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

By Lance Gui*

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Buprenorphine, like nicotine gum for quitting smoking, provides a safe alternative for managing opioid withdrawals during addiction recovery. Despite its effectiveness, a significant gap persists between those needing treatment and those receiving it. The Comprehensive Addiction and Recovery Act (CARA) of 2016, a landmark federal legislation, introduced a critical provision allowing Nurse Practitioners (NPs) to prescribe buprenorphine. Leveraging pre-existing state-level regulations on NPs' prescription authority and comparing pre- and post-CARA implementation periods, I examine the effect of allowing NPs to prescribe buprenorphine independently. I find a notable increase in NPs prescribing buprenorphine, equivalent to 27% of all buprenorphine prescribers before CARA. This leads to a 16% rise in buprenorphine dispensation and an 11% reduction in opioid-related mortality. However, two unintended consequences emerge: evidence of increased opioid misuse, despite the reduction in mortality, and deviations from standard prescribing practices by new entrants in regions with intense provider competition.

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I. Introduction

The opioid crisis remains one of the most pressing public health challenges in the United States. Opioids now account for nearly three-quarters of all overdose fatalities, with synthetic opioids like fentanyl emerging as the leading cause of death among Americans aged 18 to 45.[1] This raises the critical question of how to decrease the prevalence and severity of Opioid Use Disorder (OUD). Despite evidence that medications like buprenorphine[2] reduce opioid misuse and overdose risk (Connery 2015, Timko et al. 2016, Ma et al. 2019), a significant treatment gap persists. According to Krawczyk et al. (2022), 87% of individuals with OUD who could benefit from such treatments remain untreated.

Opponents of medication-assisted treatment argue that it may replace one dependency with another, without addressing underlying issues.[3] Moreover, policymakers are particularly concerned about moral hazard, as these medications might encourage riskier behaviors (e.g., co-consumption of other illicit drugs) by reducing the perceived overdose risk. Consequently, medication for OUD faces stricter regulations than other controlled substances. In recent years, policymakers have aimed to reverse course on the tight control of buprenorphine as mounting evidence underscores its benefits. The Drug Addiction Treatment Act of 2000 permitted office-based (outpatient) buprenorphine treatment but required physicians to complete training and file formal notices. Initially, these provisions excluded Nurse Practitioners (NPs), who make up about 20% of primary care providers.[4] The Comprehensive Addiction and Recovery Act (CARA) of 2016 later extended prescribing eligibility to NPs.

CARA's timing was pivotal, as 30% of the U.S. population resided in counties lacking federally designated opioid treatment programs, only around 1,800 physicians nationwide were certified in addiction medicine, and fewer than 10% of primary care physicians were authorized to prescribe buprenorphine (McBain et al., 2020). Did treatment expansion improve health outcomes? Did it introduce unintended consequences, such as moral hazards? To answer these questions, I use a unique research design that combines the effects of CARA and state-level NP prescribing laws as policy shocks. In restricted-practice states, NPs can only prescribe under physician supervision

[1] National Center for Health Statistics, Multiple Cause of Death via CDC WONDER, Accessed: 09/07/2024

[2] Buprenorphine is a partial opioid agonist, which helps reduce withdrawal symptoms and cravings for opioids without producing the same level of euphoria as full opioid agonists like heroin or oxycodone. Similar to how nicotine gum aids individuals in quitting smoking by delivering a controlled dose of nicotine, buprenorphine assists in managing opioid dependence by providing enough stimulation to reduce cravings without fully satisfying the addiction.

[3] Similar debates arise in the treatment of other substance use disorders and mental illnesses. For example, medications like naltrexone are used in alcohol dependence treatment. However, Alcoholics Anonymous typically discourages its use. Providers prescribe stimulants, like Adderall, to treat attention deficit hyperactivity disorder. Medication can mask the fundamental issues, such as lack of sleep, that behavioral therapy alone would fix. However, using medication might result in long-term medication reliance (Lembke, 2021).

[4] Primary care is defined here as family practice, general practice physicians, and NPs.

or collaboration. In contrast, full-practice states allow NPs to prescribe independently, acting like primary care providers. This variation suggests that post-CARA provider availability grew more in full-practice states. By leveraging this differential impact, I examine the effect of allowing NPs to prescribe buprenorphine independently using Differences-in-Differences (DiD).[5]

Using Medicare Part D data to identify active buprenorphine[6] prescribers, I find a significant increase in the number of NPs prescribing buprenorphine, equivalent to 27% of all buprenorphine prescribers before CARA.[7] Using Automated Reports and Consolidated Orders System (ARCOS) data, which tracks opioid shipments from manufacturers to retailers, I find a 16% increase in buprenorphine dispensation due to the policy. This, in turn, results in an 11% reduction in opioid-related mortality, based on data from the National Center for Health Statistics.

