Closing the Opioid Use Disorder Treatment Gap: Expanding Nurse Practitioners' Prescriptive Authority

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Buprenorphine, like nicotine gum for quitting smoking, provides a safe treatment for opioid withdrawal, yet access remains limited. The 2016 Comprehensive Addiction and Recovery Act (CARA) enabled Nurse Practitioners (NPs) to prescribe buprenorphine. Leveraging pre-existing state-level NP prescribing authority and comparing pre- and post-CARA periods, I find that allowing NPs to prescribe buprenorphine independently expands the pool of active buprenorphine prescribers, increases buprenorphine dispensation, and reduces opioid-related mortality by over 20%, without replacing specialized treatment. Gains were concentrated in underserved counties, with limited effects elsewhere. Finally, there is suggestive evidence of increased diversion into the secondary market.

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I. Introduction

Opioid use disorder (OUD) remains a leading public health concern in the United States, contributing to three-quarters of all overdose deaths. Synthetic opioids like fentanyl are now the leading cause of death for Americans aged 18 to 45.[1] While medications such as buprenorphine are shown to reduce opioid misuse and overdose risk (Connery 2015; Timko et al. 2016; Ma et al. 2019), a substantial treatment gap persists. Recent estimates suggest that 87% of individuals who could benefit from medication for OUD remain untreated (Krawczyk et al., 2022).

A key contributor to this gap is the limited availability of qualified prescribers. In 2016, nearly one-third of Americans lived in counties without a federally designated opioid treatment program (OTP), and fewer than 10% of primary care physicians were authorized to prescribe buprenorphine (McBain et al., 2020). To address provider shortages, the Comprehensive Addiction and Recovery Act (CARA) of 2016 expanded prescribing authority to Nurse Practitioners (NPs), who comprise approximately 20% of the primary care workforce.[2]

This policy change raises a number of questions. Did expanding buprenorphine prescribing authority to NPs meaningfully increase access to treatment? Did it improve health outcomes? And through what mechanisms did these improvements occur? I study these questions using a difference-in-differences (DiD) framework that exploits variation introduced by CARA, which authorized NPs to prescribe buprenorphine for the first time. Crucially, the effect of this federal reform depends on whether a state permits NPs to prescribe independently. In full-practice states, NPs were able to prescribe buprenorphine without physician oversight following CARA's enactment. In contrast, NPs in restricted-practice states remained subject to supervision or collaboration requirements, limiting the practical impact of the federal reform. I leverage this interaction between federal and state policy—before and after CARA, and across states with differing scope-of-practice laws—to isolate the effect of allowing NPs to prescribe buprenorphine independently, referred to throughout as "the policy," on relevant outcomes.

I begin by examining whether the policy led to greater treatment access. Using Medicare Part D data, I find that NP prescribing of buprenorphine increased substantially, representing

[1] National Center for Health Statistics, Multiple Cause of Death via CDC WONDER, Accessed: 09/07/2024
[2] Primary care is defined here as family practice, internal medicine, and general practice physicians, as well as NPs.

an expansion equivalent to 17% of all prescribers prior to CARA. Automation of Reports and Consolidated Orders System (ARCOS), which tracks the distribution of controlled substances, indicates a 14% increase in buprenorphine dispensation attributable to the policy. This expansion is associated with a 22% reduction in opioid-related mortality, based on data from the National Center for Health Statistics. To my knowledge, this is the first study to document population-level health effects of buprenorphine treatment outside controlled clinical settings.

The decline in mortality appears to operate through two primary channels. First, the policy expanded the prescriber pool by both enabling NPs to enter the buprenorphine market and encouraging participation by other primary care providers. In the years following CARA's passage, the number of active buprenorphine prescribers per capita (including NPs) increased by 47%, while the average number of prescriptions per provider declined. This pattern points to an extensive margin response. Importantly, the policy increased the total supply of prescribers rather than reallocating prescribing activity from specialists to primary care providers. There is no evidence that the policy reduced prescribing by psychiatrists or addiction medicine specialists, and it did not displace care provided through OTPs. Second, the policy helped narrow geographic disparities in access to treatment. Opioid-related mortality fell by approximately 30% in counties lacking an OTP. In contrast, counties with OTP access experienced no statistically significant change in mortality, despite increases in dispensation across both groups. This asymmetry suggests that expanding NP prescribing authority can be an especially effective tool in underserved areas, where newly active prescribers help fill gaps in care. In contrast, adding more prescribers in already well-served areas appears to yield limited marginal benefits.

As buprenorphine prescribing expanded, an important concern is whether increased availability enabled greater use outside formal treatment channels—echoing early dynamics of the opioid crisis, which was partly fueled by widespread access to prescription opioids (Alpert et al. 2018; Currie and Schwandt 2021; Alpert et al. 2022). If mortality declines reflect genuine recovery, we would expect to see a corresponding reduction in opioid misuse. However, data from the National Survey on Drug Use and Health (NSDUH) show no decrease in self-reported illicit drug use or opioid misuse following the policy change. At the same time, self-reported street-level prices from StreetRx, a crowdsourced platform that tracks illicit drug transactions, fell signif-

icantly. This pattern—greater formal dispensation without a decline in misuse, coupled with falling street prices—suggests increased diversion. One plausible explanation for the coexistence of increased diversion and falling mortality is that some diverted buprenorphine is being used as a safer substitute for more lethal opioids, such as fentanyl or heroin.[3]

I do not estimate the overall treatment effect of CARA; instead, I focus on one provision—granting NPs the authority to prescribe buprenorphine independently. This policy appears particularly effective compared to other demand-side interventions.[4] Its effectiveness likely stems from addressing a critical constraint: the shortage of qualified providers in underserved areas. While the 2023 Omnibus Bill further expands prescribing rights to all DEA-registered providers, returns may diminish as many providers had already entered under CARA. Additional prescribers alone are unlikely to resolve broader access barriers. Pharmacy stocking remains limited (Weiner et al., 2023), and prior authorization requirements can deter use.[5] Complementary demand-side policies are needed to promote patient engagement, lower logistical and financial burdens, and ensure that expanded provider capacity translates into meaningful increases in effective treatment.

***Literature*:** First, this is the first paper to evaluate the effectiveness of medications for OUD at the population level. Existing evidence largely comes from cohort studies (e.g., Degenhardt et al. 2014; Larochelle et al. 2018; Dever et al. 2024) and meta-analyses (e.g., Ma et al. 2019; Sordo et al. 2017), which consistently find that buprenorphine reduces mortality by roughly 50 percent among individuals with OUD. However, these studies are typically limited to select subpopulations, such as patients admitted for non-fatal overdose, and may be subject to selection bias. By contrast, I use a quasi-experimental design that captures a broader and more representative population. I find that expanding buprenorphine access reduces opioid-related mortality by 22% at the county level.

[3] An alternative explanation is that the mortality reduction would have been even larger absent diversion. While this cannot be ruled out, the size of the observed decline makes that interpretation less plausible. In conversations with addiction medicine physicians, one noted that patients sometimes request buprenorphine to "get by" on days when they cannot afford heroin or fentanyl—behavior consistent with self-medication rather than misuse.

[4] For example, Abouk et al. (2019) find that pharmacist naloxone access reduced mortality by 0.03 per 100,000, while the policy studied here reduces mortality by nearly 2 per 100,000. Medicaid expansion has shown little impact on opioid mortality (Averett et al., 2019; Abouk et al., 2021).

[5] According to a 2024 American Medical Association survey, 93% of physicians reported care delays due to prior authorization.

Second, this paper contributes to a growing body of work on the health effects of NPs' scope of practice. Traczynski and Udalova (2018) document that NP autonomy improves access to primary care and reduces emergency room utilization. Alexander and Schnell (2019) find that granting NPs authority to prescribe unscheduled medications leads to improvements in mental health. More recent work uses the staggered adoption of NP scope-of-practice laws to study broader effects on access and prescribing behavior (e.g., Currie, Li, and Schnell 2023). While informative, these staggered rollouts largely occurred during a period when the opioid epidemic was shifting from prescription opioids to illicit fentanyl, complicating comparisons across early and late adopters. By contrast, I leverage a single-period policy shock—CARA's 2016 authorization of NP buprenorphine prescribing—interacted with state-level practice restrictions to isolate the causal effect of allowing NPs to prescribe independently. I show that this expansion increased the number of active buprenorphine prescribers, improved access to treatment, and led to meaningful reductions in opioid-related mortality.

Third, this is the first paper in the economics literature to evaluate the impact of CARA on treatment expansion, contributing to a broader policy discussion around the opioid crisis. While prior work has predominantly focused on supply-side measures—such as the 2010 OxyContin reformulation (Severtson et al., 2013; Alpert et al., 2018; Evans et al., 2019), the implementation of prescription drug monitoring programs (Mallatt, 2018, 2022), and DEA enforcement targeting rogue distributors (Donahoe, 2024; Gui et al., 2024; Soliman, 2024)—these policies have often reduced access to prescription opioids without improving health outcomes, and in some cases, have led to substitution into illicit markets. In contrast, recent policy discussions have turned toward demand-side responses, including harm reduction strategies and expanded access to treatment. One area of recent focus has been naloxone access laws, which show mixed evidence: while some studies report mortality reductions (Abouk et al., 2019; Rees et al., 2019), others find no mortality effect but increased emergency department visits (Doleac and Mukherjee, 2022). This paper raises similar concerns about buprenorphine—namely, potential diversion as evidenced by declining secondary market prices. However, unlike naloxone, which is administered reactively, buprenorphine can substitute for more dangerous opioids in daily use. The findings show that expanded buprenorphine access reduces opioid-related mortality, suggesting it may

offer broader population health benefits than harm reduction policies alone.

The remainder of the paper is structured as follows. Section II describes the data sources and construction of key variables. Section III outlines the empirical strategy, including the DiD design and associated identification challenges. Section IV presents the main findings on the effects of granting Nurse Practitioners independent authority to prescribe buprenorphine. Section V explores the mechanisms underlying these effects, including patterns of prescriber entry and differential mortality reduction. Section VI examines potential unintended consequences, including evidence of diversion to the secondary market. Section VII reports a series of robustness checks. Section VIII discusses implications for the regulation of OUD treatment and offers policy recommendations. Section IX concludes.

II. Data

This analysis draws on three primary data sources to examine how granting NPs the authority to independently prescribe buprenorphine affects treatment availability, shipments to pharmacies, and opioid-related mortality between 2012 and 2019. States are classified based on the extent of NP scope-of-practice authority following McMichael and Markowitz (2023), distinguishing between full-practice states—where NPs may prescribe without physician oversight—and restricted-practice states, where such independence is prohibited. Key features of the data are summarized below; additional institutional details are provided in Appendix A.

A. Scope-of-Practice State-level Regulation

Scope-of-practice laws for NPs differ significantly across states, with substantial variation in the specific language of the regulations. Following the classification by McMichael and Markowitz (2023), I categorize states as either full-practice or restricted-practice based on whether NPs can establish independent practices without physician collaboration or supervision. Figure 1 illustrates the adoption of full-practice authority for NPs by episodes. Before 2013, 17 states, including the District of Columbia, allowed NPs to prescribe Schedule II-V controlled substances independently. Between 2013 and 2019, an additional 12 states transitioned to full-practice status, reflecting a nationwide expansion of NP prescriptive authority. However, several states,

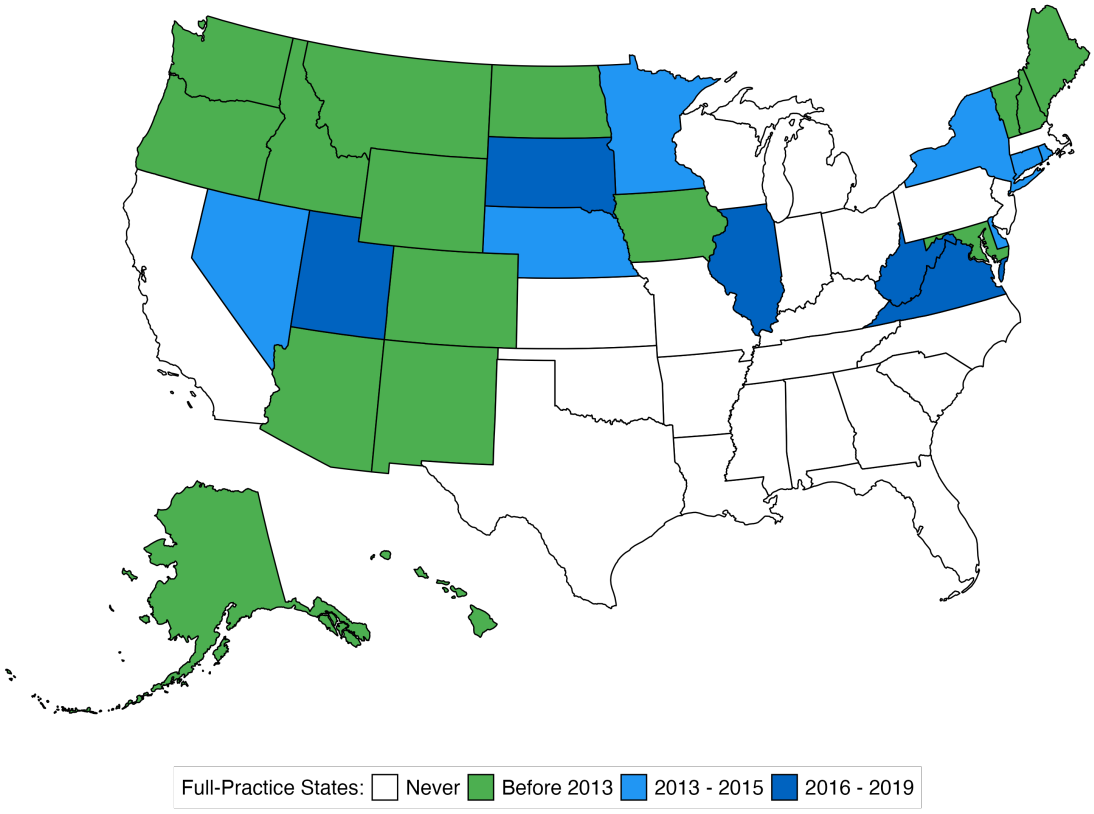


Figure 1. State Scope-of-Practice Law Status

Note: The term "full-practice states" denotes jurisdictions where NPs are authorized to prescribe controlled substances independently, without requiring supervision or collaboration with physicians. In essence, an NP's ability to prescribe is not contingent upon a doctor's oversight.

particularly in the South and large states like California, Texas, and Florida, continue to impose restrictions on NP independence.

