APPENDICES FOR ONLINE PUBLICATION for The Hazards of Unwinding the Prescription Opioid Epidemic: Implications for Child Maltreatment by Mary F. Evans, Matthew C. Harris, and Lawrence L. Kessler

APPENDIX A. Super Counties, Supplementary Information on Sample, and Additional Event Study Results

Construction of super counties

To construct child abuse and neglect measures for each super county, the basic idea is to take state-level totals and subtract the sum of the county-level totals for all of the identified counties in the state. Table A1 lists the number of identified counties by state. For a given state, all other counties (i.e., the non-identified counties) will be part of the super county.

We begin by forming state-level child abuse and neglect measures: (i) the number of children who were the subject of an abuse and neglect allegation in each report year and state, and (ii) the number of children considered to be victims of abuse and neglect in each report year and state (i.e. substantiations). Because of the way in which these state-level measures are constructed, they count children more than once if they are the subject of an allegation/substantiation in more than one county in the state in the report year. This feature is necessary for forming the super county abuse and neglect measures; otherwise the sum of allegations/substantiations from all identified counties in the state may exceed the respective state-level measure. For identified counties, the child abuse and neglect measures are the county-level counterparts to the state-level measures. For super counties, the child abuse and neglect measures are the difference between the state-level measure and the sum of the identified county-level measures for each state/report year.

We use a similar technique to form most covariates for the super counties. For the cancer crude rate variable, the super county covariate reflects the (unweighted) mean value for the non-identified counties in the state.
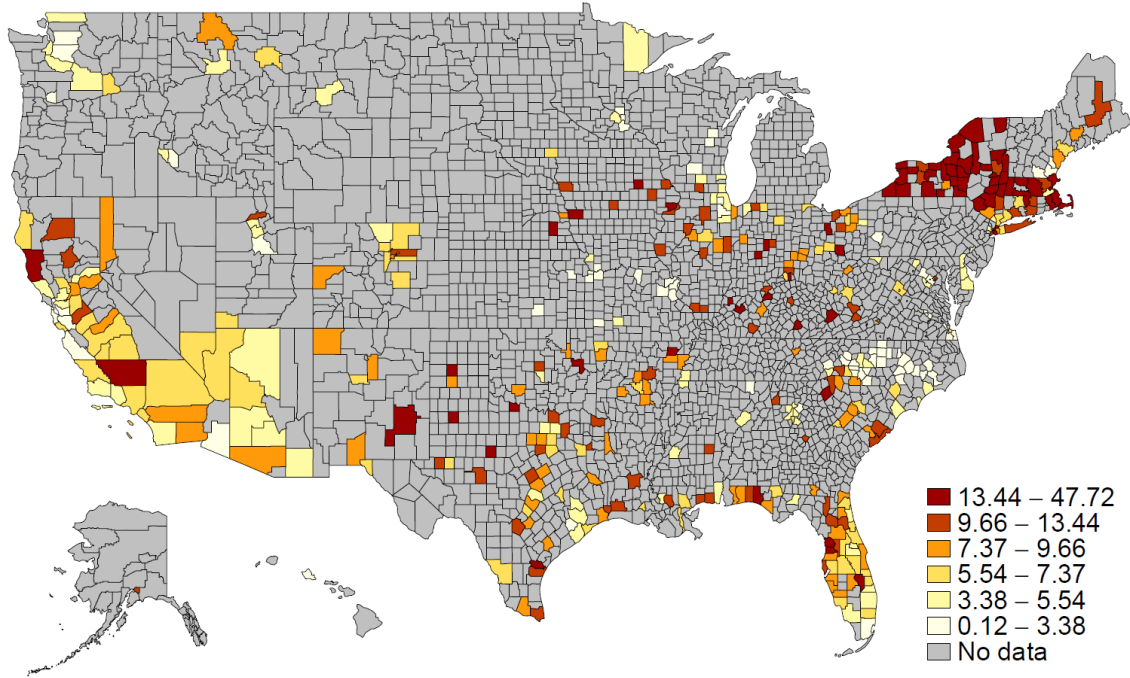
FIGURE A1. MEDIAN SUBSTANTIATIONS OF PHYSICAL ABUSE OR NEGLECT FOR IDENTIFIED COUNTIES, 2006-2016

Notes: Figure shows the median number of children per 1000 with substantiated physical abuse or neglect by county between 2006 and 2016 for 438 identified counties. Counties in grey are included in super counties. Shading reflects quantiles of the distribution.
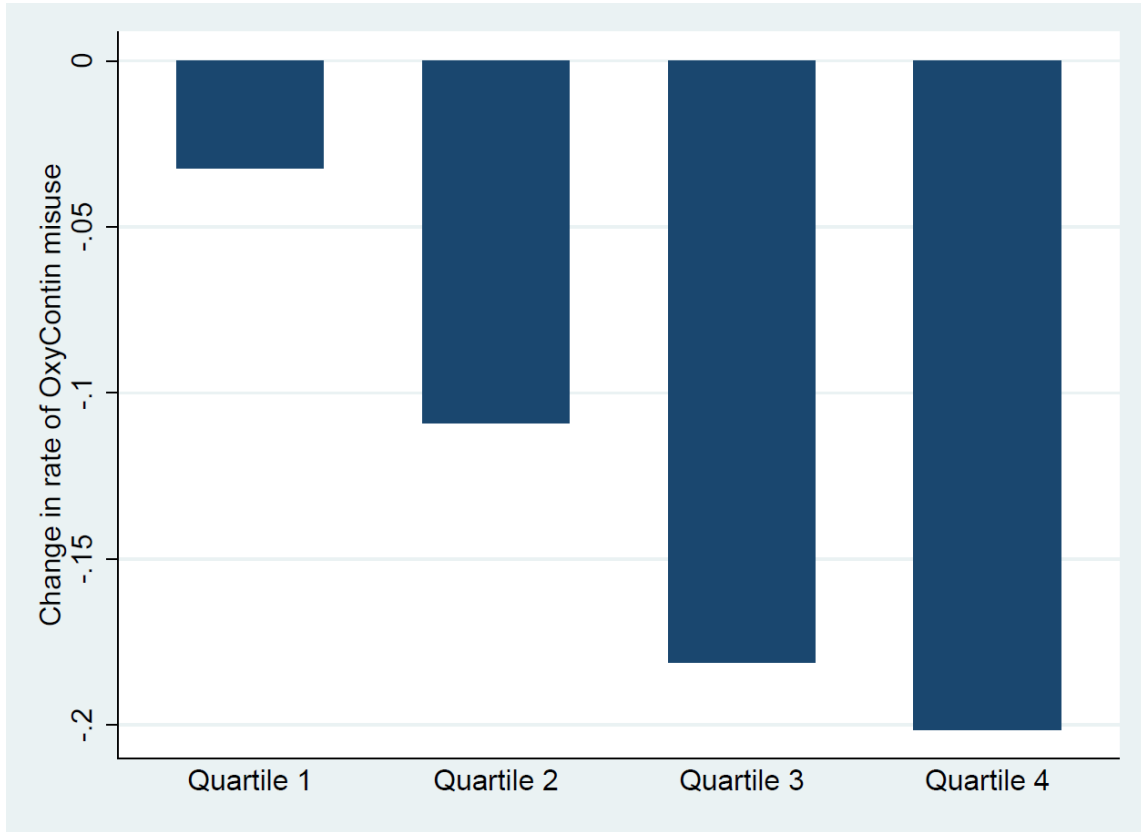
FIGURE A2. OXYCONTIN ANALYSIS: RELATIONSHIP BETWEEN PRE-INTERVENTION EXPOSURE AND THE CHANGE IN OXYCONTIN MISUSE BETWEEN 2008 AND 2012

Notes: Quartiles are formed based on the population-weighted mean per capita opioid prescriptions in the county for the period 2006 to 2009 (i.e., pre-intervention exposure). Quartile 1 includes the 122 counties with the lowest mean exposure while quartile 4 includes the 121 counties with the highest mean exposure. The figure shows larger reductions in the state-level population-weighted mean rate of OxyContin misuse between 2008 and 2012 based on Alpert et al.'s (2018) measure in counties with higher pre-intervention exposure based on the CDC data.