Despite the reduction in mortality, the policy led to a 6% increase in the dispensation of oxycodone and hydrocodone—two painkillers that drove the opioid epidemic in the early 2000s. Moreover, I find a rise in illicit drug use, using the state-level estimates from the National Survey on Drug Use and Health. These findings raise two concerns. First, as individuals view buprenorphine as a safer option, they may misuse it or combine it with other substances. Second, the driving force behind the mortality reduction is the substitution for or co-consumption of buprenorphine rather than individuals quitting opioid abuse altogether.

A closer examination of provider decisions reveals important nuances. In highly competitive counties, where half of all buprenorphine providers reside, an analysis of individual providers' prescribing patterns reveals a shift in behavior among new entrants. On average, they now prescribe 4.6 more days of buprenorphine per prescription than the mean three-week period, a pattern not seen in the full sample. This suggests that heightened competition may reduce the frequency of essential check-ups, which are crucial for adjusting dosages to prevent withdrawal symptoms from underdosing or euphoria from overdosing, potentially undermining long-term recovery. I further analyze outcomes by competition level. Counties with limited OUD treatment availability see the largest reductions in opioid-related mortality, approximately 15%, indicating that expanding the pool of prescribers brings significant benefits to underserved areas. Conversely, in counties with already high availability, mortality slightly increases, though this is not statistically significant. This likely reflects that patients in these areas had sufficient treatment

[5]Throughout the paper, I refer to allowing NP to prescribe buprenorphine independently as "the policy" to distinguish it from broader CARA provisions.

[6]In this paper, buprenorphine refers specifically to medications used for OUD treatment and excludes formulations intended for pain management, such as Butrans.

[7]Although Medicare Part D data underestimates the total number of buprenorphine prescribers, it still captures approximately two-thirds of all active prescribers based on 2019 cross-sectional data from the DEA obtained through a public request. More importantly, Medicare Part D buprenorphine prescriptions strongly predict all buprenorphine providers at the county level. The selection issue implications of using Medicare Part D data will be discussed in more detail.

access before CARA, thus additional providers offered limited marginal benefits.

I do not estimate the overall treatment effect of CARA; instead, I focus on one specific provision, granting NPs the authority to prescribe buprenorphine. The impact of this policy is particularly effective compared to other demand policies.[8] The effectiveness of allowing NPs to prescribe buprenorphine lies in addressing a critical issue: the lack of treatment providers in underserved areas. As regulations evolve, the 2023 Omnibus Bill now allows all DEA-registered providers to prescribe buprenorphine, which could further reduce mortality. However, adding providers may have diminishing returns, as many entered under CARA. Removing buprenorphine restrictions alone is unlikely to address the addiction medicine specialist shortage. Moreover, increased provider competition could lead to more deviations from standard prescribing practices. Moral hazards likely persist, as buprenorphine's safer profile still encourages riskier behavior among some patients. Policymakers should reassess these trade-offs, as further liberalization may complicate efforts to address the opioid crisis.

***Literature*:** First, this study augments the emerging literature regarding the consequences of expanding NP's prescribing authority on health outcomes. Traczynski and Udalova (2018) show that NP autonomy increases the frequency of routine checkups, improves care quality, and reduces emergency room usage. Alexander and Schnell (2019) find that enabling NPs to prescribe unscheduled drugs, including most antidepressants independently, leads to notable improvements in mental health outcomes. Prior studies rely on the staggered adoption of NP laws to proxy for expanded access (e.g., Currie, Li, and Schnell 2023). While the staggered approach is sound, many states adopted these laws during the 2010s when the opioid epidemic rapidly shifted from prescription drugs to illicit opioids. This makes it difficult to consider the treatment effects on early and late adopters. By focusing on a single-period policy shock, this paper avoids this issue. I find that this expanded authority significantly increases the number of active NP buprenorphine prescribers, encourages other providers to prescribe buprenorphine, enhances access to OUD treatment, and leads to a substantial reduction in opioid-related mortality.