Despite differences in practice authority and geographic location, the overall distribution of healthcare providers is relatively similar across the two categories of states. Table C1 presents the 2015 summary statistics of general practice physicians (including family practice) and NPs per 100,000 people across full-practice and restricted-practice states.[6] It is important to note that, at the state level, the composition of healthcare providers—including the number of NPs and general practice physicians—does not differ significantly between these two categories, at least within primary care. Consistent with Alexander and Schnell (2019), the adoption of full-practice authority appears to reflect political and institutional variation rather than systematic differences in local health needs.

To assess potential confounding policy environments, I estimate a series of balancing regressions examining whether the adoption of independent NP prescribing correlates with other state-level laws during the study period. Table C2 shows no systematic associations, mitigating concerns that the estimated effects reflect underlying policy bundles rather than the effect of the prescribing expansion itself. To further address concerns about cross-county comparability, the primary empirical specification employs a county-level synthetic DiD approach that reweights observations to ensure that treated and control units are similar in pre-treatment trends and characteristics.

B. Access to OUD Treatment

This analysis draws on two primary datasets to measure local access to OUD treatment: (1) the Drug Enforcement Administration's Automation of Reports and Consolidated Orders System (ARCOS), and (2) the Medicare Part D Provider and Drug dataset. These sources allow me to identify both methadone-dispensing OTPs and buprenorphine prescribers at the county level in 2013, prior to the policy change.

ARCOS is a national surveillance system established under the Controlled Substances Act of 1971. It tracks shipments of controlled substances from manufacturers and distributors to

[6]Provider counts are from June 9, 2015, using the Wayback Machine archive of the NPPES NPI registry, link: Wayback Machine archive.

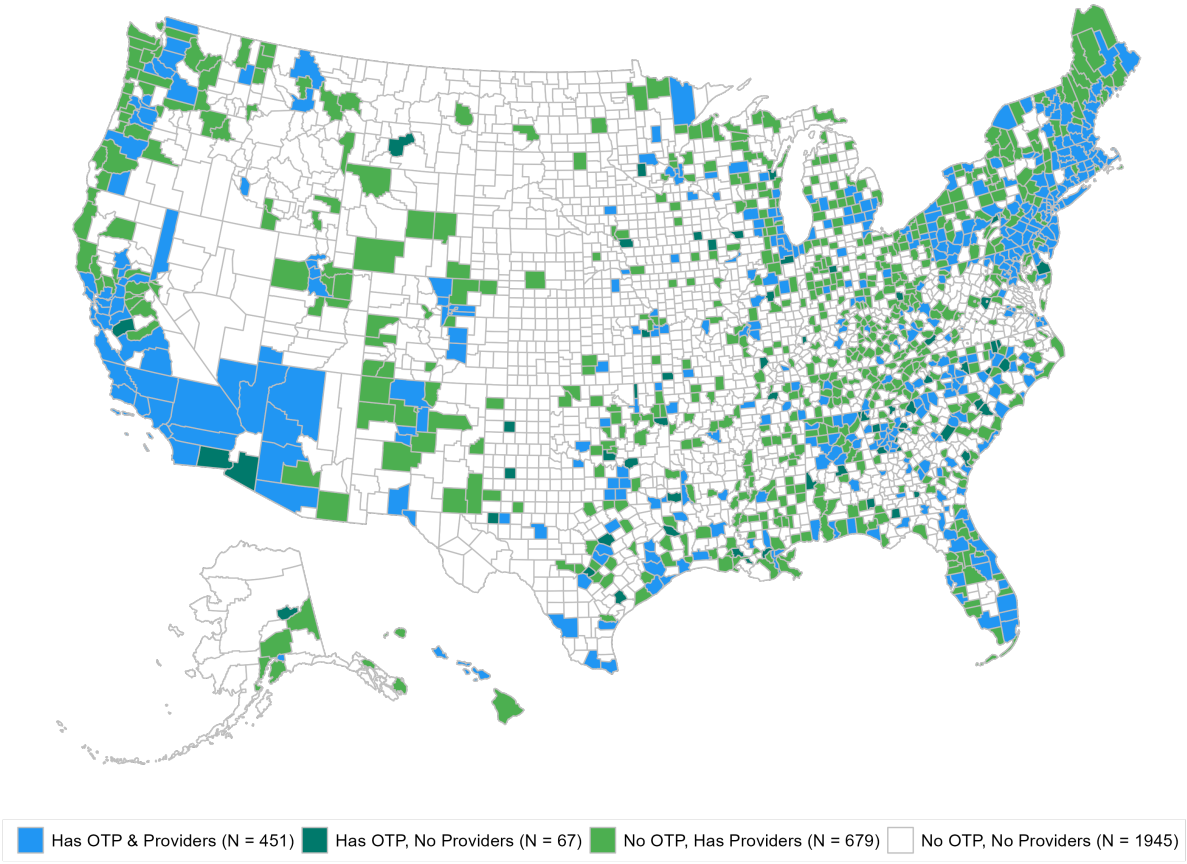


Figure 2. Geographic Distribution of OUD Treatment Access in 2013

Note: Access to OTPs is identified through ARCOS data if the facility is listed for maintenance or detoxification services and received methadone shipments for OUD, as indicated by National Drug Codes. Provider access is measured by the presence of Medicare Part D prescribers who issued prescriptions for buprenorphine-naloxone, the most common buprenorphine formulation used in OUD treatment.

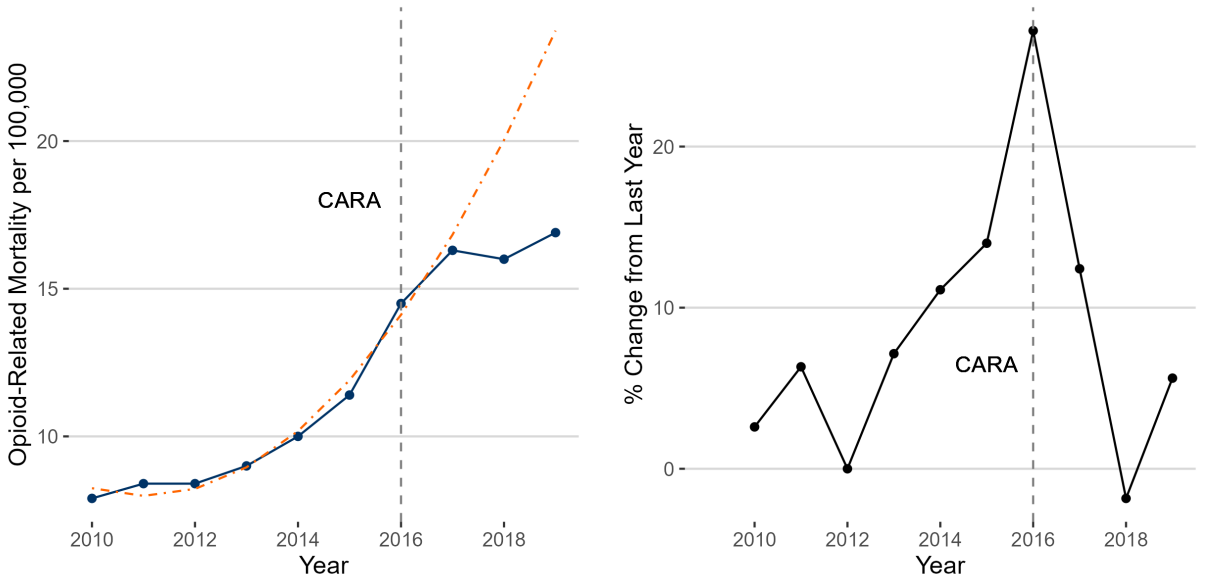
retail-level facilities, including hospitals, pharmacies, and OTPs. The dataset records the date, quantity, dosage, and National Drug Code for each shipment, as well as the identities of the sending and receiving entities. I use ARCOS to identify OTPs that received methadone for OUD treatment, defined by the presence of detoxification or maintenance service codes associated with the receiving entity and methadone-specific NDCs.[7] In parallel, I use Medicare Part D data to identify prescribers of buprenorphine-naloxone—the dominant formulation for outpatient treatment. This dataset reports, for each provider-drug pair, the number of claims and total spending. Prescribers with 10 or fewer claims are excluded. Although Medicare represents only a subset of buprenorphine prescribers, I show in Appendix B that the number of Medicare buprenorphine prescribers in a county strongly predicts the total number of authorized providers based on DEA public request records.

Using these two sources, I classify OUD treatment access as follows: a county is considered to have access if it contains at least one methadone-dispensing OTP or one Medicare Part D buprenorphine-naloxone prescriber. Figure 2 maps access across the United States in 2013. Approximately 62% of counties lacked both an OTP and a Medicare buprenorphine prescriber. About 13% of the U.S. population resided in such counties, while 31% lived in counties without OTP access. These gaps are especially acute in rural areas, including in regions heavily affected by the opioid crisis, such as Appalachia.

OTPs and non-OTP providers differ in both treatment modality and care intensity. OTPs are the only facilities federally authorized to dispense methadone and typically provide structured, high-contact care for patients with severe or complex needs. In contrast, non-OTP providers—such as primary care physicians and NPs—can prescribe buprenorphine in outpatient settings, offering a more accessible but less specialized form of care. CARA expanded access by allowing NPs, after completing 24 hours of training, to prescribe buprenorphine independently in full-practice states.

Two limitations merit note. First, the access measure is binary and does not reflect treatment capacity or provider density. Second, reliance on Medicare data may understate access in counties where prescribers do not treat Medicare beneficiaries. Nonetheless, the Medicare data

[7]This excludes methadone formulations primarily indicated for pain.



(a) Opioid-Related Mortality Rate

(b) Percentage Change in Mortality

Figure 3. National Trends in Opioid-Related Mortality

Note: The figures depict opioid-related mortality per 100,000 people, sourced from the National Vital Statistics System using codes T40.0–T40.4, as well as X42, X62, and Y12. The dashed orange line in Subfigure 3a represents a polynomial fit for the pre-2016 trend (2010–2016). Subfigure **??** shows the percentage change from the previous year, calculated as $(Y_t - Y_{t-1})/Y_{t-1}$.

provide a useful proxy for overall availability, and variation across counties captures meaningful disparities in the treatment landscape.

C. Health Outcomes

The health outcome I focus on is opioid-related mortality. The opioid-related mortality data are from the restricted National Vital Statistics System for the years 2012 to 2019. This dataset provides granular details on the date and location (down to the county level) of all deaths in the United States, along with their causes. Following standard practice in opioid research, I use multiple cause-of-death codes to identify fatal drug overdoses involving opioids, specifically T40.0–T40.4, X42, X62, and Y12.

Figure 3a shows the overall trend in opioid-related mortality rates, while Figure 3b highlights the annual percentage changes. Notably, between 2016 and 2017, the United States saw its first

decline in opioid-related deaths per capita in 25 years, and this trend remained relatively stable until the onset of the COVID-19 pandemic. This stabilization, following years of exponential growth, suggests a significant shift occurred in 2016.

The analysis in this paper does not focus on differences between predicted trends and observed outcomes, which could represent the treatment effect of CARA under certain assumptions, primarily the absence of other interventions in 2016. However, given the multiple federal and state policies enacted that year—for instance, the CDC's opioid prescription guidelines and Arizona's over-the-counter naloxone law—this approach is not feasible. Instead, using mortality as an example for illustration, I compare the differences in mortality reductions between states with restricted practice authority and those with full practice authority. This comparison isolates the additional reduction in mortality observed in full-practice states, which I interpret as the effect of granting NPs independent authority to prescribe buprenorphine.

III. Empirical framework

A. Event Study Difference-in-Differences

To estimate the impact of allowing NPs to prescribe buprenorphine independently, I implement an event study DiD framework. I use the timing of CARA implementation to distinguish between pre- and post-implementation periods, with 2015 serving as the omitted baseline year ($k = 2015$).[8] The treatment group consists of states with full-practice authority, in which NPs could prescribe independently following CARA. The control group includes states with restricted-practice authority, where NPs remained subject to physician oversight. The main outcome variable, Y_{it}, is measured at the county-year or state-year level. I examine several outcomes, such as the number of NPs actively prescribing buprenorphine, per capita buprenorphine dispensation, and per capita opioid-related mortality. The sample is restricted to the years 2012–2019 and excludes states that modified NP scope-of-practice laws during this period. The

[8]CARA was signed into law on July 22, 2016, and its implementation did not occur until October 2017.

estimating equation is given by:

$$Y_{it} = \sum_{k \neq 2015} \tau_k^{did} \times Treat_i + X_{it}\delta + \phi_i + \psi_t + \epsilon_{it} \tag{1}$$

Here, τ_k^{did} captures the year-specific treatment effect relative to 2015. The vector X_{it} includes demographic and socioeconomic controls (e.g., age, gender, race, income, educational attainment, poverty, and unemployment rates), as well as state-level policies that may influence opioid-related outcomes. These policies include: (i) naloxone access laws, which enhance public access to the opioid overdose reversal drug; (ii) involuntary commitment laws for substance use, which allow courts to mandate treatment for individuals arrested for drug-related offenses; (iii) informed consent laws requiring disclosure of risks before opioid prescribing; (iv) limits on opioid prescribing duration or dosage; (v) prescription drug monitoring programs, which track controlled substance prescriptions; and (vi) Medicaid expansion under the Affordable Care Act. Additionally, ϕ_i and ψ_t represent unit- and year-fixed effects, respectively.

B. Event Study Synthetic Difference-in-Differences

To improve comparability between treated and control counties, I implement the synthetic DiD estimator developed by Arkhangelsky et al. (2021) and adapt it to an event study framework. This approach reweights control units so that their pre-treatment outcome trajectories more closely resemble those of the treated units, helping to address violations of the parallel trends assumption. For example, if a treated county experienced a gradual rise in buprenorphine dispensation before the policy, the estimator assigns greater weight to control counties with similar upward trends—rather than averaging over all control counties, many of which may have flat or declining trends. This targeted weighting limits the influence of dissimilar units and improves the credibility of the estimated policy effect.

I begin by residualizing the outcome with respect to covariates and fixed effects, and then estimate treatment effects by tracking deviations between treated units and their synthetic controls over time. This framework produces a set of year-specific estimates, τ_t^{sdid}, which are directly comparable to the coefficients from the event study specification in Equation 1.

The procedure begins by estimating a two-way fixed effects regression:

$$Y_{it} = X_{it}\beta + \gamma_t + \delta_i + u_{it}, \tag{2}$$

and then constructing residualized outcomes:[9]

$$\tilde{Y}_{it} = Y_{it} - X_{it}\hat{\beta} - \hat{\gamma}_t - \hat{\delta}_s \tag{3}$$

Let N index all units, with N_{tr} treated units and $N_{co} = N - N_{tr}$ controls. Unit weights $\hat{\omega}_i$ are chosen to minimize pre-treatment imbalances such that: $\sum_{i=1}^{N_{co}} \hat{\omega}_i \tilde{Y}_{it} \approx N_{tr}^{-1} \sum_{i=N_{co}+1}^{N} \tilde{Y}_{it}$ for all $t \leq T_{pre}$. Time weights $\hat{\lambda}_t$ are also estimated to balance pre- and post-treatment periods. Details on the weight estimation process can be found in Arkhangelsky et al. (2021).