Panel A. Panel A. Alleged physical abuse or neglect

Alleged physical abuse or neglect

Panel B. Substantiated physical abuse or neglect
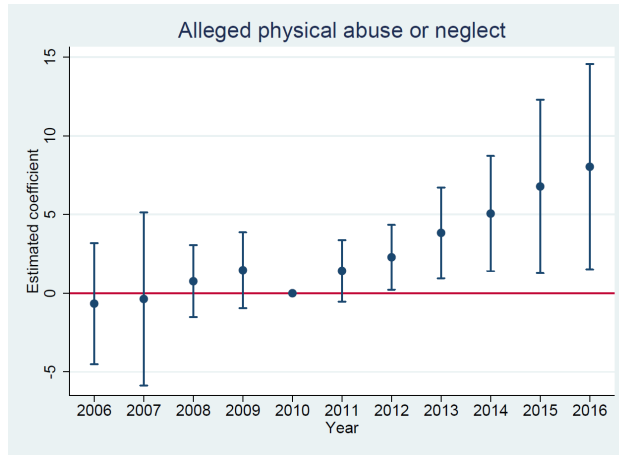
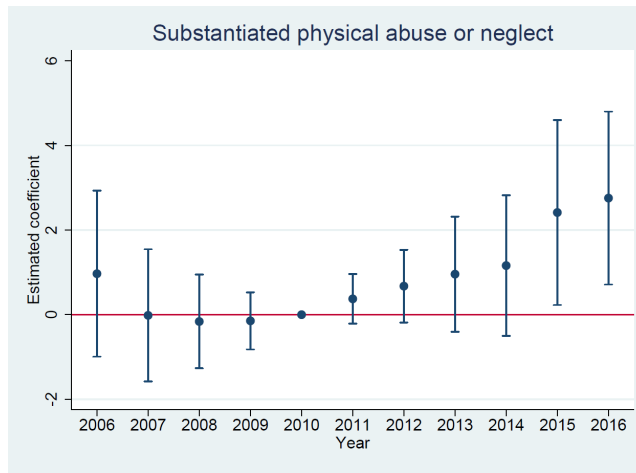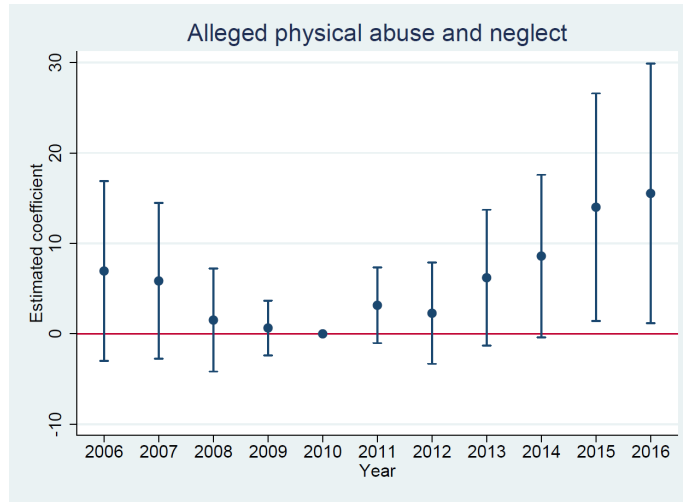Substantiated physical abuse or neglect

FIGURE A3. OXYCONTIN ANALYSIS—EVENT STUDY RESULTS WITH IDENTIFIED COUNTY-BY-YEAR SAMPLE

Notes: Each figure reports point estimates and 95% confidence intervals on the interaction terms from specification (1) with 2010, the year in which OxyContin was reformulated, normalized to zero. Allegations refer to the number of children per 1000 with at least one allegation of physical abuse or neglect. Substantiations refer to the number of children per 1000 with at least one substantiated case of physical abuse or neglect. Specifications include county and year fixed effects; percent female, white, Black, Hispanic population; number of cancer deaths per 100,000 population; percent population under age 19, between 20 and 24, between 25 and 34, between 35 and 44, between 45 and 54, and between 55 and 64; unemployment and labor force participation rates, and indicators for a PDMP of any form and a medical marijuana law. Standard errors are clustered on state with 44 clusters.

Panel A. Alleged physical abuse or neglect

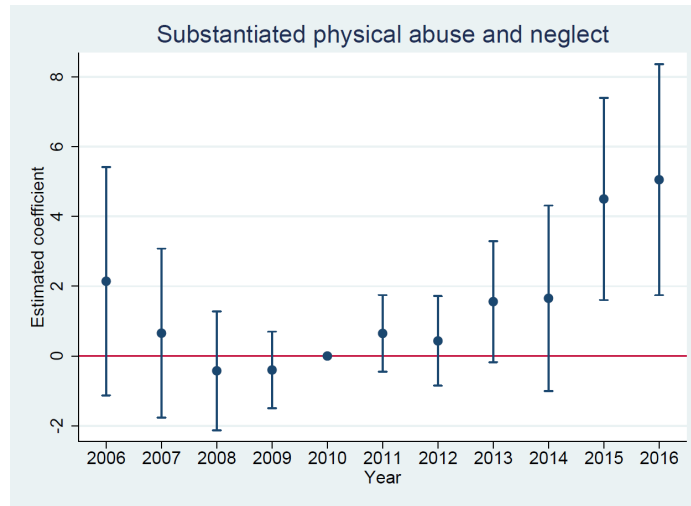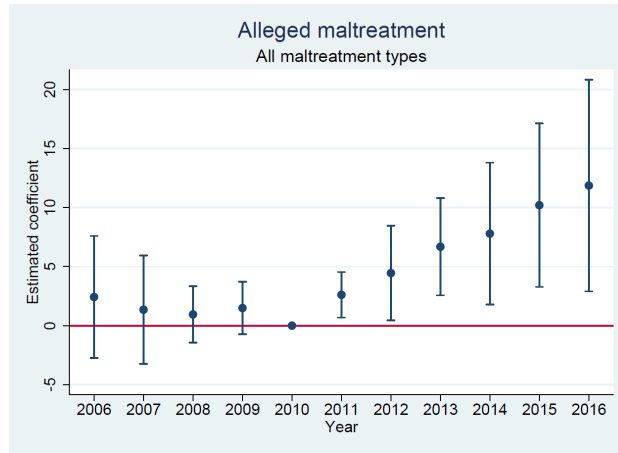Panel B. Substantiated physical abuse or neglect

FIGURE A4. OXYCONTIN ANALYSIS—EVENT STUDY RESULTS WITH STATE-BY-YEAR SAMPLE

Notes: Each figure reports point estimates and 95% confidence intervals on the interaction terms from specification (1) with 2010, the year in which OxyContin was reformulated, normalized to zero. Allegations refer to the number of children per 1000 with at least one allegation of physical abuse or neglect. Substantiations refer to the number of children per 1000 with at least one substantiated case of physical abuse or neglect. Specifications include county and year fixed effects; percent female, white, Black, Hispanic population; number of cancer deaths per 100,000 population; percent population under age 19, between 20 and 24, between 25 and 34, between 35 and 44, between 45 and 54, and between 55 and 64; unemployment and labor force participation rates, and indicators for a PDMP of any form and a medical marijuana law. Sample reflects 51 states. Standard errors are clustered on state.

Panel A. Alleged maltreatment

Alleged maltreatment
All maltreatment types

Panel B. Substantiated maltreatment
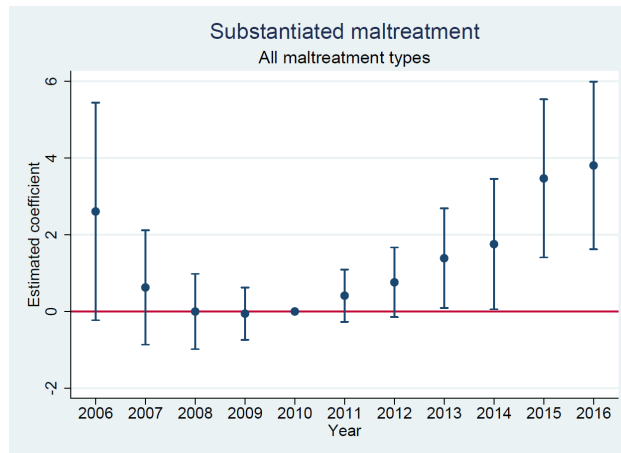
Substantiated maltreatment
All maltreatment types

FIGURE A5. EVENT STUDY RESULTS WITH BROADER MEASURES OF CHILD MALTREATMENT

Notes: Each figure reports point estimates and 95% confidence intervals on the interaction terms from specification (1) with 2010, the year in which OxyContin was reformulated, normalized to zero. Alleged maltreatment is the number of children per 1000 with at least one allegation of maltreatment of any type. Substantiated maltreatment is the number of children per 1000 with at least one substantiated case of maltreatment of any type. Specifications include county and year fixed effects; percent female, white, Black, Hispanic population; number of cancer deaths per 100,000 population; percent population under age 19, between 20 and 24, between 25 and 34, between 35 and 44, between 45 and 54, and between 55 and 64; unemployment and labor force participation rates, and indicators for a PDMP of any form and a medical marijuana law. Standard errors are clustered on state.

