yes	Yes
Linear Trends	Yes	Yes	Yes	Yes
Observations	549	549	549	549

Notes: *** Denotes significance at 1%, ** at 5%, and * at 10%. Results from Quasi-Poisson regressions with standard errors clustered at the state-level are reported in parentheses. The unit of observation are state-year cells from fiscal year 2006 to 2016. Panel A estimates the effect of OxyContin's reformulation on child out-of-home placement rates as an averaged effect over the post-reformulation period. Panel B shows estimates when also controlling for a common linear trend, post-2010 trend break. All estimates control for year and state fixed-effects, a common linear trend, post-2010 trend break, and the following child demographic population shares: share of the population age 25-34, 35-44, and 44-54 years old, non-Hispanic black, non-Hispanic other race and Hispanic, female, parent's with a high school degree, parent's with a some college or associates degree, parent's with a bachelors degree or more, living in single female households, and living below 100% of the poverty line. Also included are the average household income, mean parent's age, parent's unemployment rates, whether a state PDMP program was active, average receipt from state SNAP and TANF programs for a family of three, and the natural log of the total population. Omitted categorical variables were the share of the non-Hispanic white, males, and mother's education less than high school education.

Table 23: State Analysis: Effect of Oxycontin's Reformulation on Adults using Fixed Effects

	Heroin (1)	OxyContin Synthetic (2)	Any Opiate (3)	Not Opiate (4)
$\mathbb{1}_{2006} \times ln(Oxy\_Supply_s^{2010})$	0.027	−0.140	−0.084	−0.074
	(0.058)	(0.114)	(0.101)	(0.101)
$\mathbb{1}_{2007} \times ln(Oxy\_Supply_s^{2010})$	0.044	−0.152	−0.055	−0.055
	(0.069)	(0.095)	(0.094)	(0.094)
$\mathbb{1}_{2008} \times ln(Oxy\_Supply_s^{2010})$	0.012	−0.053	−0.040	0.001
	(0.067)	(0.052)	(0.067)	(0.067)
$\mathbb{1}_{2010} \times ln(Oxy\_Supply_s^{2010})$	0.025	0.018	0.024	−0.063
	(0.065)	(0.047)	(0.043)	(0.043)
$\mathbb{1}_{2011} \times ln(Oxy\_Supply_s^{2010})$	0.130*	0.281**	0.219*	0.112
	(0.068)	(0.124)	(0.127)	(0.127)
$\mathbb{1}_{2012} \times ln(Oxy\_Supply_s^{2010})$	0.268*	0.080	0.195*	0.018
	(0.149)	(0.057)	(0.116)	(0.116)
$\mathbb{1}_{2013} \times ln(Oxy\_Supply_s^{2010})$	0.386**	0.025	0.208	−0.024
	(0.179)	(0.079)	(0.145)	(0.145)
$\mathbb{1}_{2014} \times ln(Oxy\_Supply_s^{2010})$	0.300	−0.095	0.099	−0.113
	(0.228)	(0.124)	(0.186)	(0.186)
$\mathbb{1}_{2015} \times ln(Oxy\_Supply_s^{2010})$	0.553***	−0.047	0.278	−0.079
	(0.214)	(0.166)	(0.204)	(0.204)
$\mathbb{1}_{2016} \times ln(Oxy\_Supply_s^{2010})$	0.561**	−0.054	0.270	−0.053
	(0.258)	(0.196)	(0.226)	(0.226)
Year Fixed–Effects	Yes	Yes	Yes	Yes
State Fixed–Effects	Yes	Yes	Yes	Yes
Observations	549	549	549	549

Notes: *** Denotes significance at 1%, ** at 5%, and * at 10%. Results from Quasi-Poisson regressions with standard errors clustered at the state-level are reported in parentheses. The unit of observation are state-year cells from fiscal year 2006 to 2016. All estimates control for year and state fixed-effects and the following demographic population shares: share of the population age 25-34, 35-44, and 44-54 years old, non-Hispanic black, non-Hispanic other race and Hispanic, female, with a high school degree, some college or associates degree, bachelors degree or more, military veteran, married, and living below 100% of the poverty line. Also included are the average per capita income, unemployment rates, whether a state PDMP program was active, and the natural log of the total population. Other race non-Hispanic includes Asian, Pacific Islander, American Indian, and other racial groups as well as multi-racial individuals. Omitted categorical variables were the share of the non-Hispanic white, males, and less than high school education.