The synthetic control outcome for treated unit j in year t is defined as $\tilde{Y}_{jt}^{co} = \sum_{i=1}^{N_{co}} \hat{\omega}_i \tilde{Y}_{it}$, and the event study estimate is computed as:

$$\tau_t^{sdid} = \left(\bar{\tilde{Y}}_t^{tr} - \bar{\tilde{Y}}_t^{co}\right) - \left(\bar{\tilde{Y}}_{baseline}^{tr} - \bar{\tilde{Y}}_{baseline}^{co}\right) \tag{4}$$

In the standard DiD approach, the baseline is typically fixed—often the year prior to treatment. In Equation 1, 2015 serves as the baseline. However, in the synthetic DiD approach, pre-treatment weights are optimally chosen as $\hat{\lambda}_t$, which implies a data-driven baseline constructed from the pre-treatment period.[10]

$$\bar{\tilde{Y}}_{baseline}^{tr} = \sum_{t=1}^{T_{pre}} \hat{\lambda}_t \bar{\tilde{Y}}_t^{tr}, \quad \text{and} \quad \bar{\tilde{Y}}_{baseline}^{co} = \sum_{t=1}^{T_{pre}} \hat{\lambda}_t \bar{\tilde{Y}}_t^{co} \tag{5}$$

[9] This approach deviates slightly from the original method proposed in Arkhangelsky et al. (2021), which regresses Y directly on covariates without fixed effects. However, based on findings by Kranz (2023), I opt for residualization with fixed effects.

[10] Unit weights $\hat{\omega}_i$ remain fixed across post-treatment periods, as they are determined solely by pre-treatment fit. However, the event study framework raises the question of whether time weights should vary across post-treatment years. To assess this, I recalculate time weights separately for each post-treatment period by iteratively including one additional post-treatment year in the pre-treatment set used to generate $\hat{\lambda}_t$. This alternative weighting scheme yields results nearly identical to the baseline specification, indicating that the estimated effects are not sensitive to how time weights are constructed.

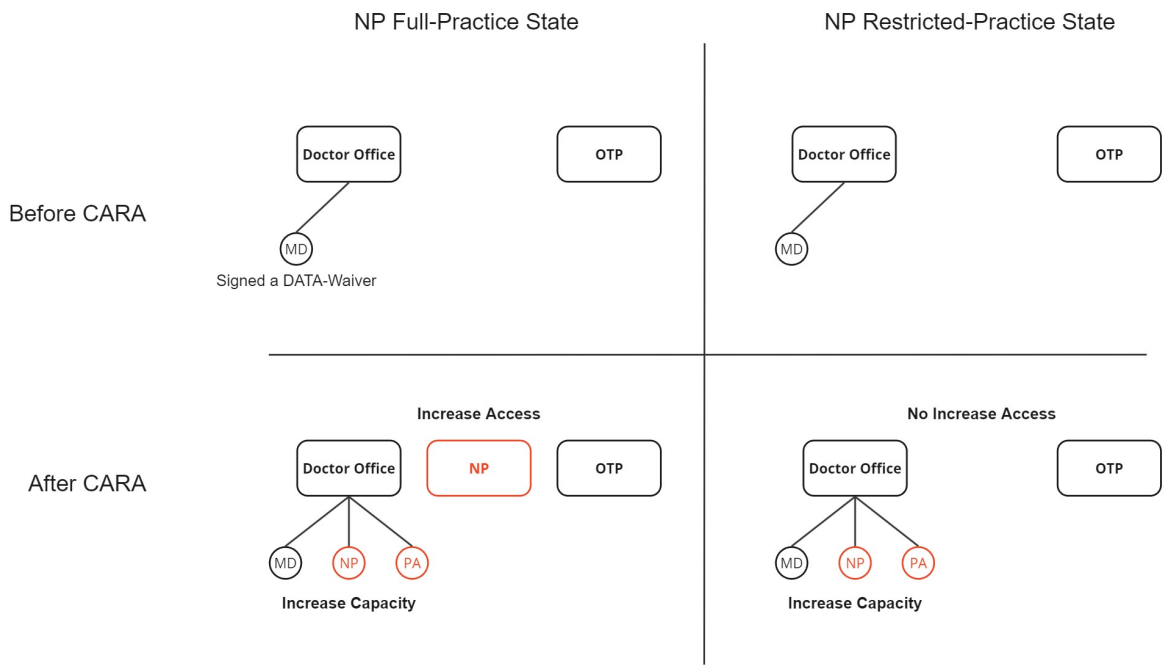


Figure 4. CARA and Scope-of-Practice Laws Interaction

Lastly, the confidence intervals for τ_t^{sdid} are constructed using bootstrap methods.

C. *Interpretation of The Treatment*

Figure 4 illustrates how CARA interacts with state-level NP regulations to generate treatment variation. In restricted-practice states, NPs may prescribe buprenorphine only under physician supervision and can obtain a waiver, but only if their supervising physician also holds one. This may increase prescribing capacity within existing practices, but does not expand the number of treatment locations. In full-practice states, CARA allows NPs to obtain waivers and prescribe independently. This regulatory combination—federal authorization and state-level autonomy—creates new treatment locations and expands access for patients.

These mechanical differences also imply divergent incentive structures. Independent NPs, who are responsible for building and maintaining their own patient panels, have stronger incentives to offer buprenorphine as a way to attract patients. I therefore expect greater uptake of buprenor-

phine prescribing among NPs in full-practice states. Moreover, this entry may generate strategic responses from other primary care providers. In anticipation of NP entry, physicians may begin prescribing buprenorphine themselves to retain patients. I provide evidence of this dynamic in the results that follow. Taken together, these mechanisms suggest a greater expansion in treatment availability—and consequently greater buprenorphine use—in full-practice states relative to restricted-practice states.

This framework also clarifies the interpretation of the estimated treatment effect. One potential concern is that other components of CARA—or unrelated policies introduced around the same time—could confound the estimates if their effects were concentrated in full-practice states. To my knowledge, the only component of CARA that may have varied significantly across states is the allocation of federal grant funding. However, these funds were not disbursed until late 2017, after the initial effects observed in the data. Moreover, according to Murrin (2020), states allocated CARA funds in broadly similar ways, primarily to support treatment expansion. It is unlikely that differential grant use drives the observed treatment effects. I also examine whether other state-level policies confound the estimates in the next subsection.

D. Identification Assumptions

The primary threat to identification in a DiD framework is the potential violation of the parallel trends assumption. This assumption requires that, in the absence of treatment, trends in outcomes would have evolved similarly across treated and control states, conditional on observables. In this setting, the assumption holds if restricted-practice states serve as credible counterfactuals for full-practice states after the enactment of CARA.

Several features of the institutional environment support this assumption. First, while state scope-of-practice laws govern whether NPs may prescribe independently, federal laws determine whether they may prescribe buprenorphine for OUD. Prior to CARA, state-level scope-of-practice reforms could not have directly affected buprenorphine-based OUD treatment access, limiting concerns that such reforms were endogenous responses to the opioid crisis. In Table C3, I assess this empirically by estimating whether lagged opioid-related mortality predicts adoption of full-practice authority. I find no evidence that prior mortality trends predict the timing of

adoption. This is consistent with Alexander and Schnell (2019), who show that scope-of-practice expansions were driven primarily by state political dynamics rather than local health conditions.

Second, I address the concern that the timing of NP prescribing authority may coincide with other state-level policy changes. While the main regressions control for a broad set of contemporaneous laws, Pei et al. (2019) recommends conducting balancing regressions to assess whether treatment timing is systematically correlated with other policy adoptions. Following this approach, I estimate a series of regressions using each policy variable as the dependent variable and test for correlation with the timing of NP prescribing authority. As shown in Table C2, the timing of expanded NP authority is not systematically associated with any other policy except Medicaid expansion. However, prior research finds that Medicaid expansion had little impact on opioid-related mortality (Averett et al., 2019; Abouk et al., 2021), indicating that this overlap is unlikely to meaningfully bias the estimates.

Third, I exclude from the main analysis states that transitioned to full-practice authority after the baseline year (2015)—specifically, Illinois, South Dakota, and Virginia—to maintain a clean separation between treated and control groups. I also exclude states that adopted full-practice authority between 2012 and 2015 (Connecticut, Delaware, Minnesota, Nevada, New York, and Rhode Island). While these states transitioned prior to CARA, NPs may not have had sufficient time to establish independent practices before the federal expansion took effect. Including them could conflate early adoption effects with the treatment effect of interest. As a robustness check, I include these states as treated units and find that results remain consistent.

Finally, even if the standard parallel trends assumption is violated, the synthetic DiD estimator can still yield consistent estimates under weaker identifying assumptions. Specifically, it requires only that reweighted control units form a valid synthetic counterfactual for treated units. As shown in the event study results below, pre-treatment estimates are close to zero and statistically insignificant, offering additional support for the identification strategy.

IV. Main Results

This section presents the main findings. I begin by showing that granting NPs independent authority to prescribe buprenorphine led to a substantial increase in the number of NPs actively

prescribing. This expansion in prescriber access was accompanied by a corresponding increase in buprenorphine dispensation. Finally, I document a significant reduction in opioid-related mortality associated with these changes.

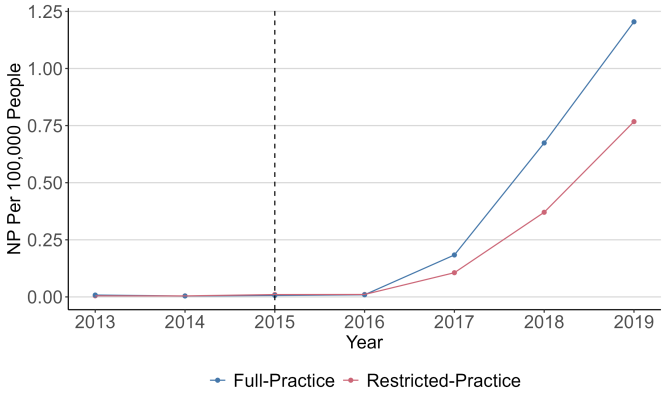
A. Increasing Number of NPs Prescribing Buprenorphine

Figure 5a shows the annual average number of NPs prescribing buprenorphine per 100,000 people in full-practice and restricted-practice counties.[11] Prior to 2016, NPs were generally not authorized to prescribe buprenorphine, aside from narrow exceptions.[12] Following the passage of CARA, NP prescribing increased in both groups of counties, but the increase was significantly larger in full-practice counties. This divergence is consistent with regulatory constraints: in restricted-practice counties, NPs must prescribe under physician supervision, which may limit both capacity and incentives to enter the market. In contrast, NP autonomy in full-practice states likely encouraged independent prescribing. Figure 5b presents DiD estimates of the policy effect using Equation 1, while Figure 5c implements the same specification using the synthetic DiD estimator (Equation 4). Estimates from both approaches are similar, though the synthetic DiD is preferred for its greater robustness to violations of the parallel trends assumption. The results indicate that allowing NPs to prescribe buprenorphine independently led to an increase of 0.41 NPs per 100,000 residents by 2019. For context, the average number of active buprenorphine prescribers in full-practice counties in 2015 was 1.53 per 100,000 people, implying a 27% increase in provider availability over the four-year period.

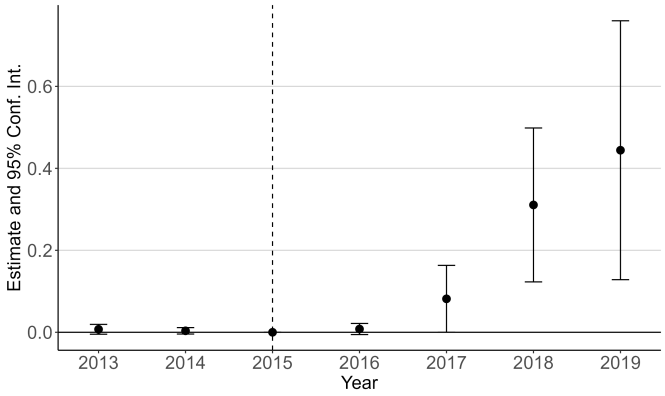
An important question is whether these findings based on Medicare Part D data generalize to the broader provider population. First, the Medicare-based results serve as a robustness check for the broader analysis in the next subsection, which uses shipment data to capture overall dispensation. This observed increase primarily reflects new provider entry rather than intensified prescribing by existing providers. Second, concerns about selection bias in the Medicare data are likely minimal in this context. Although the Medicare population is older, buprenorphine supply

[11] Most of my analysis spans the years 2012 to 2019 in order to include a longer pre-treatment period, which strengthens the credibility of the results by providing a better assessment of pre-trends. However, due to limitations in the Medicare Part D dataset—which is only available from 2013 onward—analyses that rely on Medicare Part D data are restricted to the 2013–2019 period.

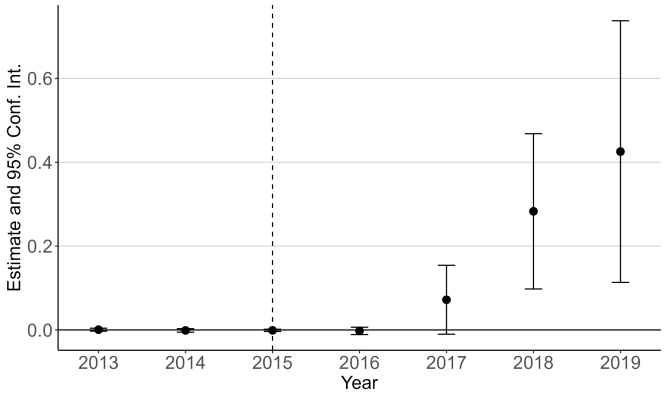
[12] In some cases, NPs could petition to prescribe controlled substances in areas with physician shortages, though such waivers were rare and difficult to obtain.



(a) Mean Trends



(b) Dynamic DiD Results



(c) Dynamic Synthetic DiD Results

Figure 5. Effect on the Number of Buprenorphine Prescribing NPs

Note: This figure examines the number of NPs per 100,000 people across counties. Panel (a) shows raw trends in the county-level average number of NPs from 2013 to 2019, comparing full-practice and restricted-practice states. Panel (b) presents event-study estimates from Equation 1, with 95% confidence intervals and county-clustered standard errors. Panel (c) displays estimates from the synthetic DiD specification in Equation 4, with confidence intervals computed via bootstrap resampling.