Panel A. Panel A. Alleged physical abuse or neglect
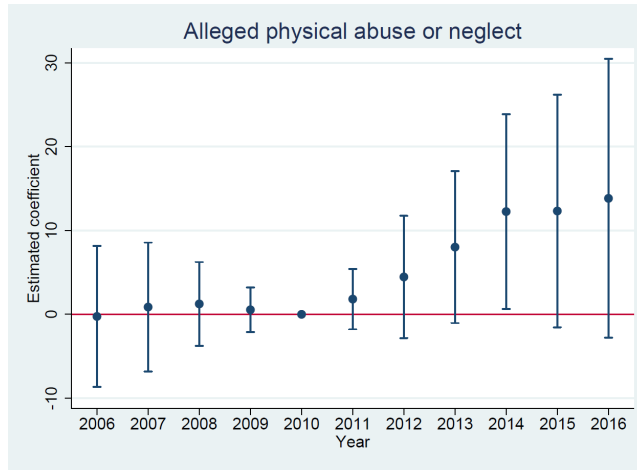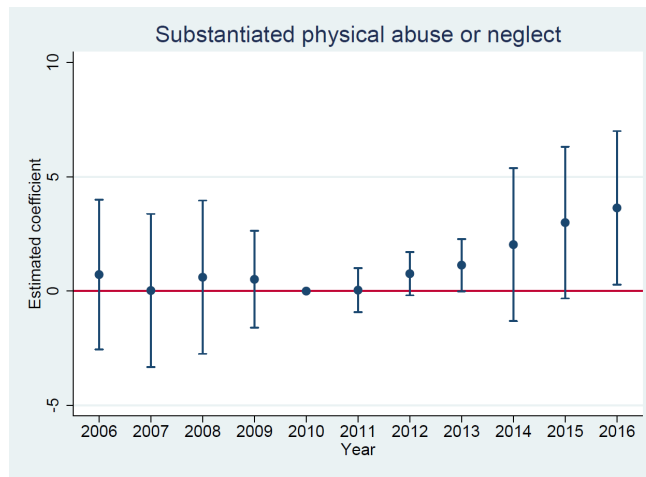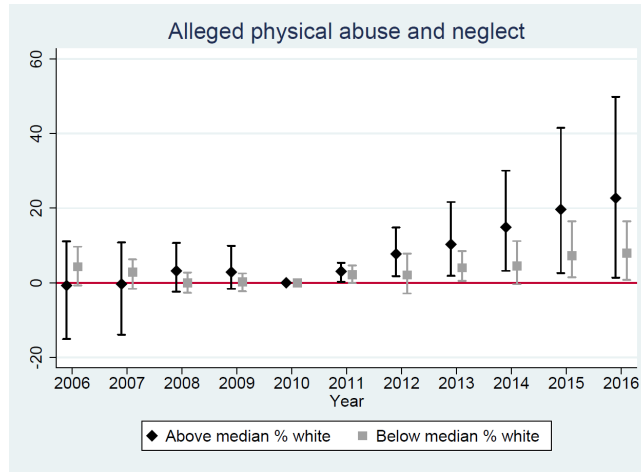

Panel B. Substantiated physical abuse or neglect

FIGURE A6. OXYCONTIN ANALYSIS—EVENT STUDY RESULTS WITH ALPERT ET AL. (2018) EXPOSURE MEASURE

Notes: Each figure reports point estimates and 95% confidence intervals on the interaction terms from specification (1) with 2010, the year in which OxyContin was reformulated, normalized to zero. Allegations refer to the number of children per 1000 with at least one allegation of physical abuse or neglect. Substantiations refer to the number of children per 1000 with at least one substantiated case of physical abuse or neglect. Specifications include county and year fixed effects; percent female, white, Black, Hispanic population; number of cancer deaths per 100,000 population; percent population under age 19, between 20 and 24, between 25 and 34, between 35 and 44, between 45 and 54, and between 55 and 64; unemployment and labor force participation rates, and indicators for a PDMP of any form and a medical marijuana law. Standard errors are clustered on state.

Panel A. Alleged physical abuse and neglect

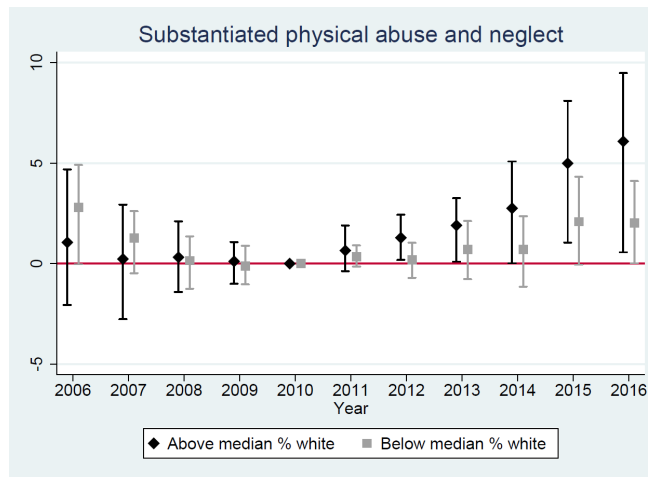Panel B. Substantiated physical abuse and neglect

FIGURE A7. OXYCONTIN ANALYSIS—EVENT STUDY RESULTS, HETEROGENEOUS EFFECTS BY PERCENTAGE WHITE

Notes: Each figure reports point estimates and 95% confidence intervals on the interaction terms from specification (1) with 2010, the year in which OxyContin was reformulated, normalized to zero. Allegations refer to the number of children per 1000 with at least one allegation of physical abuse or neglect. Substantiations refer to the number of children per 1000 with at least one substantiated case of physical abuse or neglect. Specifications include county and year fixed effects; percent female, white, Black, Hispanic population; number of cancer deaths per 100,000 population; percent population under age 19, between 20 and 24, between 25 and 34, between 35 and 44, between 45 and 54, and between 55 and 64; unemployment and labor force participation rates, and indicators for a PDMP of any form and a medical marijuana law. Standard errors are clustered on state and estimated using the wild cluster bootstrap procedure.

Panel A. Alleged physical abuse and neglect
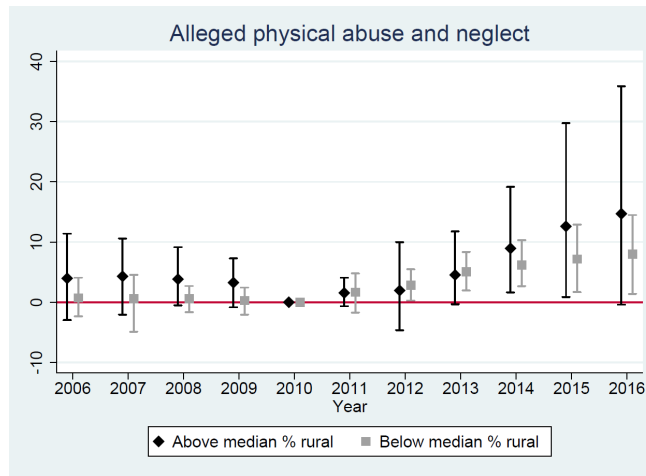