Table 24: State Analysis: Effect of Oxycontin's Reformulation on Children

	Total Entries (1)	Drug-Related Entries (2)	Drugs, Neglect, etc. (3)	Grandchildren (4)
Panel A: Baseline Model				
$Post \times ln(Oxy\_Supply_s^{2010})$	0.007	−0.044	0.004	0.001
	(0.030)	(0.048)	(0.029)	(0.029)
Year Fixed–Effects	Yes	Yes	Yes	Yes
State Fixed–Effects	Yes	Yes	Yes	Yes
Panel B: Controlling for Linear Trends				
$Post \times ln(Oxy\_Supply_s^{2010})$	−0.004	−0.095	−0.014	−0.012
	(0.042)	(0.059)	(0.044)	(0.011)
$Post \times (t-2011) \times ln(Oxy\_Supply_s^{2010})$	0.018*	0.005	0.029**	0.006
	(0.009)	(0.022)	(0.014)	(0.005)
Year Fixed–Effects	Yes	Yes	Yes	Yes
State Fixed–Effects	Yes	Yes	Yes	Yes
Linear Trends	Yes	Yes	Yes	Yes
Observations	561	561	561	561

Notes: *** Denotes significance at 1%, ** at 5%, and * at 10%. Results from Quasi-Poisson regressions with standard errors clustered at the state-level are reported in parentheses. The unit of observation are state-year cells from fiscal year 2006 to 2016. Panel A estimates the effect of OxyContin's reformulation on child out-of-home placement rates as an averaged effect over the post-reformulation period. Panel B shows estimates when also controlling for a common linear trend, post-2010 trend break. All estimates control for year and state fixed-effects, a common linear trend, post-2010 trend break, and the following child demographic population shares: share of the population age less than 2, 2-5, 6-11, and 12-17 years old, non-Hispanic black, non-Hispanic other race and Hispanic, female, parent's with a high school degree, parent's with a some college or associates degree, parent's with a bachelors degree or more, living in single female households, and living below 100% of the poverty line. Also included are the average household income, mean parent's age, parent's unemployment rates, whether a state PDMP program was active, average receipt from state SNAP and TANF programs for a family of three, and the natural log of the total population. Omitted categorical variables were the share of the non-Hispanic white, males, and mother's education less than high school education.

Table 25: State Analysis: Effect of Oxycontin's Reformulation on Children using Fixed Effects

	Total Entries (1)	Drug-Related Entries (2)	Drugs, Neglect, etc. (3)	Grandchildren (4)
$\mathbb{1}_{2006} \times ln(Oxy\_Supply_s^{2010})$	0.013	−0.049	0.015	−0.008
	(0.036)	(0.057)	(0.051)	(0.051)
$\mathbb{1}_{2007} \times ln(Oxy\_Supply_s^{2010})$	0.006	−0.048	−0.001	0.019
	(0.025)	(0.035)	(0.030)	(0.030)
$\mathbb{1}_{2008} \times ln(Oxy\_Supply_s^{2010})$	0.038	0.036*	0.038**	0.019
	(0.024)	(0.019)	(0.017)	(0.017)
$\mathbb{1}_{2010} \times ln(Oxy\_Supply_s^{2010})$	−0.014	−0.032	−0.032	0.002
	(0.032)	(0.051)	(0.035)	(0.035)
$\mathbb{1}_{2011} \times ln(Oxy\_Supply_s^{2010})$	−0.006	−0.089	−0.037	−0.013
	(0.048)	(0.056)	(0.048)	(0.048)
$\mathbb{1}_{2012} \times ln(Oxy\_Supply_s^{2010})$	0.009	−0.054	−0.004	0.012
	(0.041)	(0.055)	(0.043)	(0.043)
$\mathbb{1}_{2013} \times ln(Oxy\_Supply_s^{2010})$	−0.007	−0.082	−0.019	0.002
	(0.038)	(0.061)	(0.034)	(0.034)
$\mathbb{1}_{2014} \times ln(Oxy\_Supply_s^{2010})$	0.018	−0.071	0.020	0.022
	(0.037)	(0.065)	(0.041)	(0.041)
$\mathbb{1}_{2015} \times ln(Oxy\_Supply_s^{2010})$	0.046	−0.022	0.057	0.007
	(0.043)	(0.065)	(0.048)	(0.048)
$\mathbb{1}_{2016} \times ln(Oxy\_Supply_s^{2010})$	0.055	−0.014	0.061	0.032
	(0.059)	(0.056)	(0.060)	(0.060)
Year Fixed–Effects	Yes	Yes	Yes	Yes
State Fixed–Effects	Yes	Yes	Yes	Yes
Observations	561	561	561	561