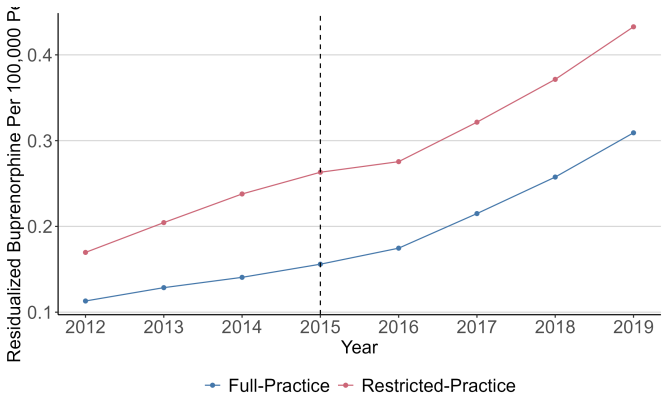
is not age-targeted: providers willing to prescribe to Medicare beneficiaries are generally not restricted to that demographic. In fact, relying solely on the Medicare population is unlikely to be financially viable for buprenorphine prescribers, as younger patients comprise the bulk of OUD cases. Moreover, Medicare Part D data capture roughly two-thirds of all active buprenorphine prescribers nationally, and prescriber counts from this source are strongly correlated with overall provider availability at the county level (Appendix B).

B. Increasing Buprenorphine Dispensation

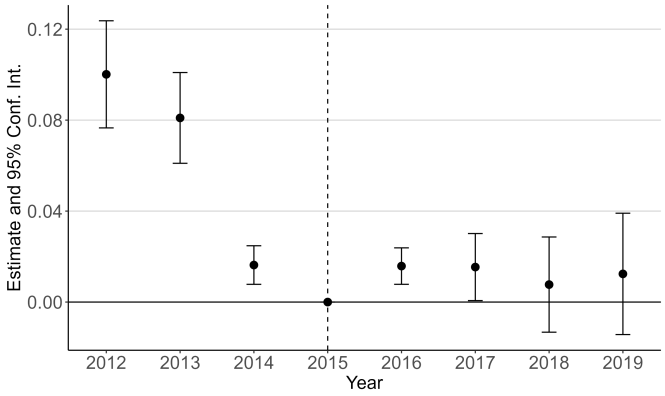
The previous subsection showed that allowing NPs to prescribe independently led to a substantial increase in the number of NP buprenorphine prescribers. I now examine whether this expansion in prescriber supply resulted in greater buprenorphine use, as measured by the volume of buprenorphine dispensed.

Figure 6a plots per capita buprenorphine dispensation, measured in morphine gram equivalents, across full-practice and restricted-practice counties. Prior to 2015, restricted-practice counties had higher average levels of buprenorphine dispensing. This gap narrowed in the years following CARA. To quantify these changes, Figure 6b shows DiD estimates based on Equation 1, and Figure 6c presents synthetic DiD estimates based on Equation 4. By 2019, full-practice counties experienced a nearly 20% increase in buprenorphine dispensation relative to 2015 levels. Interestingly, the increase in dispensation begins in 2016, before CARA's NP prescribing provision took effect in 2017. Although this may appear counterintuitive, it is consistent with anticipatory behavior. Providers may have expanded prescribing in response to the expected entry of NPs. By mid-2016, it was widely known that CARA had passed and would authorize NPs to prescribe buprenorphine. In anticipation, providers may have sought to establish patient relationships before NPs entered the market. I return to this mechanism in Section VI.

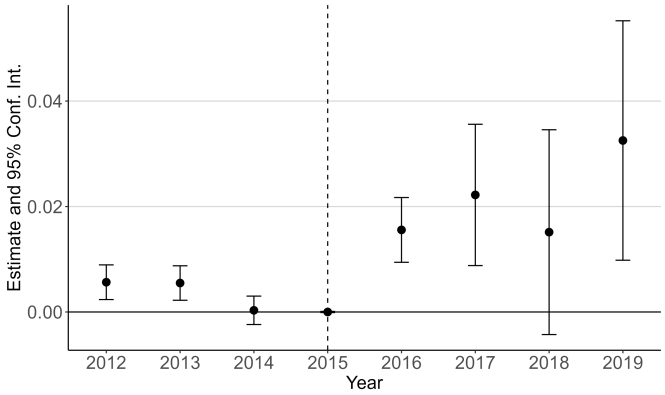
The implications of increased buprenorphine dispensation are nuanced. On the one hand, expanded access likely improved treatment uptake among individuals with OUD. On the other hand, higher dispensation volumes may raise concerns about diversion. As I show in a later section, secondary-market growth appears concentrated in the pure buprenorphine formulation,



(a) Mean Trends



(b) Dynamic DiD Results



(c) Dynamic Synthetic DiD Results

Figure 6. Effect on the Buprenorphine Dispensed Per Capita

Note: This figure examines the number of NPs per 100,000 people across counties. Panel (a) shows raw trends in county-level averages from 2013 to 2019, comparing full-practice and restricted-practice states. Panel (b) presents event-study estimates from Equation 1, with 95% confidence intervals and standard errors clustered at the county level. Panel (c) displays estimates from the synthetic DiD specification in Equation 4, with confidence intervals computed via bootstrap resampling.

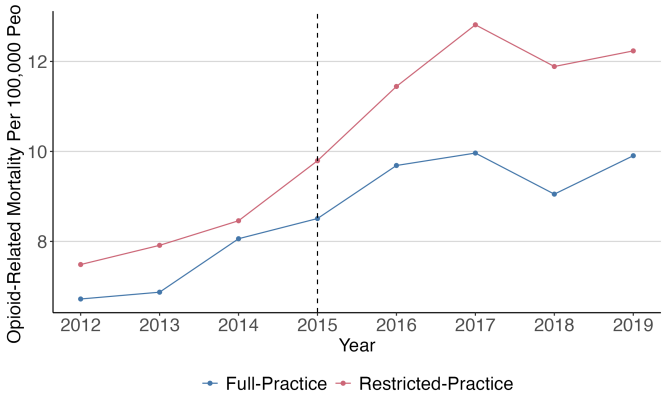
which has higher misuse potential than the buprenorphine-naloxone combination.

C. *Decrease Opioid-Related Mortality*

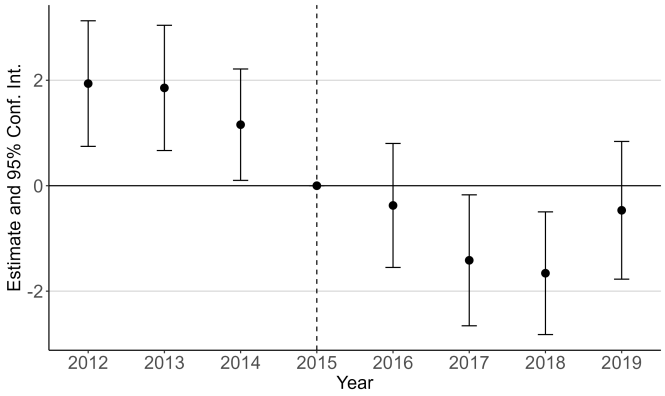
A central question in evaluating this policy is whether expanding NP prescribing authority improves health outcomes. I focus on opioid-related mortality as the primary outcome. Figure 7a plots average opioid overdose death rates (per 100,000 population) for full-practice and restricted-practice counties. Prior to 2016, restricted-practice counties exhibited slightly higher mortality, though trends were broadly similar across both groups. In the years following CARA, mortality rates declined in both groups, but the reduction was substantially larger in full-practice counties. This widening gap is consistent with the interpretation that independent NP prescribing contributed to a greater expansion in access to treatment and, ultimately, improved outcomes.

Figure 7b presents estimates based on Equation 1, while Figure 7c shows corresponding results using the synthetic DiD estimator (Equation 4). Both sets of estimates show a substantial decline in opioid-related mortality. According to the synthetic DiD results, mortality in full-practice counties fell by 22% relative to 2015 levels, with the largest reduction of 31% occurring in 2018, followed by a slight tapering in 2019.

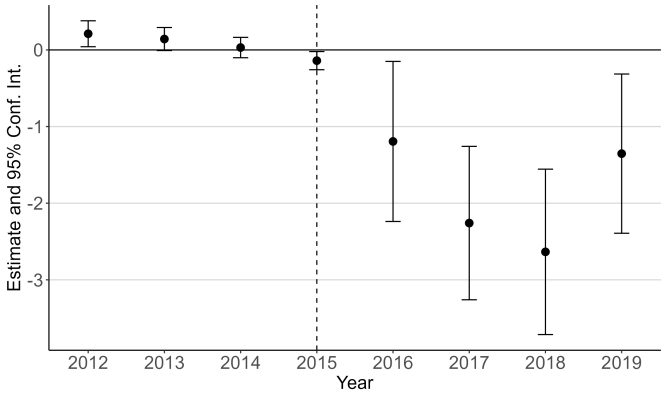
These reductions are large compared to the effects of other well-studied interventions. For example, Doleac and Mukherjee (2022) find that expanding naloxone access does not significantly reduce opioid-related deaths. Similarly, Medicaid expansion—despite covering medications for OUD—has not been consistently shown to increase buprenorphine uptake or lower mortality (Averett et al. 2019; Abouk et al. 2021). In contrast, the results presented here suggest that increasing the supply of authorized prescribers can directly reduce mortality by narrowing the treatment gap. While naloxone alone is critical for preventing fatal overdoses, it does not address the underlying addiction. These findings underscore the importance of improving access to buprenorphine rather than relying on downstream interventions alone.



(a) Mean Trends



(b) Dynamic DiD Results



(c) Dynamic Synthetic DiD Results

Figure 7. Effect on Opioid-Related Mortality Per 100,000

Note: This figure reports estimates of opioid-related mortality per 100,000 people at the county level. The construction mirrors that of Figure 5. Panel (a) presents raw trends by state practice authority. Panel (b) shows event-study estimates from Equation 1, with standard errors clustered at the county level. Panel (c) presents synthetic DiD estimates from Equation 4, with confidence intervals computed via bootstrap resampling.

V. Mechanisms

The results so far suggest that supply constraints play an important role in the treatment gap. The policy led to increases in both buprenorphine dispensation and reductions in opioid-related mortality, implying that greater provider availability can translate into improved treatment access and outcomes. This section explores two mechanisms. First, I examine how NP entry affected other providers—specifically, whether it shifted treatment away from specialized care—and whether provider expansion occurred at the extensive or intensive margin. Second, I examine the policy's distributional impact by comparing treatment gains across counties with varying levels of buprenorphine access in 2013.

A. Prescriber Dynamics in Response to Policy Change

The timing of the increase in buprenorphine dispensation suggests that the policy's effects were not limited to NP entry alone. As shown earlier, dispensation began rising in 2016—prior to the implementation of CARA's NP prescribing provision in 2017—suggesting that other providers may have adjusted prescribing behavior in anticipation of the policy change. Figure 8 presents synthetic DiD estimates from Equation 4 for (1) the total number of buprenorphine prescribers per 100,000 residents and (2) the number of buprenorphine-prescribing NPs per 100,000. Because NP prescribers are included in the overall count, any divergence in timing between the two series helps isolate non-NP responses. The results are consistent with anticipatory behavior by non-NP providers: the number of all buprenorphine prescribers rose sharply in 2016, while NP prescribing remained flat. Non-NP growth continued over the following years, and by 2019, the total number of prescribers had increased by 100% relative to 2015 levels, with approximately one-third of that increase attributable to NPs.

This anticipatory pattern likely reflects early entry by primary care physicians, particularly in full-practice states where NPs were expected to gain independent prescribing authority. The passage of CARA in mid-2016 may have prompted some providers to begin prescribing buprenorphine ahead of NP entry, in order to establish patient relationships before competition increased. Importantly, such a response is unlikely to reflect general awareness of CARA alone. If anticipation had occurred uniformly across states, those effects would be differenced out by the DiD

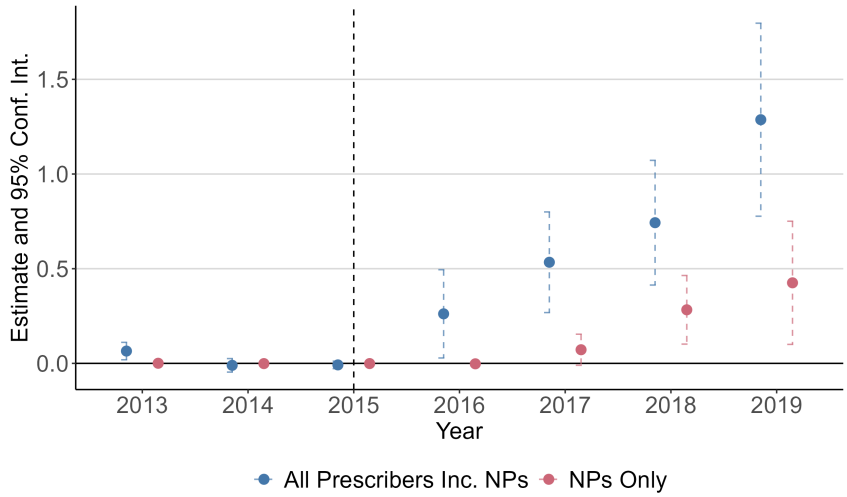


Figure 8. Anticipated Entries by Other Prescribers

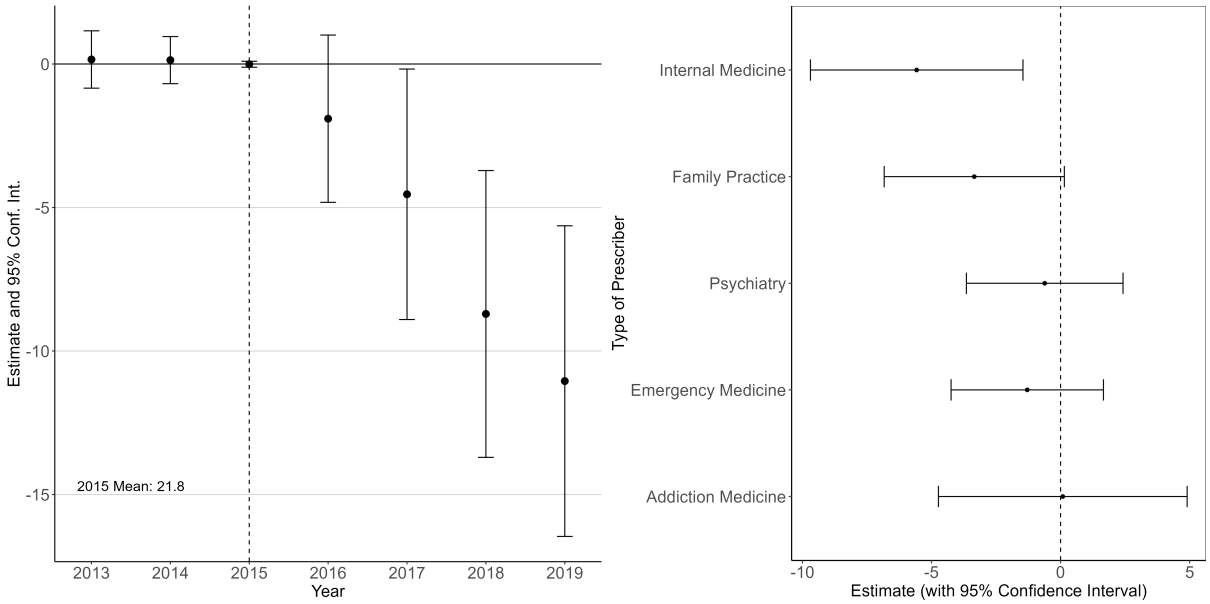
Note: This figure plots synthetic DiD estimates from Equation 4, with standard deviations obtained via bootstrap resampling. The outcomes are (1) the total number of buprenorphine prescribers per 100,000 people, including NPs, and (2) the number of buprenorphine-prescribing NPs per 100,000 people, both measured at the county level. Estimates for NP prescribers replicate those shown separately in Figure 5c. Confidence intervals are computed via boostrap resampling.

framework. The observed divergence instead suggests a differential anticipatory response in states where NPs were positioned to prescribe independently—consistent with providers reacting to the anticipated change in their competitive environment.