Panel B. Substantiated physical abuse and neglect

FIGURE A8. OXYCONTIN ANALYSIS—EVENT STUDY RESULTS, HETEROGENEOUS EFFECTS BY RURAL STATUS

Notes: Each figure reports point estimates and 95% confidence intervals on the interaction terms from specification (1) with 2010, the year in which OxyContin was reformulated, normalized to zero. Allegations refer to the number of children per 1000 with at least one allegation of physical abuse or neglect. Substantiations refer to the number of children per 1000 with at least one substantiated case of physical abuse or neglect. Specifications include county and year fixed effects; percent female, white, Black, Hispanic population; number of cancer deaths per 100,000 population; percent population under age 19, between 20 and 24, between 25 and 34, between 35 and 44, between 45 and 54, and between 55 and 64; unemployment and labor force participation rates, and indicators for a PDMP of any form and a medical marijuana law. Standard errors are clustered on state and estimated using the wild cluster bootstrap procedure.
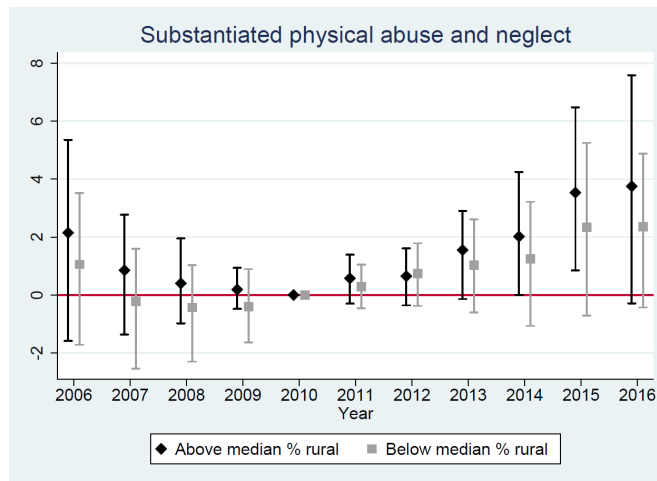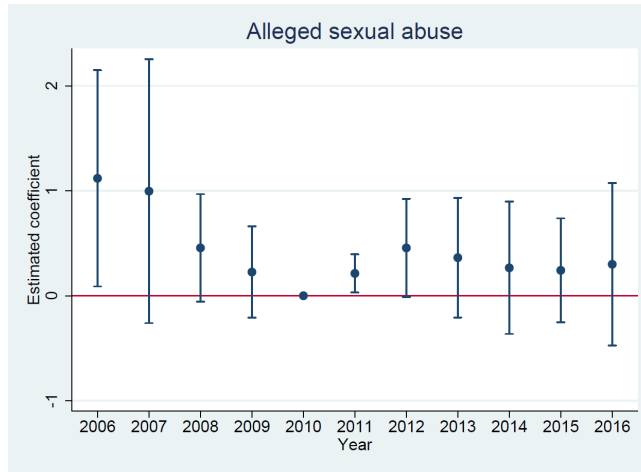
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Panel A. Alleged sexual abuse

Panel B. Substantiated sexual abuse

FIGURE A9. OXYCONTIN ANALYSIS—EVENT STUDY RESULTS FOR SEXUAL ABUSE

Notes: Each figure reports point estimates and 95% confidence intervals on the interaction terms from specification (1) with 2010, the year in which OxyContin was reformulated, normalized to zero. Alleged sexual abuse refers to the number of children per 1000 with at least one allegation of sexual abuse. Substantiated sexual abuse refers to the number of children per 1000 with at least one substantiated case of sexual abuse. Specifications include county and year fixed effects; percent female, white, Black, Hispanic population; number of cancer deaths per 100,000 population; percent population under age 19, between 20 and 24, between 25 and 34, between 35 and 44, between 45 and 54, and between 55 and 64, and over age 65; unemployment and labor force participation rates, and indicators for a PDMP of any form and a medical marijuana law. Standard errors are clustered on state.

Panel A. Alleged physical abuse or neglect

Panel B. Substantiated physical abuse or neglect

FIGURE A10. OXYCONTIN ANALYSIS—EVENT STUDY RESULTS BY TREATMENT OF INFANT SUBSTANCE EXPOSURE IN MALTREATMENT DEFINITION

Notes: Each figure reports point estimates and 95% confidence intervals on the interaction terms from specification (1) with 2010, the year in which OxyContin was reformulated, normalized to zero. Allegations refer to the number of children per 1000 with at least one allegation of physical abuse or neglect. Substantiations refer to the number of children per 1000 with at least one substantiated case of physical abuse or neglect. Specifications include county and year fixed effects; percent female, white, Black, Hispanic population; number of cancer deaths per 100,000 population; percent population under age 19, between 20 and 24, between 25 and 34, between 35 and 44, between 45 and 54, and between 55 and 64; unemployment and labor force participation rates, and indicators for a PDMP of any form and a medical marijuana law. Standard errors are clustered on state and estimated using the wild cluster bootstrap procedure.

Panel A. Alleged physical abuse or neglect
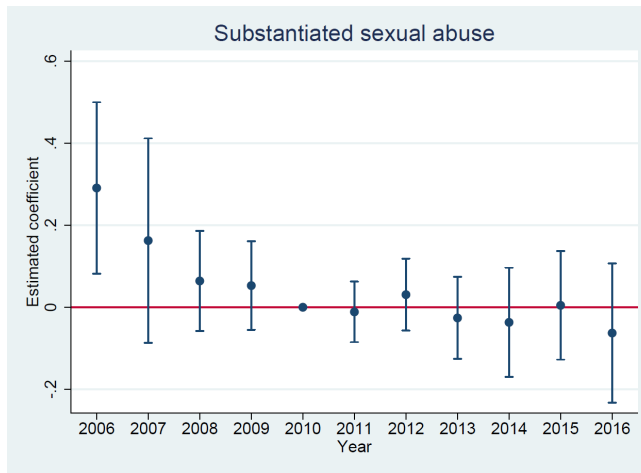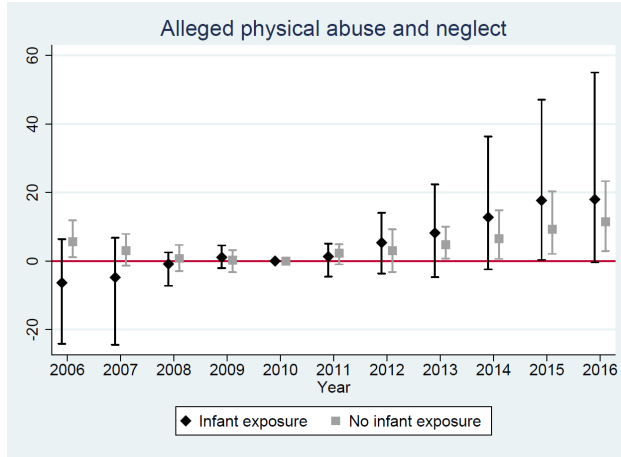

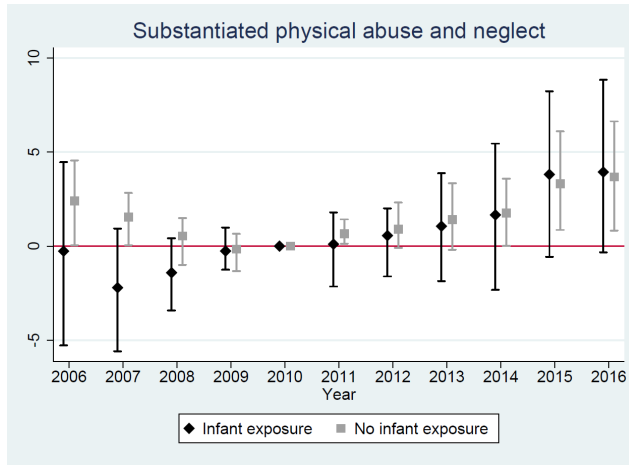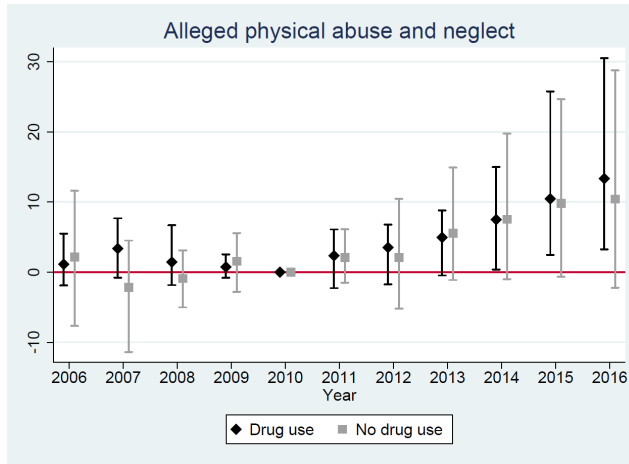Panel B. Substantiated physical abuse or neglect

FIGURE A11. OXYCONTIN ANALYSIS—EVENT STUDY RESULTS BY TREATMENT OF CAREGIVER SUBSTANCE USE IN
MALTREATMENT DEFINITION

Notes: Each figure reports point estimates and 95% confidence intervals on the interaction terms from specification (1) with 2010, the year in which OxyContin was reformulated, normalized to zero. Allegations refer to the number of children per 1000 with at least one allegation of physical abuse or neglect. Substantiations refer to the number of children per 1000 with at least one substantiated case of physical abuse or neglect. Specifications include county and year fixed effects; percent female, white, Black, Hispanic population; number of cancer deaths per 100,000 population; percent population under age 19, between 20 and 24, between 25 and 34, between 35 and 44, between 45 and 54, and between 55 and 64; unemployment and labor force participation rates, and indicators for a PDMP of any form and a medical marijuana law. Standard errors are clustered on state and estimated using the wild cluster bootstrap procedure.