Notes: *** Denotes significance at 1%, ** at 5%, and * at 10%. Results from Quasi-Poisson regressions with standard errors clustered at the state-level are reported in parentheses. The unit of observation are state-year cells from fiscal year 2006 to 2016. All estimates control for year and state fixed-effects and the following demographic population shares: share of the population age less than 2, 2-5, 6-11, and 12-17 years old, non-Hispanic black, non-Hispanic other race and Hispanic, female, parent's with a high school degree, parent's with a some college or associates degree, parent's with a bachelors degree or more, living in single female households, and living below 100% of the poverty line. Also included are the average household income, mean parent's age, parent's unemployment rates, whether a state PDMP program was active, average receipt from state SNAP and TANF programs for a family of three, and the natural log of the total population. Omitted categorical variables were the share of the non-Hispanic white, males, and mother's education less than high school education.

Appendix

Missing Observations for Substance Abuse Treatment Admissions

The following state-year observations are not available in the public-use TEDS-A data:

- 2006: Alaska, District of Columbia
- 2007: Alabama
- 2008: Mississippi
- 2009: District of Columbia, Mississippi
- 2010: Mississippi
- 2014: South Carolina
- 2015: Oregon, South Carolina
- 2016: Georgia, Oregon

Therefore these state-year observations are not included in the adult substance abuse treatment admissions panel. For the child-level panel, there are no missing state-year-age cells (10,098). When merged with the adult-level panel, I lose 216 state-year-age cells, therefore the OLS and IV regressions are done using 9,882 cells.

Inter-temporal Treatment Measure Correlation

Figure 9: Correlation: Mean Pre-2010 Oxycodone Supply to 2006 Oxycodone Supply

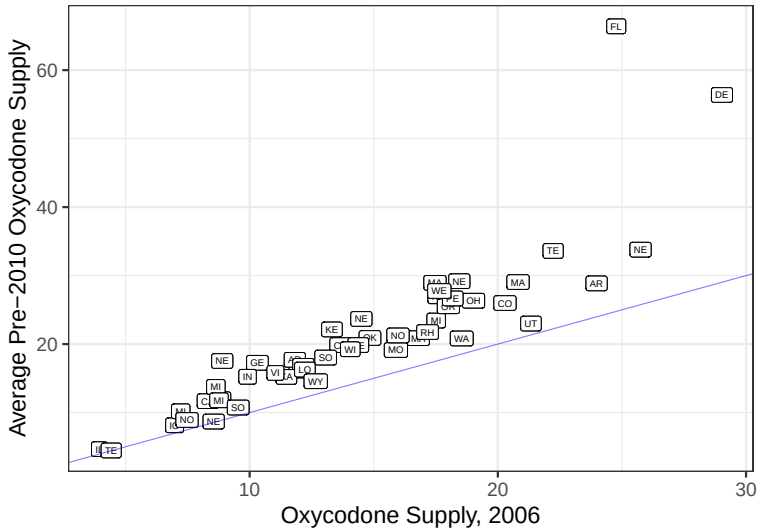


Figure 10: Correlation: Mean Pre-2010 Oxycodone Supply to 2010 Oxycodone Supply

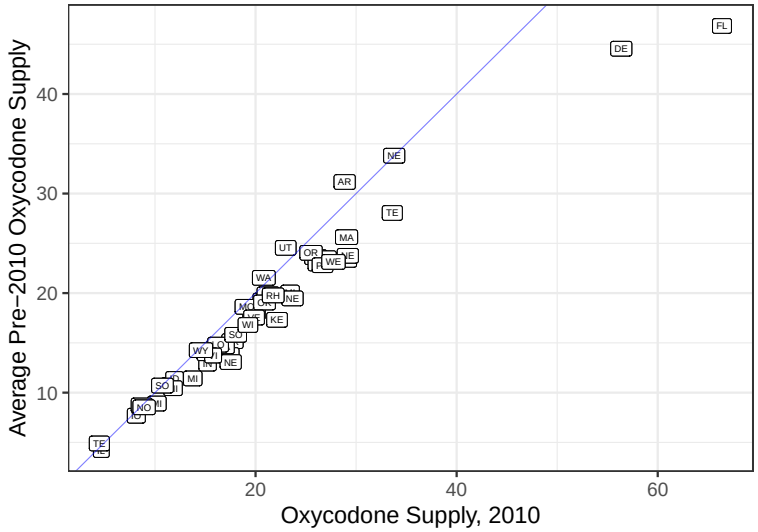


Figure 11: Correlation: 2006 to 2010 Oxycodone Supply