While early entry of new providers and expanded prescribing are important, they raise additional questions about the nature of this expansion. Specifically, was growth driven by more providers entering the market (an extensive margin response), or by existing providers writing more prescriptions (an intensive margin response)? Figure 9a plots synthetic DiD estimates of buprenorphine claims per prescriber.[13] Following the policy change, claims per prescriber declined, suggesting that new entry—rather than increased activity by existing providers—was the dominant margin of adjustment.

This shift toward the extensive margin could have important implications for access. It also raises a concern: was this growth in primary care prescribing offset by a decline in specialized treatment? To assess whether expanded NP authority reshaped the composition of prescribers

[13]Counties with no prescribers are coded as zero. The results are similar when restricting the sample to counties with at least one prescriber.



(a) Buprenorphine Claims Per Prescribers

(b) Buprenorphine Claims Per Prescribers by Type

Figure 9. Effect on Other Prescribers

Note: Figures 9a and 9b report estimates from the synthetic DiD approach at the county level. The outcome in Figure 9a is the average number of buprenorphine claims per prescriber, calculated as the total number of claims divided by the number of prescribers in a given county-year. Counties with no prescribers are assigned a value of zero. Figure 9b disaggregates the estimates by provider type, ordered by total prescriber count. Both figures draw on data from the Medicare Part D database. Confidence intervals are computed via boostrap resampling.

by crowding out specialists, Figure 9b presents the corresponding average treatment effect, decomposing claims per prescriber by provider type. The decline is concentrated among family and internal medicine physicians—those most substitutable for NPs in the eyes of patients. In contrast, prescribing by psychiatrists, emergency medicine physicians, and addiction specialists remains stable. This pattern suggests that the policy expanded access through primary care channels without crowding out specialized providers.

Finally, I consider whether buprenorphine prescribing displaced access to methadone treatment at OTPs. These facilities typically serve patients with more severe addiction and are the only settings legally authorized to dispense methadone for OUD. Using methadone dispensation per capita at OTPs as a proxy for treatment intensity in specialized care, I re-estimate Equation 4 and present the results in Figure 10. Contrary to concerns about crowd-out, methadone

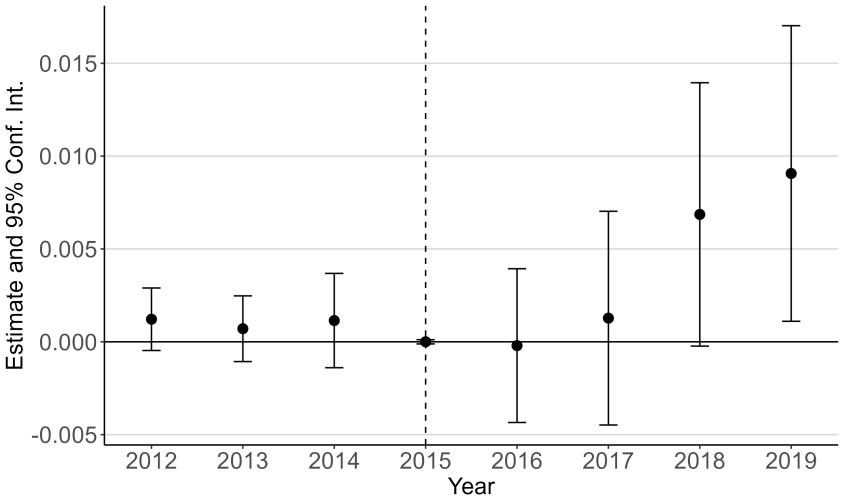


Figure 10. OTP Methadone Dispensation Per Capita

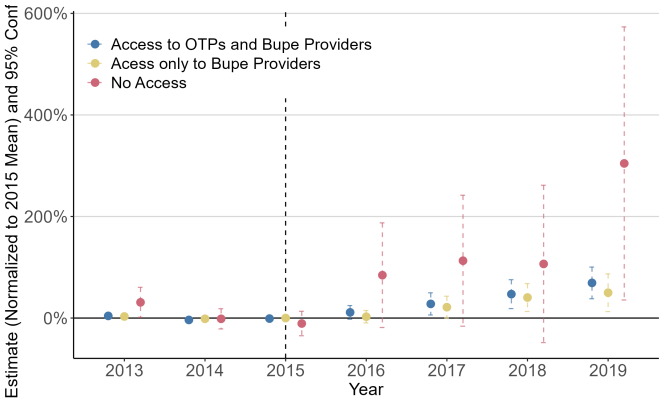
Note: This figure presents synthetic DiD estimates from Equation 4, with the outcome defined as methadone dispensation at OTP, measured in per capita terms at the county level. Confidence intervals are constructed using bootstrap resampling.

use increased in full-practice counties following the policy change. This suggests a complementary relationship: expanded buprenorphine prescribing may have brought more individuals into the treatment system, some of whom were later referred to OTPs.

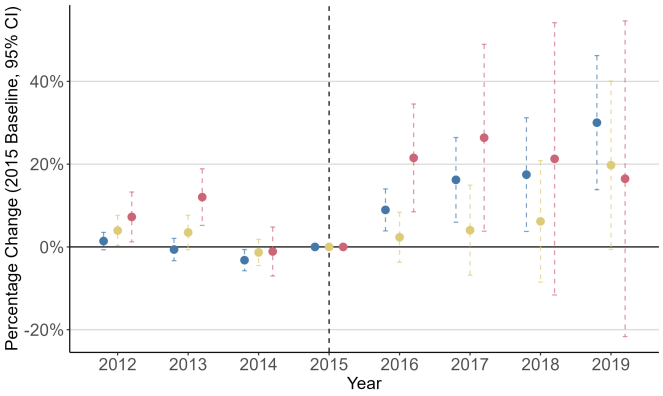
In summary, the policy spurred entry not only among NPs but also among other providers, particularly those in primary care. This expansion reduced provider concentration, with a broader set of prescribers each serving a smaller share of patients. Although I do not observe the number of patients per provider directly, if the number of claims per patient remained relatively stable, this pattern suggests a decline in patient load per prescriber. In rural areas with limited provider access, such a shift could reduce travel distances and shorten wait times for appointments. Notably, the decline in claims per prescriber does not appear in specialties where NPs are unlikely to substitute—such as psychiatry or addiction medicine—indicating that more severe OUD cases likely continue to receive care in specialized settings.

B. Reducing Treatment Inequality

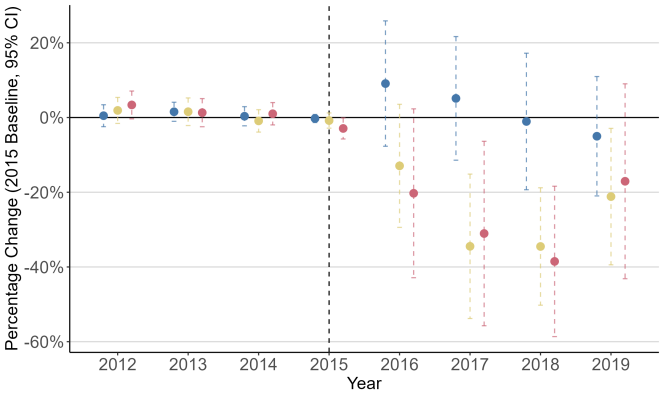
Next, I examine whether the effects of NP prescribing authority vary across counties with different levels of treatment access. If the treatment gap is primarily driven by limited provider



(a) Number of Buprenorphine Prescribers per 100,000



(b) Buprenorphine Dispensation per Capita



(c) Opioid-Related Mortality per 100,000

Figure 11. County Heterogenous Response to NP Independent Prescribing

Note: Figures 11a, 11b, and 11c report county-level synthetic DiD estimates based on Equation 4, stratified by baseline treatment availability in 2013. Counties are grouped into three categories: (1) no access to medication for OUD, (2) access to buprenorphine providers only, and (3) access to both buprenorphine and OTPs. Outcomes are normalized to 2015 averages within each group to facilitate comparison. Confidence intervals are constructed using bootstrap resampling.

supply, the policy should have larger effects in underserved areas. Consistent with this expectation, I find that new prescriber entry disproportionately occurred in counties with limited access, leading to greater reductions in opioid-related mortality.

To assess this, I categorize counties based on treatment availability in 2013 using two indicators: the presence of Medicare Part D buprenorphine prescribers and whether an OTP operated in the county. Counties are grouped into three categories: (1) no access (neither buprenorphine prescribers nor OTPs), (2) buprenorphine-only access, and (3) access to both buprenorphine and OTP services. OTPs are typically located in urban areas. The majority of counties in the sample lacked both types of providers in 2013.[14]

Figure 11 presents results using a synthetic DiD approach, with each outcome normalized by its 2015 mean within county type. Figure 11a shows that the number of buprenorphine prescribers per 100,000 increased most sharply in counties that initially lacked access. Figure 11b shows that buprenorphine dispensation rose across all county types, with early gains concentrated in underserved areas. The most pronounced heterogeneity emerges in mortality outcomes. Figure 11c shows that counties without OTP access experienced nearly a 40% decline in opioid-related mortality by 2018, while counties with both buprenorphine and OTP access saw no statistically significant change. These results suggest that new prescriber entry helps alleviate provider shortages in underserved areas, where additional supply yields the greatest marginal benefit. In contrast, expanding provider supply yields little additional benefit in counties that already have access to OTPs.

A potential concern is that the observed effects might be driven by concurrent changes in OTP availability, rather than by NP prescribing authority alone. This is especially relevant given prior evidence that OTPs play a central role in treating severe OUD. If access to OTPs expanded differentially in full-practice states starting in 2016, it could confound the estimated impact of the policy. To assess this, Figure C1 compares changes in the number of OTPs across county types in full- and restricted-practice states. Trends are largely similar across groups, with

[14] I exclude 67 counties that had OTP access but no Medicare Part D buprenorphine prescribers, as they represent a small group. These counties likely had both types of access in practice, through non-Medicare buprenorphine providers. Including them in the "both access" group does not materially affect the results. Ideally, access types would be defined using data from 2012 to align with the treatment definition and the start of the main analysis period. However, Medicare Part D data are only available beginning in 2013. Baseline access appears relatively stable through 2015, and using 2015 as the reference year yields similar results.

no statistically significant differences until 2019—and even then, only in the most underserved counties. This timing is inconsistent with OTP expansion driving the earlier improvements in treatment access or reductions in mortality.

Taken together, these results underscore that the policy's impact depends on baseline treatment access. In underserved counties, the entry of new prescribers substantially expanded treatment and reduced mortality. By contrast, in areas already served by providers, the marginal returns to additional prescribers were smaller. Notably, while buprenorphine dispensation increased even in counties with OTPs, opioid-related mortality did not decline in those areas—raising the possibility that some portion of the medication was diverted to the secondary market. I examine this possibility in the next section.

VI. Unintended Consequences

While the goal of expanding NP prescribing authority is to improve access to OUD treatment, a key concern—especially given the origins of the opioid epidemic—is the potential for unintended consequences. The initial wave of the crisis was fueled in part by expanded access to prescription opioids, many of which were subsequently diverted to secondary markets. Similarly, expanded buprenorphine availability could lead to informal use if some of the additional supply is diverted outside formal treatment channels. This section considers whether such diversion occurred and whether the observed reductions in mortality reflect improved access to formal care alone, or whether other behavioral responses—such as substitution away from more dangerous opioids or self-medication—may also have played a role. I begin by examining trends in self-reported opioid misuse to assess whether broader reductions in misuse accompanied the decline in mortality. I then turn to street-level price data as an indirect proxy for diversion, using changes in secondary-market pricing to infer shifts in buprenorphine supply.

A. Evidence from Self-Reported Drug Use

To explore whether the mortality reduction reflects true recovery or substitution, I turn to the National Survey on Drug Use and Health (NSDUH). If individuals are entering formal treatment and achieving recovery, we would expect to see declines in self-reported misuse. If, instead, they

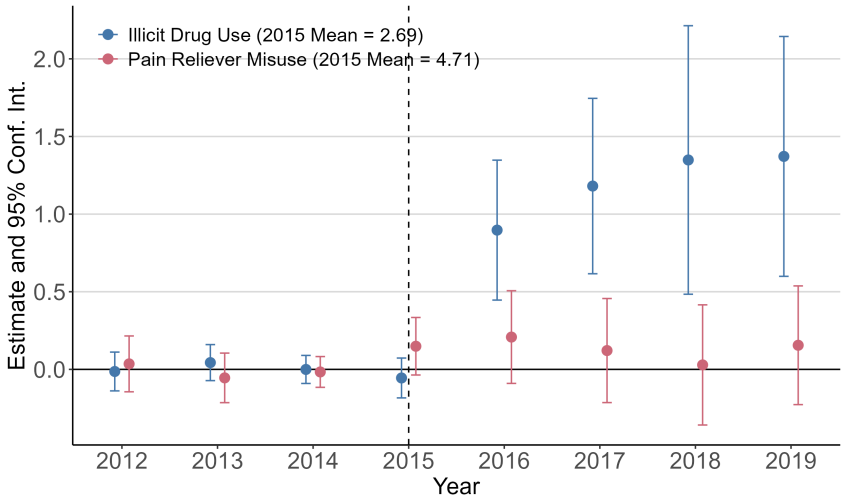


Figure 12. Survey-Reported Drug Misuse

Note: This figure reports synthetic DiD estimates from Equation 4, using data from NSDUH. The outcomes—(1) past-year illicit drug use and (2) past-year non-medical use of pain relievers—are small area prevalence estimates provided by NSDUH at the state level. Confidence intervals are constructed using bootstrap resampling. The 2015 mean in treated states is displayed in the upper-left corner.

are substituting toward buprenorphine obtained through informal channels, opioid misuse rates may remain flat or rise.