TABLE A1. NUMBER OF IDENTIFIED COUNTIES IN EACH STATE

State abbreviation	Number of counties represented in sample
AK	1
AL	3
AR	11
AZ	8
CA	34
CO	9
CT	6
DC	1
DE	3
FL	42
GA	10
HI	1
IA	7
ID	2
IL	18
IN	11
KS	4
KY	9
LA	8
MA	11
ME	4
MN	5
MO	11
MS	5
MT	4
NC	32
NE	2
NH	3
NJ	1
NM	5
NV	2
NY	46
OH	17
OK	5
PA	2
SC	11
SD	1
TN	2
TX	44
UT	5
VA	11
WA	8
WI	6
WV	7
Total	438

Notes: The following states have zero identified counties: MD, MI, ND, OR, RI, VT, WY. For these states, the super county represents the entire state.

TABLE A2. OBSERVABLE DIFFERENCES BETWEEN IDENTIFIED AND SUPER COUNTIES IN SAMPLE

Variable	Identified counties	Super counties	p-value
Allegations	38.565	31.752	0.000
Substantiations	8.854	7.110	0.000
Per capita opioid prescriptions	0.877	0.816	0.000
% White	80.778	84.072	0.000
% Black	12.165	7.849	0.000
% Hispanic	13.802	8.477	0.000
% Rural	20.425	44.589	0.000
% Female	50.786	50.141	0.000
% Under age 0 to 19	26.555	26.213	0.023
% Age 20 to 24	7.414	6.704	0.000
% Age 25 to 34	13.154	12.062	0.000
% Age 35 to 44	12.903	12.453	0.000
% Age 45 to 54	13.954	14.363	0.000
% Age 55 to 64	12.050	13.063	0.000
% Over age 64	13.973	15.143	0.000
Unemployment rate	6.829	6.544	0.028
Labor force participation rate	61.069	60.602	0.094
Cancer deaths per 100,000 population	197.510	233.145	0.000

Notes: The sample includes 438 identified counties and 48 super counties. Means are taken over the sample period with the exception of % rural, which is based on the 2010 Census, and per capita opioid prescriptions, which are based on 2006-2009. The fourth column reports p-values for equality of means tests. Allegations refer to the number of children per 1000 with at least one allegation of physical abuse or neglect. Substantiations refer to the number of children per 1000 with at least one substantiated case of physical abuse or neglect.

APPENDIX B. Additional PDMP Results and PDMP Implementation Dates

Panel A: Alleged physical abuse or neglect
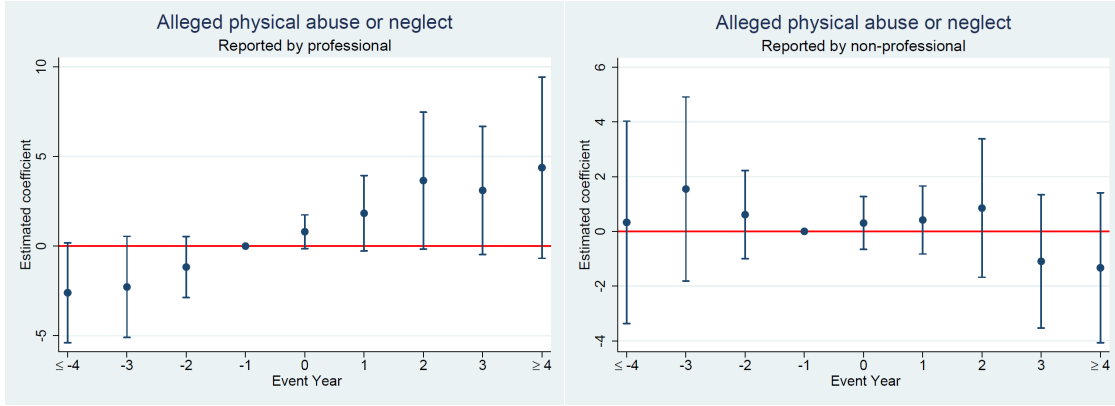
Panel B: Substantiated physical abuse or neglect

FIGURE B1. PDMP ANALYSIS: EVENT STUDY RESULTS BY REPORT SOURCE

Notes: Each figure reports weighted least squares estimates and 95% confidence intervals on the lead and lag terms from Equation (3) with the year prior to must-access PDMP implementation normalized to zero. Allegations refer to the number of children per 1000 with at least one allegation of physical abuse or neglect. Substantiations refer to the number of children per 1000 with at least one substantiated case of physical abuse or neglect. Specifications include county and year fixed effects; percent female, white, Black, Hispanic population; number of cancer deaths per 100,000 population; percent population under age 19, between 20 and 24, between 25 and 34, between 35 and 44, between 45 and 54, and between 55 and 64; unemployment and labor force participation rates. Standard errors are clustered on state. Professional reporters consist of consist of social services, medical, mental health, legal/law enforcement/criminal justice, education or child day care personnel. Non-professional reporters consist of friends, neighbors, family members, among other sources.

Panel A. Alleged physical abuse or neglect

Alleged physical abuse or neglect

Panel B. Substantiated physical abuse or neglect

Substantiated physical abuse or neglect

FIGURE B2. PDMP ANALYSIS: EVENT STUDY RESULTS WITH IDENTIFIED COUNTY-BY-YEAR SAMPLE

Notes: Each figure reports weighted least squares estimates and 95% confidence intervals on the lead and lag terms from Equation (3) with the year prior to must-access PDMP implementation normalized to zero. Allegations refer to the number of children per 1000 with at least one allegation of physical abuse or neglect. Substantiations refer to the number of children per 1000 with at least one substantiated case of physical abuse or neglect. Specifications include county and year fixed effects; percent female, white, Black, Hispanic population; number of cancer deaths per 100,000 population; percent population under age 19, between 20 and 24, between 25 and 34, between 35 and 44, between 45 and 54, and between 55 and 64; unemployment and labor force participation rates. Standard errors are clustered on state with 44 clusters.

Panel A. Alleged physical abuse or neglect

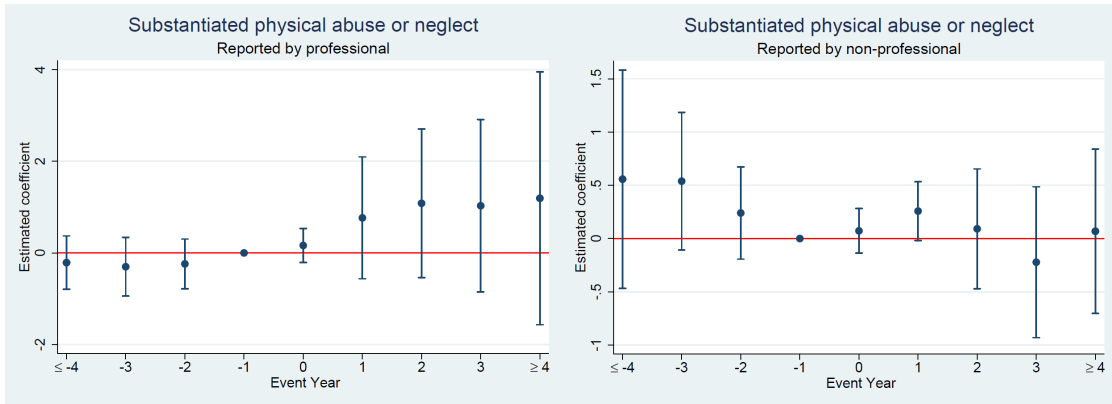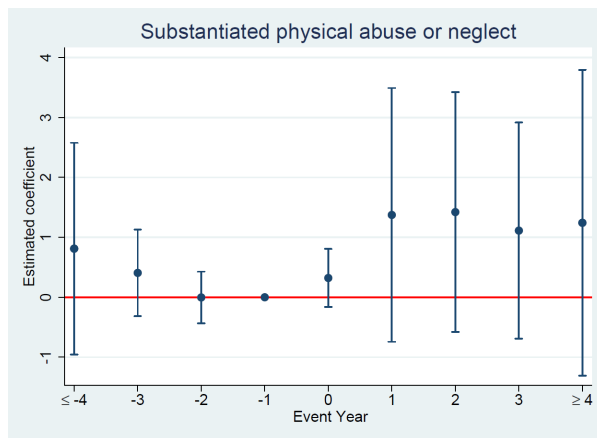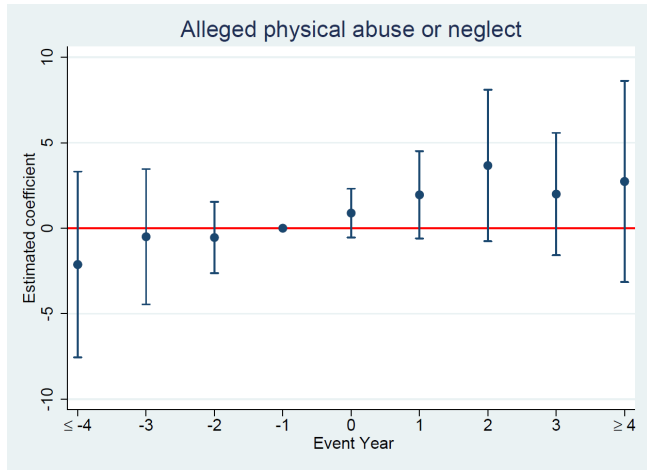Panel B. Substantiated physical abuse or neglect

FIGURE B3. PDMP ANALYSIS: EVENT STUDY RESULTS WITH STATE-BY-YEAR SAMPLE

Notes Each figure reports weighted least squares estimates and 95% confidence intervals on the lead and lag terms from Equation (3) with the year prior to must-access PDMP implementation normalized to zero. Allegations refer to the number of children per 1000 with at least one allegation of physical abuse or neglect. Substantiations refer to the number of children per 1000 with at least one substantiated case of physical abuse or neglect. Specifications include county and year fixed effects; percent female, white, Black, Hispanic population; number of cancer deaths per 100,000 population; percent population under age 19, between 20 and 24, between 25 and 34, between 35 and 44, between 45 and 54, and between 55 and 64; unemployment and labor force participation rates. Standard errors are clustered on state.

Panel A. Alleged sexual abuse

Alleged sexual abuse

Panel B. Substantiated sexual abuse

Substantiated sexual abuse

FIGURE B4. PDMP ANALYSIS—EVENT STUDY RESULTS FOR SEXUAL ABUSE

Notes Each figure reports weighted least squares estimates and 95% confidence intervals on the lead and lag terms from Equation (3) with the year prior to must-access PDMP implementation normalized to zero. Allegations refer to the number of children per 1000 with at least one allegation of sexual abuse. Substantiations refer to the number of children per 1000 with at least one substantiated case of sexual abuse. Specifications include county and year fixed effects; percent female, white, Black, Hispanic population; number of cancer deaths per 100,000 population; percent population under age 19, between 20 and 24, between 25 and 34, between 35 and 44, between 45 and 54, and between 55 and 64; unemployment and labor force participation rates. Standard errors are clustered on state.

Panel A: Alleged physical abuse and neglect
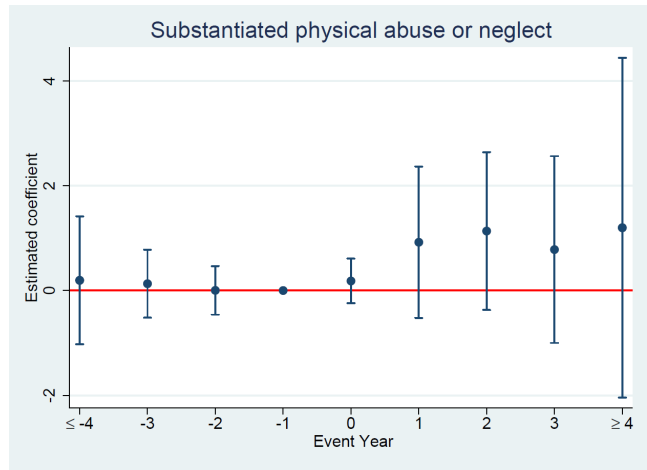

Panel B: Substantiated physical abuse and neglect

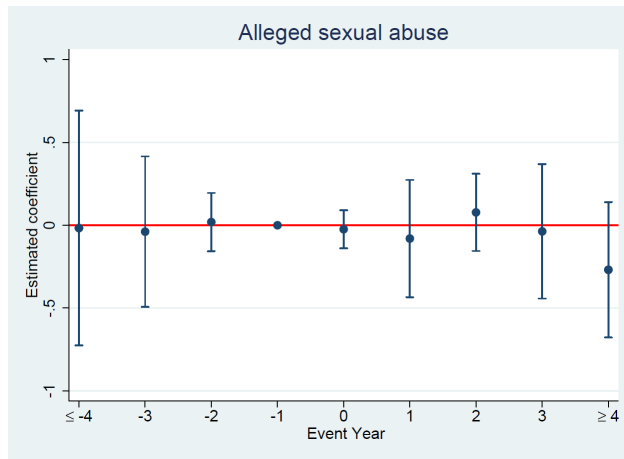FIGURE B5. PDMP ANALYSIS: PLOTS OF GOODMAN-BACON DECOMPOSED 2X2 DID ESTIMATES

Notes: The figure reflects the results of the Bacon decomposition on estimates from a model weighted by child population, with state and year fixed effects, percent female, white, Black, Hispanic population; number of cancer deaths per 100,000 population; percent population under age 19, between 20 and 24, between 25 and 34, between 35 and 44, between 45 and 54, and between 55 and 64; unemployment and labor force participation rates. Standard errors are cluster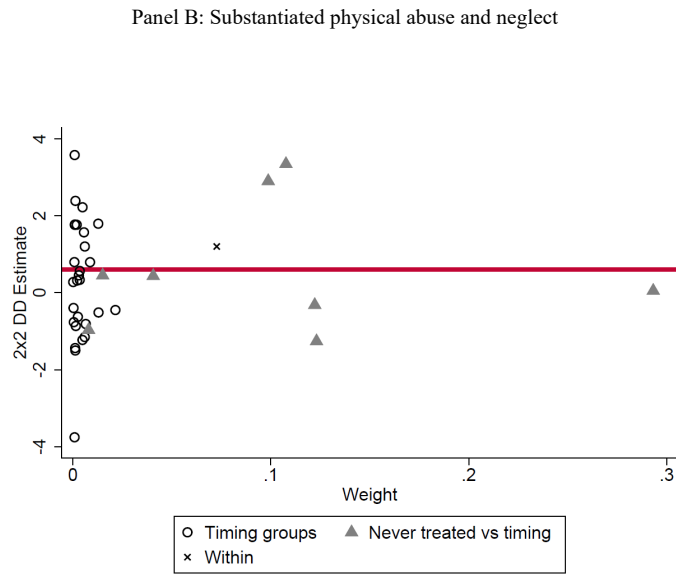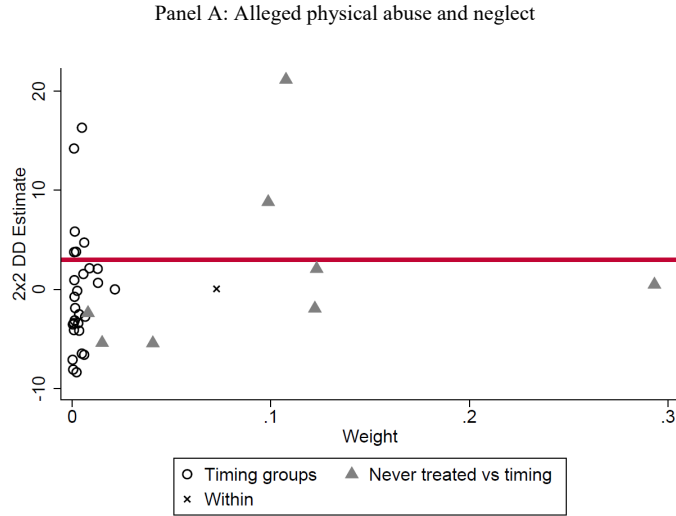ed on state. Allegations refer to the number of children per 1000 with at least one allegation of physical abuse or neglect. Substantiations refer to the number of children per 1000 with at least one substantiated case of physical abuse or neglect.