Figure 12 plots synthetic DiD estimates of (1) past-year illicit drug use and (2) non-medical use of pain relievers—the NSDUH measure most closely aligned with prescription opioid misuse. In full-practice states, illicit drug use rose by approximately 20% between 2016 and 2019. While this trend may partly reflect methodological changes introduced in 2015—such as revisions to how misuse is defined—the continued increase after 2016 suggests that it cannot be attributed solely to changes in survey design. Pain reliever misuse, which was subject to the same definitional change, does not exhibit a comparable increase. The absence of a similar trend in this measure further supports the view that the rise in illicit drug use reflects real behavioral changes. Moreover, the flat trajectory of pain reliever misuse is inconsistent with large reductions in OUD prevalence and instead suggests that the at-risk population has remained stable. Taken together, the reduction in mortality alongside stable rates of drug misuse suggests that buprenorphine may be used either as a substitute for more dangerous opioids or in combination with other substances, potentially contributing to lower mortality.

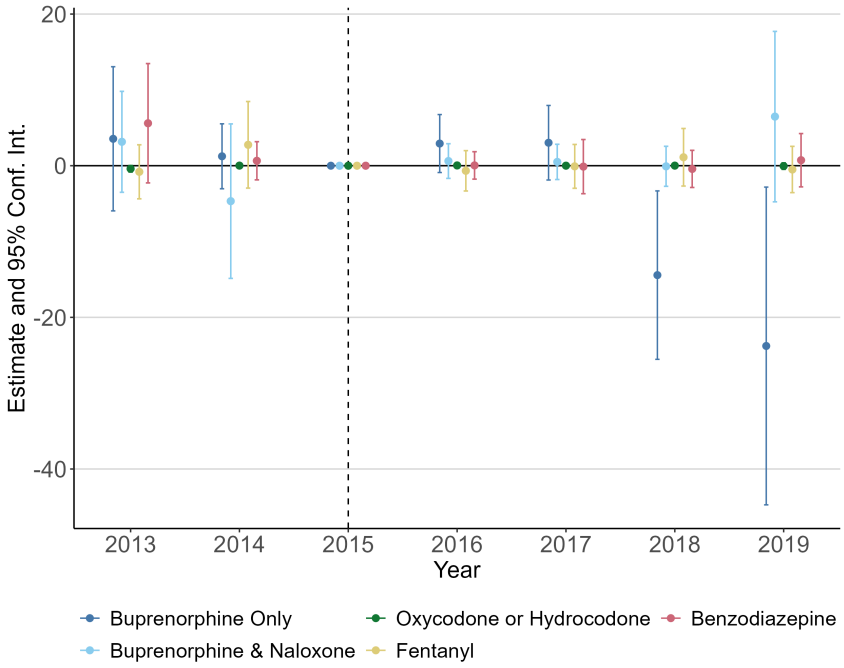


Figure 13. Secondary Market Drug Prices

Note: This figure presents state-level DiD estimates from Equation 1, using self-reported street-level drug prices from the StreetRx database. The outcome is the average price per milligram for six drugs: buprenorphine (pure formulation), buprenorphine-naloxone, fentanyl, hydrocodone, oxycodone, and benzodiazepines. Buprenorphine and buprenorphine-naloxone are medications for OUD; the others are commonly misused opioids or co-used substances. Observations with missing drug-state-year combinations are excluded. Standard errors are clustered at the state level.

B. Evidence from Street Prices

The most direct signal of diversion would be evidence that buprenorphine became more readily available on the street. Although direct measures of secondary-market supply are limited, self-reported transaction prices offer an indirect but informative proxy. A sharp decline in the street price of buprenorphine following the policy change may suggest an increase in supply rather than a drop in demand, particularly given that, as shown in the previous subsection, rates of illicit drug misuse did not decline. An isolated price drop for buprenorphine—especially alongside rising dispensation—is therefore more consistent with increased supply, potentially reflecting the diversion of some prescribed medication into informal markets.

To investigate potential diversion, I use data from StreetRx, a crowdsourced platform that col-

lects self-reported information on illicit drug transactions, including price, formulation, and location. I focus on two formulations of buprenorphine: (1) the pure form, which carries some risk of misuse but remains clinically appropriate for treating OUD, and (2) the buprenorphine-naloxone combination (e.g., Suboxone), which includes an opioid antagonist to reduce abuse potential. For comparison, I also examine prices for fentanyl, hydrocodone, and oxycodone—opioids for which buprenorphine may serve as a substitute—as well as benzodiazepines, which are commonly co-used with opioids. Figure 13 presents estimates from a standard DiD specification (Equation 1) at the state level.[15]

Following the policy change, the street price of pure buprenorphine declined significantly in full-practice states, while prices for the buprenorphine-naloxone combination remained stable. Prices for other opioids and benzodiazepines did not exhibit meaningful changes. This divergence supports a supply-side interpretation: expanded prescriber authority likely increased the overall availability of buprenorphine, and some of the additional supply—especially the more abusable pure formulation—appears to have entered secondary markets. The stability in the price of the abuse-deterrent formulation likely reflects lower demand in informal markets, as the addition of naloxone reduces its appeal for misuse. This underscores the role of product design in limiting diversion: promoting buprenorphine-naloxone as a first-line treatment may help mitigate diversion risks while preserving access to effective care.

These findings complicate efforts to attribute mortality reductions solely to expanded formal treatment access. While increased clinical availability likely played a role, the absence of a decline in self-reported opioid misuse—and the fall in street prices for pure buprenorphine—suggest that diversion to informal markets also occurred. This raises a broader question about how to interpret the role of the secondary market. On the one hand, diversion poses clear risks and can undermine the integrity of the treatment system. On the other hand, in contexts where barriers to care remain high—such as prior authorization requirements and pharmacy shortages—informal access may function as a fallback. While the evidence presented here does not allow a definitive assessment of that possibility, it does show that diversion increased without

[15]Due to missing data in several state-year pairs, the synthetic DiD approach is not applied. State-year observations with missing price data for a given drug are excluded from the analysis.

a corresponding decline in pain reliever misuse or illicit drug use.

VII. Robustness

This section presents several robustness checks to validate the main results.

First, I test whether the treatment effect estimates are driven by idiosyncratic policy spillovers or outlier states. To examine this, I re-estimate Equation 4 using a leave-one-out approach, excluding one state at a time from the sample. Figure C3 shows that the results are stable and not sensitive to any single state. I then assess whether the observed effects reflect a broader expansion of healthcare access rather than changes specific to buprenorphine. Using Medicare Part D data, I compare trends in prescriptions of other commonly used medications. As shown in Figure C4, there is no evidence of comparable increases in prescribing for non-OUD medications.

Second, I assess the sensitivity of the results to alternative definitions of full-practice authority. The main specification excludes states that transitioned to full-practice between 2013 and 2016—such as Utah, Nebraska, Minnesota, New York, West Virginia, Delaware, and Connecticut. I reclassify these states as treated and re-estimate the effects. I also adopt a broader definition of full-practice status, which includes states where NPs may operate independently under collaborative agreements without on-site physician supervision.[16] Under this classification, states such as Alabama, California, Florida, Kansas, North Carolina, and Tennessee are also treated. Figure C5 shows that the results remain robust under both reclassification schemes. To further rule out cross-border spillovers, I exclude counties in restricted-practice states that border full-practice states. If patients in restricted-practice states are traveling to nearby full-practice counties to access treatment, this could bias estimates downward. Removing these border counties does not meaningfully change the results, as also shown in Figure C5.

Finally, I test for violations of the parallel trends assumption by extending the pre-treatment period back to 2010 for outcomes with available data. To ensure a stable policy environment, I exclude any states that changed scope-of-practice laws between 2010 and 2019. Using the synthetic DiD event study specification (Equation 4), Figure C6 shows that pre-treatment trends remain flat, providing additional support for the identification strategy.

[16]This follows state-level coding based on whether "physical presence is not required" and "no on-site supervision is necessary," as documented in the Annual APRN Legislative Update.

VIII. Discussion

CARA largely succeeded in its central aim: expanding access to treatment for OUD. The legislation references "access" and "availability" more than 50 times, and the evidence suggests it was effective in advancing this goal. By authorizing NPs to prescribe buprenorphine and increasing federal support for treatment infrastructure, CARA meaningfully expanded treatment access. As Figure C2 shows, 477 counties gained access to OUD care relative to 2013, with the largest gains in previously underserved areas.

Yet the benefits of the policy were not evenly distributed. The largest reductions in opioid-related mortality occurred in counties that previously lacked access to OTPs. In contrast, counties with existing OTP services, typically more urban and home to a larger share of individuals with OUD, saw no statistically detectable effect on mortality. As a result, although relative gains were substantial in underserved areas, the absolute reduction in mortality at the population level was more modest.

At the same time, other indicators offer a more mixed picture. Self-reported rates of non-medical pain reliever use and illicit drug use remained flat or even increased. This divergence raises two possibilities: first, that formal treatment continues to miss a large share of at-risk individuals; and second, that at least some of the observed mortality reduction reflects harm-reducing behaviors outside the healthcare system rather than formal treatment effects alone.

One indication of residual access barriers comes from the secondary market. Although buprenorphine is widely covered by Medicaid and Medicare—often making it free to OUD patients—the ongoing demand for street-purchased buprenorphine suggests persistent frictions. These may include difficulty locating a prescriber, prior authorization requirements, or pharmacy stocking issues. Importantly, the existence of a secondary market may reflect not misuse, but unmet demand for treatment through formal channels. This highlights a broader point: while CARA focused on expanding prescriber supply, effective access also depends on multiple points of contact across the treatment pathway. Even after obtaining a prescription, patients may face delays, denials, or stigma that obstruct care. Without addressing these frictions, further increases in prescriber numbers may yield diminishing returns.

IX. Conclusion

This paper evaluates the impact of allowing NPs to prescribe buprenorphine independently. The findings show that the policy substantially increased access to OUD treatment, particularly in underserved areas. The expansion was driven by new prescriber entry—including early responses from non-NP providers—and was not offset by crowding out methadone-based treatment or specialist care. Crucially, reductions in opioid-related mortality were concentrated in counties that previously lacked access to treatment.

At the same time, the analysis reveals that increased access alone does not fully explain downstream outcomes. Buprenorphine dispensation rose even in well-served areas where mortality did not decline, and street prices for pure buprenorphine fell following the policy. These patterns suggest that some of the additional supply may have entered informal markets. While diversion raises legitimate concerns, it may also reflect self-medication in response to persistent barriers in the formal treatment system—such as prior authorization requirements or limited pharmacy availability—especially among populations less equipped to navigate those obstacles.

Institutional Details

A1. Medication for OUD and Its Regulations

Buprenorphine, methadone, and naltrexone are the only medications sanctioned by the Food and Drug Administration for OUD management today. Buprenorphine, a partial opioid agonist, mitigates cravings and withdrawal symptoms and also has less overdose potential than methadone, rendering it a safer option in OUD treatment. Due to its pharmacological attributes, buprenorphine's prescription regulations are more lenient compared to methadone. It can be prescribed outside of federally approved OTPs, which permits office-based treatments. Nonetheless, eligible physicians are required to complete a training course and submit a notification of intent to the Substance Abuse and Mental Health Services Administration.[17]

Methadone, a full opioid agonist with a long half-life,[18] effectively mitigates opioid cravings and withdrawal symptoms, making it suitable for withdrawal treatment. Its distribution is tightly controlled, as there is a risk of overdose with methadone, given that it is a full opioid agonist. Methadone is solely distributed through OTPs, requiring patients to visit clinics for their doses regularly or stay inpatient. This limits access, but methadone remains critical in treating more severe OUD patients, as it is more long-lasting than buprenorphine.

Naltrexone, a non-opioid, is non-addictive and does not induce withdrawal upon cessation. Given its non-opioid nature, it is less effective than methadone and buprenorphine in curbing cravings that accompany opioid withdrawal. Naltrexone can be administered in many ways, including a monthly injection that can be provided by any practitioner within their scope of practice, making it less regulated than buprenorphine or methadone. Primarily, it is utilized for alcohol use disorder and, to a lesser extent, OUD treatment (Volkow et al. 2020).

The Drug Addiction Treatment Act of 2000 is the primary law that governs buprenorphine and methadone prescriptions when used for treating OUD, which separates them from other con-

[17] Under Drug Addiction Treatment Act, physicians may apply for a waiver to prescribe buprenorphine for the treatment of opioid addiction or dependence outside of an OTP. The act was intended to bring the treatment of addiction back to the primary care provider. Thus, most waivers are obtained after taking an 8-hour course from one of the five medical organizations designated in the Act.

[18] Methadone has a relatively long half-life (24–36 hours or longer). Steady-state serum levels generally do not reach until about five half-lives. This implies that patients may not experience the full effect of the initial dose for 4 or more days, even with consistent daily dosing.

trolled substances with additional restrictions. The primary distinction between buprenorphine and methadone and other controlled substances is that, first, the buprenorphine and methadone prescriber needs to meet eligibility criteria under the law. Before 2016, this excluded NPs. Second, methadone must only be used in OTPs. CARA includes NPs and PAs as eligible under the Drug Addiction Treatment Act.[19] However, methadone regulation remained unchanged.

Medicare Part D Buprenorphine Prescribers

A limitation of relying on Medicare Part D data is the extent to which these prescribers represent all active buprenorphine prescribers. To address this, I obtained the DEA's 2019 dataset on doctors authorized to prescribe buprenorphine through a public request. Although this dataset is a cross-sectional snapshot rather than panel data (with only a "last updated" attribute), it can help assess whether Medicare Part D data serves as a reasonable proxy for the broader prescriber population in 2019. Specifically, I aim to evaluate whether the number of Medicare Part D buprenorphine prescribers predicts the total number of active prescribers, and how many active buprenorphine prescribers are also Medicare Part D providers. It is noteworthy that approximately 50% of eligible prescribers do not actively prescribe buprenorphine, as reported by Duncan et al. (2020). Given my county-level analysis, I aggregate the number of prescribers from both the Medicare Part D and DEA datasets at the county level for 2019. I then conduct a regression analysis, regressing the number of DEA-listed prescribers at the county level (divided by two to account for active prescribers) on the adjusted Medicare Part D prescriber count, while controlling for county demographics and including state fixed effects.