TABLE B1. YEARS IN WHICH MUST-ACCESS PDMPS WENT INTO EFFECT FOR ADOPTING STATES

Year	States			
2007	NV			
2008				
2009				
2010	OK			
2011		OH		
2012	DE	KY	NM	WV
2013	MA	NY	TN	VT
2014	IN	LA		
2015	CT	NJ	VA	
2016	NH	RI		

Notes: Must-access PDMP implementation dates were taken from Sacks et al. (2021), but with five corrections based on information uncovered from state statutes.

    i.   Georgia was removed from the treatment group. Georgia did not implement a must-access PDMP until 2018 through 2018 Georgia Code Title 16. Crimes and Offenses § 16-13-63 Section.

    ii.   Louisiana's date was changed to 2014 (LA Rev Stat § 40:978 Section F).

    iii.   Massachusetts's date was changed to 2013. Massachusetts implemented a must-access PDMP in 2013 under Chapter 94C Sec 24A.

    iv.   Ohio's date was changed to 2011. For physicians specifically, Ohio's must access provision went into effect in 2011 under Chapter 4731-11-11.

    v.   Oklahoma's date was changed to 2010. Starting in November 2010 prescribers had to check the database before prescribing methadone (see Oklahoma Statutes, 2015. §63-2-302). This provision was broadened to all control substances in 2015 through H.B. 1948, Section G.

TABLE B2. PDMP ANALYSIS: BACON DECOMPOSITION

Treatment-control comparisons	Weight	Average DID estimate	
		Allegations	Substantiations
Timing groups	0.118	0.348	0.266
Never vs. timing	0.809	3.698	0.597
Within	0.073	0.049	1.199

Notes: We perform the Bacon decomposition on estimates from the full sample model, weighted by child population, with state and year fixed effects; percent female, white, Black, Hispanic population; number of cancer deaths per 100,000 population; percent population under age 19, between 20 and 24, between 25 and 34, between 35 and 44, between 45 and 54, and between 55 and 64; unemployment and labor force participation rates. Standard errors are clustered on state. Allegations refer to the number of children per 1000 with at least one allegation of physical abuse or neglect. Substantiations refer to the number of children per 1000 with at least one substantiated case of physical abuse or neglect.

Table B3. PDMP analysis: DID results for child physical abuse and neglect by pre-implementation exposure to prescription opioids

Outcome		Above median pre-implementation exposure	Below median pre-implementation exposure
Panel A: Alleged physical abuse and neglect			
(1)	Allegations	3.624 (2.941)	0.551 (1.450)
(2)	Allegations reported by professional	4.657** (2.152)	1.673 (1.757)
(3)	Allegations reported by non-professional	-0.364 (2.001)	-1.040 (1.179)
Panel B: Substantiated physical abuse and neglect			
(4)	Substantiations	0.474 (0.651)	0.520 (0.611)
(5)	Substantiations reported by professional	0.834 (0.759)	0.763 (0.845)
(6)	Substantiations reported by non-professional	-0.344 (0.433)	-0.254 (0.430)

Notes: Table reports weighted least squares estimates of the β_1 coefficient in equation (4). Allegations refer to the number of children per 1000 with at least one allegation of physical abuse or neglect. Substantiations refer to the number of children per 1000 with at least one substantiated case of physical abuse or neglect. Specifications include county and year fixed effects; percent female, white, Black, Hispanic population; number of cancer deaths per 100,000 population; percent population under age 19, between 20 and 24, between 25 and 34, between 35 and 44, between 45 and 54, and between 55 and 64; unemployment and labor force participation rates. Standard errors in parentheses are clustered on state. Sample reflects 486 unique counties. Above median sample includes 243 unique counties in 38 states. Below median sample includes 243 unique counties in 40 states.

*** Significant at the 1 percent level.

** Significant at the 5 percent level.

* Significant at the 10 percent level.

APPENDIX C: Comparison to Gihleb et al. (2019)

A paper closely related to ours is Gihleb et al. (2019), which finds that the implementation of "mandatory access" PDMPs reduces admissions to the foster care system.[1] In contrast to our findings, their results imply that must-access PDMPs have positive spillover effects on children. By comparison, we find that must-access PDMPs likely have some adverse effect on child maltreatment for the sample as a whole, but our results are less than definitive. We also find evidence of increased numbers of allegations in counties with higher exposure to prescription opioids (relative to counties with lower exposure). Several aspects of our research designs and data may contribute to our divergent findings. First, Gihleb et al. compare states with a must-access PDMP to states with any operational PDMP, meaning their sample excludes states without PDMPs. Second, while both of our outcome measures center around child welfare, our measures of interest are fundamentally different. Child removal and engagement with the foster care system is an extreme outcome and is only one of many possible responses to child abuse or neglect. In 2017, child protective service agencies received referrals involving more than seven million children, whereas roughly 270,000 children entered foster care that same year (U.S. Department of Health and Human Services, 2019; Child Welfare Information Gateway, 2019). Furthermore, Doyle and Aizer (2018) show that the associative relationship between child maltreatment and foster care engagement is incredibly weak. It is therefore possible that a policy intervention, such as the implementation of muss-access PDMPs, can have differing effects on child maltreatment and foster care engagement.

We also note that the only statistically significant adverse effects we uncover are through the split sample DID model for allegations, which examines the effects of must-access PDMP implementation among high exposure counties relative to low exposure counties. This is different than the DID models in Gihleb et al., which examine the effects of must-access PDMPs among all treated versus control states. However, our standard DID model (similar to that of Gihleb et al.) finds close to statistically significant evidence that must-access PDMP implementation leads to an increase in allegations of child maltreatment among the full sample. Nonetheless, this finding still differs from those in Gihleb et al. (2019).

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[1] Gihleb et al. (2019) use the term "mandatory access" while we adopt the term "must-access" following Buchmueller and Carey (2018), and Sacks et al. (2021), among others. In our description of Gihleb et al.'s work, we use "must-access PDMP" to refer to their results about "mandatory access" PDMPs. These terms can be used interchangeable as they both refer to provisions which require the provider to check the PDMP database *before* writing/dispensing a prescription.

Finally, the difference in results between our study and those from Gihleb et al. (2019) could be driven by differences in the timing of treatment (i.e., dates on which states implemented their must-access PDMP). The treatment dates used in our study are triangulated based on Sacks et al. (2021), Gihleb et al. (2019), Mallatt (2020), and the Brandeis University's Prescription Monitoring Program Training and Technical Assistance Center (TTAC). We used the dates from Sacks et al (2021) if all four of the aforementioned sources had the same implementation date. Otherwise, we found additional external sources, relying most heavily on state statutes to determine which date was correct.[2] The dates used in our analysis are listed in Appendix Table B1.[3]

A year-by-year comparison of the treatment and control groups from Gihleb et al. and our study suggests a number of differences, driven by differences in implementation dates. For example, according to Gihleb et al. (2019), Texas implemented a must-access PDMP in 2009, and Florida and Mississippi implemented their respective programs in 2011. Conversely, in our analysis none of these states had a must-access PDMP whatsoever (between the years 2006 and 2016). Similarly, in our study Indiana, and Oklahoma implemented must-access PDMPs during our sample time period, but neither state had such a program in Gihleb et al. (2019).

Finding PDMP dates that differ across studies is relatively common in the literature. Horwitz et al. (2018) document variation in PDMP implementation dates across data sources, suggesting the potential for some degree of measurement error in the implementation dates that we use and those used in Gihleb et al. (2019). Given this, we explore how the estimated effect of must-access PDMP implementation on child maltreatment varies with different assumptions about assignment to and timing of treatment. In the first column of Appendix Table C1, we present results from our DID specification with two baselines for treatment assignment and timing of treatment: Panel A uses information from Gihleb et al., Panel B uses the must-access PDMP implementation dates from our paper.[4] Each subsequent column then 'flips' one state,

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[2] Additional information on must-access PDMP implementation dates and state statutes is available upon request.

[3] After a thorough investigation into state statutes, we made 5 adjustments to the dates in Sacks et al: 1)   Georgia was removed from treatment group (rather than 2014). 2) Louisiana's implementation date was changed from 2009 to 2014. 3) Massachusetts' date was changed to 2013 (rather than 2014). 4) Ohio's date was changed to 2011 (rather than 2012). 5) Oklahoma's date was changed to 2010 (rather than 2011). Further detail on must access PDMP state statutes are available upon request.

[4] For this exercise, we measure child maltreatment as the total number of allegations or substantiations (of any kind) because Florida, which is one of the states where our treatment assignment differs from Gihleb et al, is one of the few states where a large proportion of maltreatment cases are classified as "other" rather than as physical abuse or neglect. For example, in 2017, 44.8 percent of maltreatment cases in Florida were classified into the other category, while for the nation as a whole only 7.1 percent of cases were classified as "other" (U.S. Department of Health and Human Services, 2019). DID results with all allegations and all substantiations (first column of Appendix Table C1, Panel B) are similar to our main DID results, where we focus on alleged and substantiated physical abuse or neglect.

replacing the baseline assumption on treatment status (or timing of treatment) for that state with the analogous assumption in the other study. In the case of Gihleb et al. (Panel A), we reassign a given state the treatment status (or timing of treatment) from our data, and vice versa.   The two key takeaways from Appendix Table C1 are that results using the dates from our paper are generally robust to changes in the composition of the treatment group, as are the results from the Gihleb et al. baseline. Both sets of results are generally insignificant.

In the Gihleb et al. baseline, we find negative and insignificant results, qualitatively consistent with the findings from their paper. However, once Florida is removed from the treatment group, the sign of the DID estimate on substantiations flips and the results suggest that must-access PDMPs are associated with an *increase* in substantiated cases of child maltreatment, though the estimated effect is not statistically significant. Similarly, removing Indiana from our treatment group or adding it to Gihleb et al.'s treatment group flips the sign on allegations. We point out the Florida and Indiana results because their state statutes reveal that Florida should not be in the treatment group while Indiana should be in the treatment group. While Florida did change their PDMP laws in 2011, they adopted a less stringent *mandatory reporting* PDMP at that time. In contrast to a must-access PDMP, which requires prescribers and pharmacists to check a patient's prescription history *before* writing/dispensing a prescription, a mandatory reporting PDMP only requires providers to report the dispensation of a controlled substance to the PDMP database *after* the fact.[5] Florida did not implement a must-access PDMP until 2018 when former Governor Rick Scott signed HB21 into law. Conversely, Indiana did create a must-access PDMP in 2014, and therefore should have been included in the Gihleb et al. treatment group.[6] Furthermore, the PDMP dates used in Gihleb et al. end in 2014, although their sample time period, like ours, extends through 2016. Therefore, the last five columns of Table C1 add (remove) those states that implemented a must-access PDMP in 2015 or 2016 to the Gihleb (our) treatment group.

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[5] According to Florida's 2011 statute 893.055: "each time a controlled substance is dispensed to an individual, the controlled substance shall be reported to the department through the system as soon thereafter as possible, but not more than 7 days after the date the controlled substance is dispensed." https://www.flsenate.gov/Laws/Statutes/2011/0893.055. Accessed on February 19, 2020

[6] Indiana created a must access PDMP in 2014 under   844 Indiana Administrative Code 5-6. According to Section 7 "At the outset of an opioid treatment plan, and at least annually thereafter, a physician prescribing opioids for a patient shall run an INSPECT report on that patient under IC 35-48-7-11.1(d)(4) and document in the patient's chart whether the INSPECT report is consistent with the physician's knowledge of the patient's controlled substance use history." https://casetext.com/regulation/indiana-administrative-code/title-844-medical-licensing-board-of-indiana/article-5-standards-of-professional-conduct-and-competent-practice-of-medicine/rule-844-iac-5-6-opioid-prescribing-requirements

It is important to note that while the signs flip when Florida is appropriately excluded from the treatment group and when Indiana is correctly added to the treatment group, neither of these coefficients are statistically significant. Furthermore, the extent to which Gihleb et al.'s results on foster care admissions are robust to alternative assumptions about treatment assignment or timing of treatment remains unclear but the results in Appendix Table C1 suggest that differences in assumptions regarding these features provide an additional explanation for the divergence in ours and Gihleb et al.'s findings. We also reiterate that, while differing treatment dates may be one source for our divergence in findings, there are two other important differences, as discussed above: first, the construction of control groups differs. In Gihleb et al., they exclude states without an operational PDMP from their analysis, while our control group is a combination of states with no PDMP and states with a PDMP but no must-access provision as in Buchmueller and Carey (2018). Second, and arguably most importantly, we are measuring different outcomes of interest, and while child maltreatment and foster care engagement are both adverse childhood outcomes, they are not strongly related to one another (Doyle and Aizer, 2018).

TABLE C1. SENSITIVITY TO MUST-ACCESS PDMP TREATMENT ASSIGNMENT AND TIMING OF TREATMENT

Panel A. Baseline from Gihleb et al. (2019)							MA PDMPs Implemented after 2014				
	All dates from Gihleb et al.	Remove FL from treatment	Remove TX from treatment	Remove MS from treatment	Add OK to treat-ment	Add IN to treat-ment	Add VA to treatment	Add CT to treatment	Add NJ to treatment	Add NH to treatment	Add RI to treatment
All allegations	-1.186	-0.550	-0.961	-1.405	-1.269	1.114	-1.284	-1.504	-1.112	-1.175	-1.214
	(1.270)	(1.426)	(1.436)	(1.222)	(1.291)	(1.728)	(1.247)	(1.267)	(1.258)	(1.267)	(1.268)
All substantiations	-0.004	0.349	-0.095	-0.092	0.100	0.253	0.001	-0.0284	-0.010	-0.006	-0.005
	(0.499)	(0.542)	(0.580)	(0.505)	(0.496)	(0.503)	(0.472)	(0.488)	(0.478)	(0.495)	(0.497)

Panel B. Evans et al.							MA PDMPs Implemented after 2014				
	All dates from Evans et al.	Add FL to treatment	Add TX to treatment	Add MS to treatment	Remove OK from treat-ment	Remove IN from treat-ment	Remove VA from treatment	Remove CT from treatment	Remove NJ from treatment	Remove NH from treatment	Remove RI from treatment
All allegations	1.817	0.808	1.031	1.979	2.035	-1.149	2.085	2.275	1.870	1.817	1.862
	(2.353)	(2.088)	(1.614)	(2.228)	(2.505)	(1.521)	(2.463)	(2.439)	(2.509)	(2.361)	(2.364)
All substantiations	0.612	0.184	0.554	0.694	0.502	0.298	0.630	0.652	0.649	0.617	0.616
	(0.618)	(0.530)	(0.480)	(0.597)	(0.642)	(0.610)	(0.650)	(0.632)	(0.653)	(0.621)	(0.621)

Notes: All allegations reflect the number of children per 1000 with at one least maltreatment allegation (of any type). All substantiations reflect the number of children per 1000 with at least one substantiated maltreatment case (of any type). All models include year and county fixed effects; percent female, white, Black, Hispanic population; number of cancer deaths per 100,000 population; percent population under age 19, between 20 and 24, between 25 and 34, between 35 and 44, between 45 and 54, and between 55 and 64; unemployment and labor force participation rates. Standard errors are clustered at the state level. Must-access PDMP dates from Gihleb et al. (2019): Delaware (2012), Florida (2011), Kentucky (2012), Louisiana (2014), Massachusetts (2013), Mississippi (2011), New Mexico (2012), Nevada (2007), New York (2013), Ohio (2011), Tennessee (2013), Texas (2009), Vermont (2013), West Virginia (2012) . Must-access PDMP dates from Evans et al. are presented in Table B1.

*** Significant at the 1 percent level.

** Significant at the 5 percent level.

* Significant at the 10 percent level.

Appendix D: Institutional Details on NCANDS Reporting

In the NCANDS data, county reflects the county of report or the jurisdiction to which the child report was assigned. Most states have a county-based system for investigating child abuse and neglect allegations so for most cases the county of report is highly likely to be the county of residence. RI and MA represent exceptions. In RI, all cases are handled by the state-level office in Providence. In MA, catchment areas for the Department of Social Services are not based on county boundaries; for cases in MA, the assigned county reflects the county associated with the area office responsible for investigating the case. Thus, while there are 14 counties in MA, all child abuse/neglect cases in MA are assigned to one of 11 counties.

To address one source of measurement error, we follow the recommendation in the NCANDS User's Guides to keep only the instance in the most recent fiscal year. An instance may be reported in multiple years for several reasons, including for example, cases with appeals. We do this to avoid counting the same incident – or the same report – in multiple years. This does not preclude the inclusion of multiple reports in multiple years for one child.

In the manuscript, we state "State reporting under NCANDS is voluntary but most states and the District of Columbia consistently report during the period covered by our analysis." The states that failed to report in at least one year between 2006 and 2017 were MD, MI, ND, and OR.

On the construction of super counties: DE and MA do not have a super county as all of the cases in these states are assigned to counties. This is also the case for DC. Additionally, in the following states, the super county consists of the entire state: MD, MI, ND, OR, RI, VT, WY.

Finally, with respect to heterogenous actions between states in mapping incidents into maltreatment types, NCANDS documentation includes state forms to map maltreatment into categories. Unfortunately, these forms are inconsistently available across states over the sample period making it difficult to systematically document differences.