In Table B1, the number of Medicare Part D prescribers strongly predicts the number of active buprenorphine prescribers at the county level, with a high R^2 and regardless of additional covariates. This is consistent with expectations, as Medicare Part D prescribers often also serve patients who are not covered by Medicare Part D. However, the population of prescribers who do not treat Medicare patients is missing from this data.

To estimate the proportion of buprenorphine prescribers who are Medicare Part D providers, I

[19]Despite CARA's inclusivity toward physician assistants, the impact of physician assistants would be much smaller. These professionals typically require closer collaboration with physicians, constraining their ability to prescribe independently.

Table B1— Medicare Part D Buprenorphine Prescribers Predict All Buprenorphine Prescribers

	Number of DEA Prescribers / 2		
	(1)	(2)	(3)
Medicare Part D Prescribers	1.519***	1.492***	1.553***
	(0.1085)	(0.1144)	(0.1179)
County Demographics		✓	✓
State Fixed Effects			✓
Constant	-0.2627	21.85***	
	(0.3529)	(5.671)	
Fit statistics			
Observations	3,143	3,143	3,143
R^2	0.82627	0.83208	0.85194
Within R^2			0.82444

Note: Standard errors are clustered at the county level. The observation is at county level. The table presents regression results examining the relationship between the number of Medicare Part D buprenorphine prescribers and the estimated number of active buprenorphine prescribers, as derived from the DEA data and adjusted to reflect only active prescribing practitioners (divided by two). $^{***}p < 0.01$

conducted a simple exercise assuming that Medicare Part D prescribers are representative of the broader prescriber population. Achieving a one-to-one correspondence—where each additional Medicare Part D prescriber aligns with an additional general prescriber—requires multiplying the Medicare Part D prescriber count by approximately 1.5. This implies that Medicare Part D prescribers account for about two-thirds of the total buprenorphine prescriber population.

B1. Comprehensive Addiction and Recovery Act of 2016

CARA is extensive legislation addressing various components of the opioid epidemic, including prevention, treatment, recovery, law enforcement, criminal justice reform, and overdose reversal. It authorizes more than $181 million annually in new federal funding to combat the opioid crisis.[20] The funding under CARA is distributed through various departments, such as the Department of Health and Human Services and the Substance Abuse and Mental Health Services Administration. These grants are primarily allocated to state health departments, which then design and implement their policies to use these funds, often expanding treatment access. According to Murrin (2020), a significant portion of the grants across states was used similarly to expand treatment access.

[20]https://www.ncbi.nlm.nih.gov/books/NBK575704/, accessed: 07/30/2024

A pivotal aspect of CARA is the inclusion of NPs and PAs under the Drug Addiction Treatment Act, thereby increasing the number of practitioners eligible to treat OUD. The focus on NP authority in this paper is due to their relative independence in practice compared to PAs, who face stricter supervision requirements under state laws.

Additionally, CARA encompasses various components aimed at broadening the scope of the opioid epidemic response. These include expanded research and education on addiction treatment, mandated improvements in overdose reversal measures such as increased availability of naloxone, and enhanced support for law enforcement and criminal justice initiatives to address opioid misuse and related crimes. While these components contribute to the overall strategy against the opioid epidemic, their direct impact on increasing treatment access for the general population is less pronounced, and these policies are unlikely to differ significantly between states.

B2. Drug Dictionary

In addition to the primary medications for OUD, such as methadone, buprenorphine, and naltrexone discussed in Section A.A1, several other opioids and opioid inhibitors play a significant role. This section outlines and elaborates on all the drugs mentioned in the study.

Oxycodone is a semi-synthetic opioid analgesic developed for the treatment of moderate to severe pain. It gained prominence through its extended-release version, OxyContin, produced by Purdue Pharma. Introduced in the late 1990s, its aggressive marketing significantly impacted the escalation of opioid use for pain management, subsequently increasing the risks of opioid misuse and addiction. In medical practice, oxycodone is considered when alternative pain relief methods are ineffective or unsuitable. Despite its therapeutic benefits for chronic pain, surgical recovery, and cancer-related pain, its potential for misuse and addiction—driven by the euphoric effects it can induce—remains a significant concern. Misuse ranges from non-prescribed usage to consuming higher doses than prescribed, or altering the drug form for enhanced effect.

Hydrocodone, known under brand names like Vicodin and produced by entities such as Mallinckrodt Pharmaceuticals, is a semi-synthetic opioid for moderate to severe pain relief. Functionally similar to oxycodone, it binds to the brain and spinal cord's opioid receptors,

altering pain perception and emotional response. It is prescribed for acute pain, such as post-surgical pain or injuries, and certain chronic pain conditions. Like oxycodone, hydrocodone's risk of addiction and abuse poses a serious concern, often misused for its euphoric effects and contributing to the opioid crisis.

Fentanyl, a highly potent synthetic opioid analgesic, is up to 100 times more potent than morphine. Both prescription and illicitly manufactured forms of fentanyl exist, with the latter significantly influencing the opioid crisis by being added to counterfeit pills or mixed with other drugs, enhancing the risk of fatal overdoses. Its synthetic nature allows for cost-effective production, exacerbating the spread of fentanyl-laced illicit drugs.

Naloxone is a life-saving medication designed to counteract opioid overdoses, including those from drugs like morphine and heroin. It works by displacing opioids from their receptors in the brain, rapidly reversing overdose effects, particularly respiratory depression. Available for administration via injection or nasal spray, naloxone's accessibility enables emergency use by both medical and non-medical individuals, significantly contributing to efforts to combat the opioid epidemic. Its harmlessness in individuals without opioids in their system further underscores its utility in emergency overdose interventions.

Suboxone combines buprenorphine with naloxone, an opioid antagonist, in a single medication used primarily for opioid addiction treatment. This combination helps reduce opioid cravings and withdrawal symptoms without producing the euphoric effects of other opioids. Naloxone's inclusion aims to prevent misuse by inducing withdrawal symptoms if the medication is injected, promoting its use as intended. Administered as a sublingual film or tablet, Suboxone is a cornerstone of medication-assisted treatment programs, which integrate medication with counseling and behavioral therapies for a comprehensive approach to addiction recovery

Additional Figures and Tables

Table C1— 2015 State Level Health Providers Landscape

State	NP Full Practice States # NP per 100,000 (1)	# GP per 100,000 (2)	Ratio (NP:DOC) (3)	Bupe Prsrbr. per 100,000 (4)	State	NP Restricted Practice States # NP per 100,000 (5)	# GP per 100,000 (6)	Ratio (NP:DOC) (7)	Bupe Prsrbr. per 100,000 (8)
AK	12.6	84.0	0.15	2.17	AL	14.3	34.1	0.42	3.29
AZ	7.9	39.4	0.20	0.97	AR	11.7	49.5	0.24	1.01
CO	12.5	55.0	0.23	1.74	CA	9.4	37.3	0.25	1.26
CT	19.4	22.3	0.87	4.26	FL	16.9	41.9	0.40	2.49
DC	25.1	50.3	0.50	3.12	GA	12.6	32.9	0.38	1.68
DE	28.9	49.8	0.58	3.07	IL	12.0	41.4	0.29	1.28
HI	6.1	47.4	0.13	1.33	IN	18.4	49.8	0.37	2.10
IA	18.2	67.2	0.27	0.22	KS	22.9	59.5	0.38	0.86
ID	14.1	55.3	0.25	1.39	KY	26.9	42.6	0.63	4.95
MD	11.0	27.8	0.39	4.06	LA	11.0	33.0	0.33	3.47
ME	19.7	74.4	0.26	11.73	MA	28.6	28.9	0.99	8.76
MN	22.7	60.1	0.38	1.20	MI	17.4	53.5	0.32	3.28
MT	13.0	58.9	0.22	1.26	MO	12.8	43.0	0.30	1.50
ND	36.7	67.4	0.55	0.66	MS	15.7	37.0	0.42	2.44
NE	19.8	59.4	0.33	0.58	NC	15.1	39.7	0.38	2.20
NH	17.2	51.2	0.34	5.26	NJ	7.5	27.7	0.27	3.19
NM	10.0	56.5	0.18	3.84	OH	14.4	41.7	0.34	4.06
NV	9.1	33.1	0.28	1.38	OK	8.0	53.6	0.15	1.59
NY	9.2	28.2	0.33	3.30	PA	14.4	53.3	0.27	4.29
OR	8.1	53.0	0.15	2.56	SC	10.6	45.1	0.24	1.88
RI	21.7	35.7	0.61	8.33	SD	20.0	57.9	0.35	0.70
VT	15.0	62.1	0.24	12.62	TN	21.1	35.1	0.60	4.91
WA	16.3	60.9	0.27	2.08	TX	7.3	35.4	0.21	1.07
WY	8.7	55.5	0.16	2.04	UT	11.3	33.0	0.34	2.60
					VA	11.0	43.6	0.25	1.60
					WI	31.2	54.1	0.58	1.90
					WV	12.6	60.1	0.21	6.34
Average	13.7	40.8	0.33	2.74		13.3	44.5	0.30	2.44

Note: The table presents the number of primary healthcare providers per 100,000 in each state, categorized by NP practice authority as defined in McMichael and Markowitz (2023). Column (1), (2), (3), (5), (6), and (7) are derived from the NPESS 2015 database and include providers with NPI numbers. GP is defined as those whose primary taxonomy is general practice (208D00000X) or family practice (207Q00000X). Columns (4) and (8) are derived from Medicare Part D Prescribers - by Provider for the number of buprenorphine prescribers in the Medicare Part D program. This should be considered the lower bound of all buprenorphine providers, as some eligible prescribers might not have seen any patients, and some providers might not have submitted a claim through Medicare Part D.

Table C2— State-Level Policy Balance Test

	Naloxone Access	Involuntary Commitment	Opioid Prescribing Limit
	(1)	(2)	(3)
NP Indep. Bupe.	0.074	-0.096	-0.074
	(0.100)	(0.102)	(0.087)
Year Fixed Effects	✓	✓	✓
State Fixed Effects	✓	✓	✓
Observations	408	408	408
R^2	0.656	0.684	0.601
	PDMP	Informed Consent for Opioid	Medicaid Expansion
	(4)	(5)	(6)
NP Indep. Bupe.	0.022	-0.044	0.169*
	(0.034)	(0.075)	(0.075)
Year Fixed Effects	✓	✓	✓
State Fixed Effects	✓	✓	✓
Observations	408	408	408
R^2	0.227	0.614	0.782

Note: Each column reports results from a balancing regression estimated at the state-year level. The dependent variable is a binary indicator equal to one if a specific opioid-related state policy is in effect in a given year. The key independent variable is an indicator for whether NPs are authorized to independently prescribe buprenorphine. Standard errors are clustered at the state level. This table tests whether the timing of NP prescribing authority is systematically associated with other policy changes that may confound the main results. $^*p < 0.05$

Table C3— Lagged Opioid Mortality and the Timing of NP Independent Prescribing Authority

	NP Independent Prescribing Authority	
	(1)	(2)
Constant	0.036	
	(0.043)	
1-Year Lag Opioid Mortality	0.001	0.000
	(0.010)	(0.013)
2-Year Lag Opioid Mortality	-0.012	-0.006
	(0.018)	(0.022)
3-Year Lag Opioid Mortality	0.016	0.013
	(0.016)	(0.014)
Year Fixed Effects		✓
Observations	216	216
R^2	0.008	0.033

Note: Each observation is a state-year. The dependent variable is a binary indicator equal to one if, in that year, NPs were authorized to independently under state law. The sample excludes always-treated states and includes only the year of adoption for newly adopting states, reflecting the one-time nature of the policy change. The key independent variables are lagged values of opioid-related mortality per 100,000 residents. Standard errors are clustered at the state level.

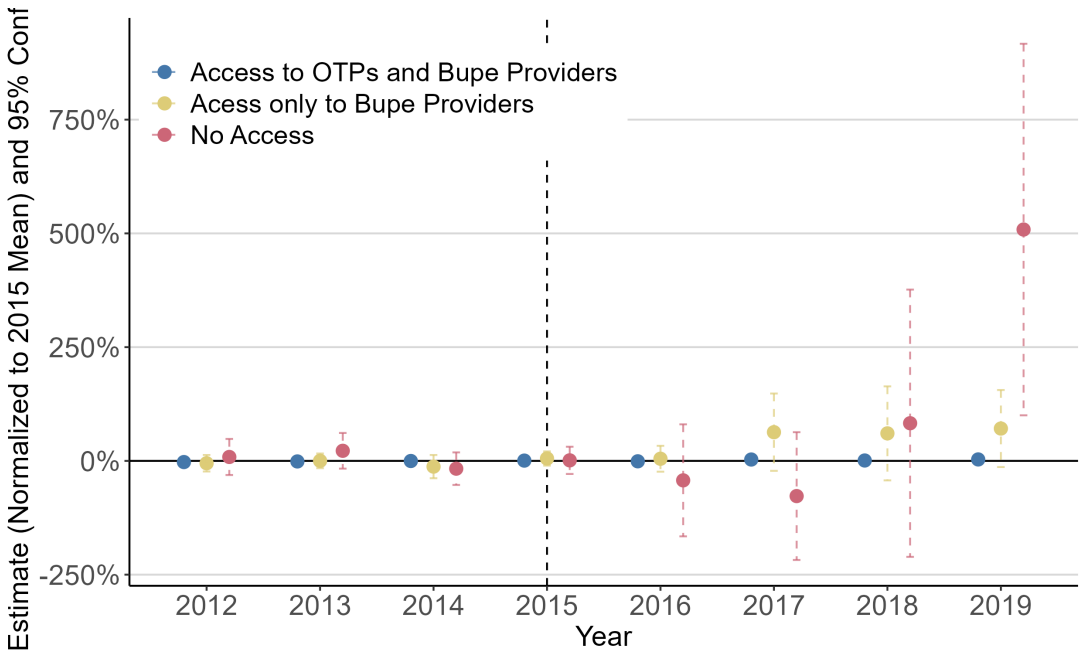


Figure C1. County Heterogenous Response on Number of OTPs

Note: This figure reports county-level synthetic DiD estimates from Equation 4, where the outcome is the number of OTPs per 100,000 residents. Counties are stratified by baseline treatment availability in 2013: (1) no access to medication for OUD, (2) access to buprenorphine providers only, and (3) access to both buprenorphine and OTPs. Estimates are normalized to 2015 averages within each group to facilitate comparison across strata. Confidence intervals are constructed via bootstrap resampling.

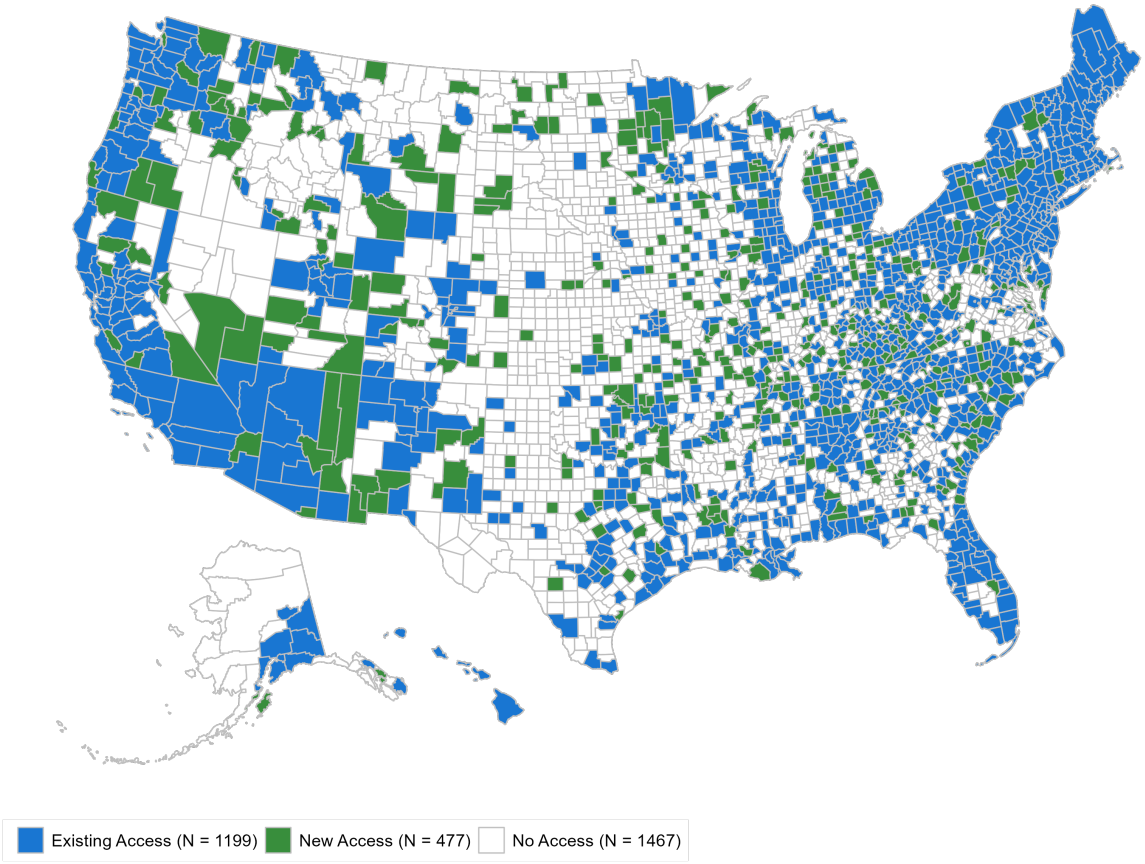
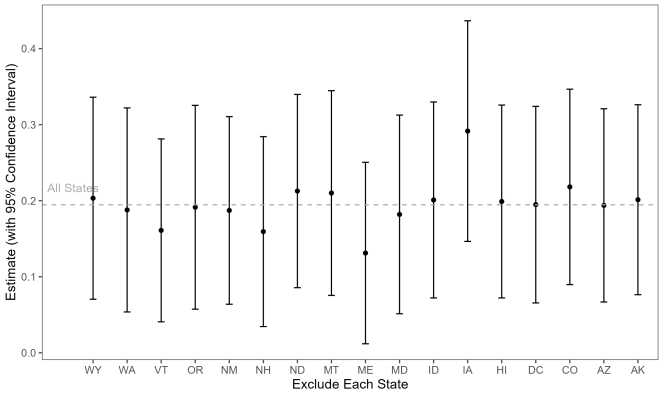
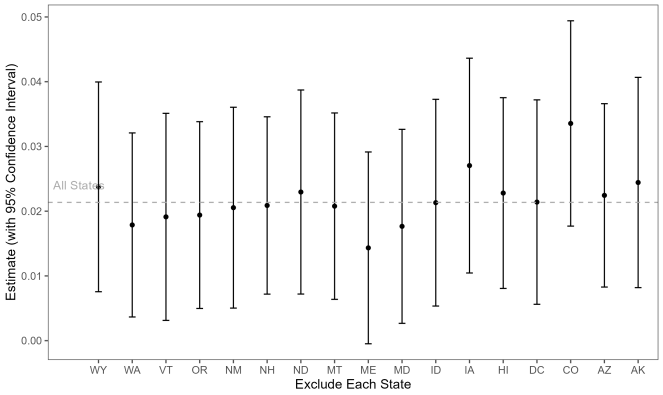


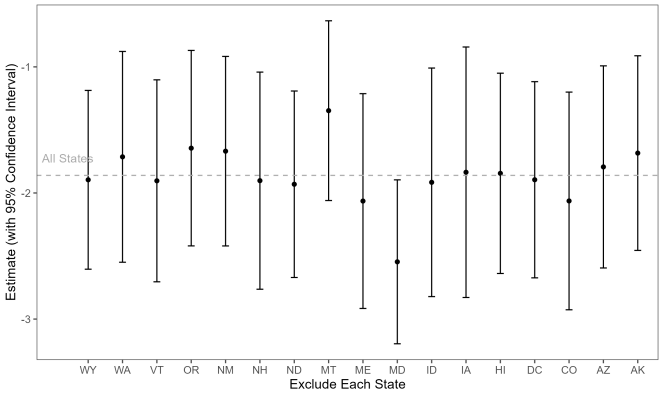
Figure C2. County Gained Access in 2019 Compare to 2013



(a) Number of Buprenorphine Prescribers per 100,000



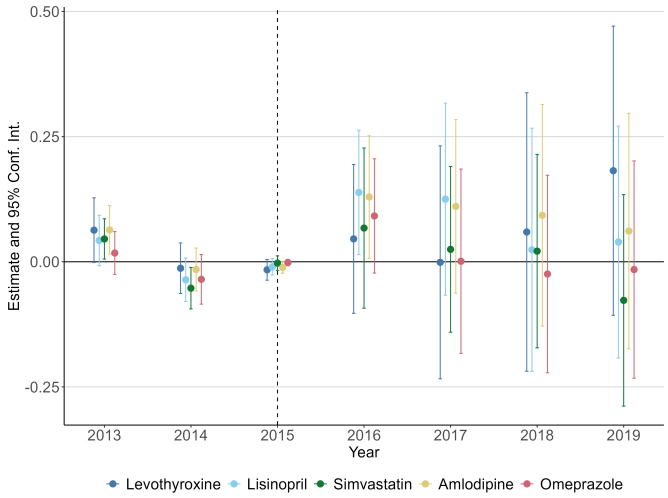
(b) Buprenorphine Dispensation per Capita



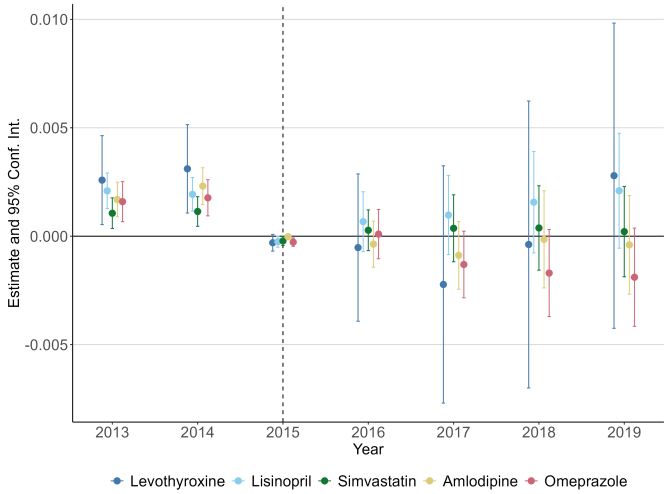
(c) Opioid-Related Mortality per 100,000

Figure C3. Robustness Check: Leave One Out

Note: This robustness check re-estimates Equation 4 for each of the three main outcomes presented in Section IV: (1) buprenorphine prescribers per 100,000 population, (2) buprenorphine dispensation per capita (in morphine gram equivalents), and (3) opioid-related mortality per 100,000 population. Estimates are obtained by sequentially excluding one state at a time. The grey dashed line marks the estimate using the full sample. Confidence intervals are constructed using bootstrap resampling.



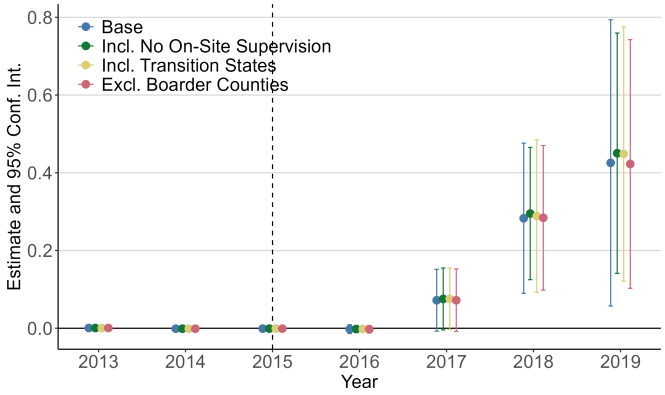
(a) Number of Prescribers per 100,000



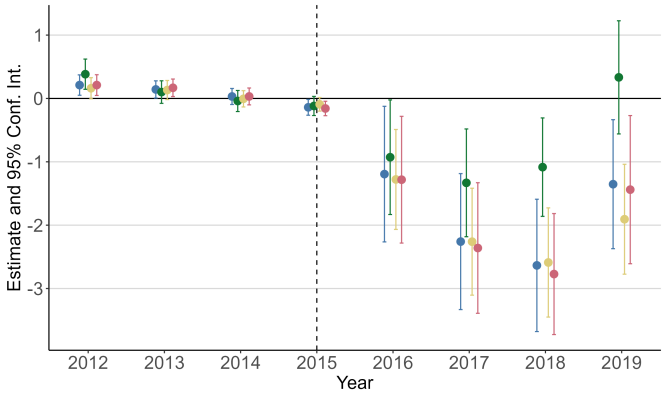
(b) Number of Claims per Capita

Figure C4. Robustness Check: Effect of Other Drugs

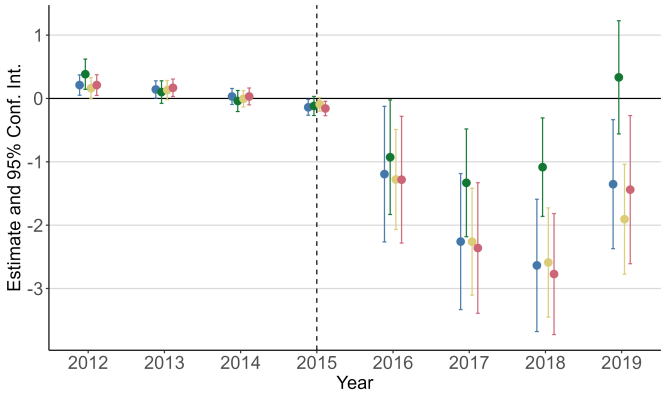
Note: These figures present estimates from Equation 4, using the number of prescribers per 100,000 and claims per capita as outcomes for commonly prescribed medications unrelated to OUD. The analysis includes five drugs with the highest claim volumes in the 2013 Medicare Part D data: levothyroxine, lisinopril, simvastatin, amlodipine, and omeprazole. Confidence intervals are constructed using bootstrap resampling.



(a) Number of Buprenorphine Prescribers per 100,000



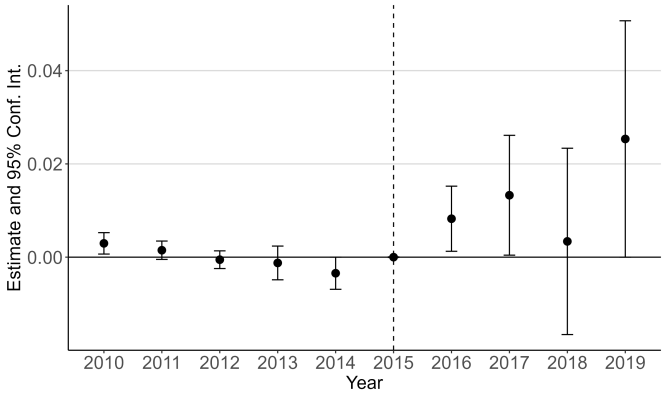
(b) Buprenorphine Dispensation per Capita



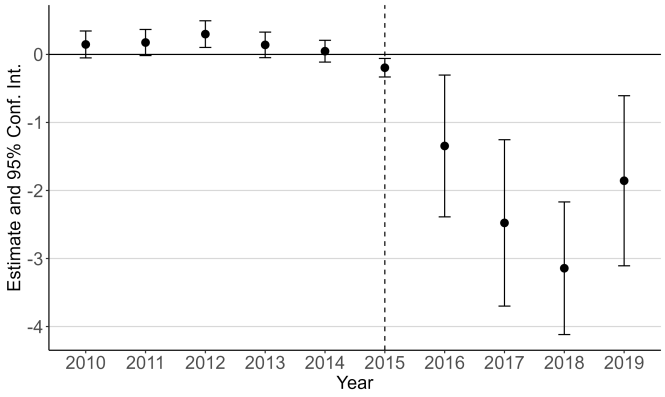
(c) Opioid-Related Mortality per 100,000

Figure C5. Robustness Check: Under Alternative Definitions of Treatment States

Note: This figure presents robustness checks estimating Equation 4 using alternative definitions of treatment status. Outcomes include: (1) the number of buprenorphine prescribers per 100,000 population; (2) buprenorphine dispensation per capita (in morphine gram equivalents); and (3) opioid-related mortality per 100,000 population. "Base" reflects the preferred classification used throughout the paper. "Incl. Transition States" reclassifies states that transitioned to full NP practice authority between 2013 and 2016 as treated. "Incl. No On-Site Supervision" additionally includes restricted-practice states that did not require on-site physician supervision. "Excl. Border Counties" removes counties in restricted-practice states that share a border with full-practice states. Confidence intervals are constructed using bootstrap resampling.



(a) Buprenorphine Dispensation per Capita



(b) Opioid-Related Mortality per 100,000

Figure C6. Robustness Check: Prolonged Pre-Treatment Periods

Note: This figure presents robustness check estimates from Equation 4 using an extended pre-treatment period. Outcomes include: (1) buprenorphine dispensation per capita (measured in morphine gram equivalents) and (2) opioid-related mortality per 100,000 population. The pre-treatment window is expanded to include 2010–2012, while the post-treatment period remains 2016–2019. Confidence intervals are constructed using bootstrap resampling.

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