Second, this paper is the first in the economic literature to examine CARA's impact on treatment expansion, contributing to the broader policy dialogue on the opioid crisis. Much of the existing research concentrates on supply-side measures, demonstrating that stringent policies effectively curb the supply that could lead to misuse. This, however, drives individuals with opioid addiction towards the black market, exacerbating health outcomes. Noteworthy

[8]For instance, Abouk et al. (2019) find that granting pharmacists the authority to distribute naloxone reduced opioid-related mortality by 0.03 per 100,000 after three years of implementation. In contrast, the policy in this paper leads to a mortality reduction of nearly 2 per 100,000. Efforts to expand insurance coverage for medications like buprenorphine have also shown limited success. Both Averett et al. (2019) and Abouk et al. (2021) find that Medicaid expansion under the Affordable Care Act had no significant effect on opioid-related mortality.

interventions in this domain include the 2010 reformulation of OxyContin (Severtson et al. 2013, Alpert et al. 2018, Evans et al. 2019), the implementation of prescription drug monitoring programs (Mallatt 2018, Mallatt 2022), and DEA enforcement actions (Donahoe 2024, Gui, Qin, and Xiao 2024, Soliman 2024). These developments steer researchers and policymakers towards considering demand-side policies, such as harm reduction strategies and treatment expansion. A focal point is the laws facilitating access to Naloxone, a medication that reverses opioid overdoses. While studies on naloxone access show mixed results—with some, such as Abouk et al. (2019) and Rees et al. (2019), noting mortality reductions, and others, like Doleac and Mukherjee (2022), finding no mortality change but increased emergency visits. Similar to Doleac and Mukherjee's findings, I document potential moral hazards, evidenced by increased dispensation of opioids like oxycodone and hydrocodone and a higher rate of reported misuse. However, buprenorphine may offer distinct advantages over naloxone-focused interventions. Although it is an opioid, users of heroin or fentanyl could substitute buprenorphine to reduce overdose risk, even when accessed through illicit markets. Consequently, this paper finds more buprenorphine treatment availability is associated with a reduction in mortality, whereas Doleac and Mukherjee (2022) find that easier access to naloxone does not.

Lastly, this paper contributes to the healthcare competition literature, specifically regarding the effects of competition among physicians and its impact on physician-induced demand. Dunn and Shapiro (2014, 2018) show that areas with higher concentrations of cardiac surgeons experience higher prices and greater use of procedures. Scott et al. (2022) find that general practitioners near other general practitioners provide more unnecessary imaging. The most closely related study to this paper is Currie, Li, and Schnell (2023), which indicates that when NPs can prescribe independently, increased competition leads general practice physicians to prescribe more opioids, suggesting that heightened provider competition may contribute to overprovision. In this paper, I find that competition is a double-edged sword. In underserved counties, increased provider availability reduces opioid-related mortality by addressing treatment gaps. However, additional providers have little to no effect on mortality reduction in regions where treatment availability is already high. In fact, new entrants in these areas are more likely to deviate from the standard three-week prescription supply, potentially hindering recovery.

The remainder of this paper is organized as follows: section II gives an overview of the utilized data. Section III outlines the DiD design and identification challenges. Section IV presents the main results of allowing NPs to prescribe buprenorphine independently. Section V reveals more nuanced results, suggesting CARA may not be a cure-all solution. Section VI shows my results are robust. Finally, section VII discusses the current state of regulations on medication for OUD and makes policy suggestions, and Section VIII concludes the paper.

II. Data

I utilize three primary data sources to examine how NPs can independently prescribing buprenorphine impacts treatment availability and opioid shipments to pharmacies, ultimately influencing health outcomes, particularly opioid-related mortality, from 2013 to 2019. I adhere to established literature, particularly McMichael and Markowitz (2023), to differentiate between states with full practice authority and those with restricted practices, where the former allows NPs to function as primary care providers. The key features of the data relevant to this analysis are outlined below. Further institutional context is deferred to the Appendix B.

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 2014, 19 states, including the District of Columbia, allowed NPs to prescribe Schedule II-V controlled substances independently. Between 2014 and 2019, an additional 10 states transitioned to full-practice status, reflecting a nationwide expansion of NP prescriptive authority. However, several states, 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[9] 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 practice.

Nevertheless, the inherent differences across states raise questions about the factors influencing the adoption of full-practice authority for NPs. To address these differences, the subsequent analysis employs a synthetic DiD approach, which places more weight on control states that are, on average, similar in their past trends to the treated states conditional on observed characteristics. I also conduct the DiD estimation at the county level, and the results remain robust.

[9]This is a snapshot from the National Plan and Provider Enumeration System in 2015, using the Wayback Machine.

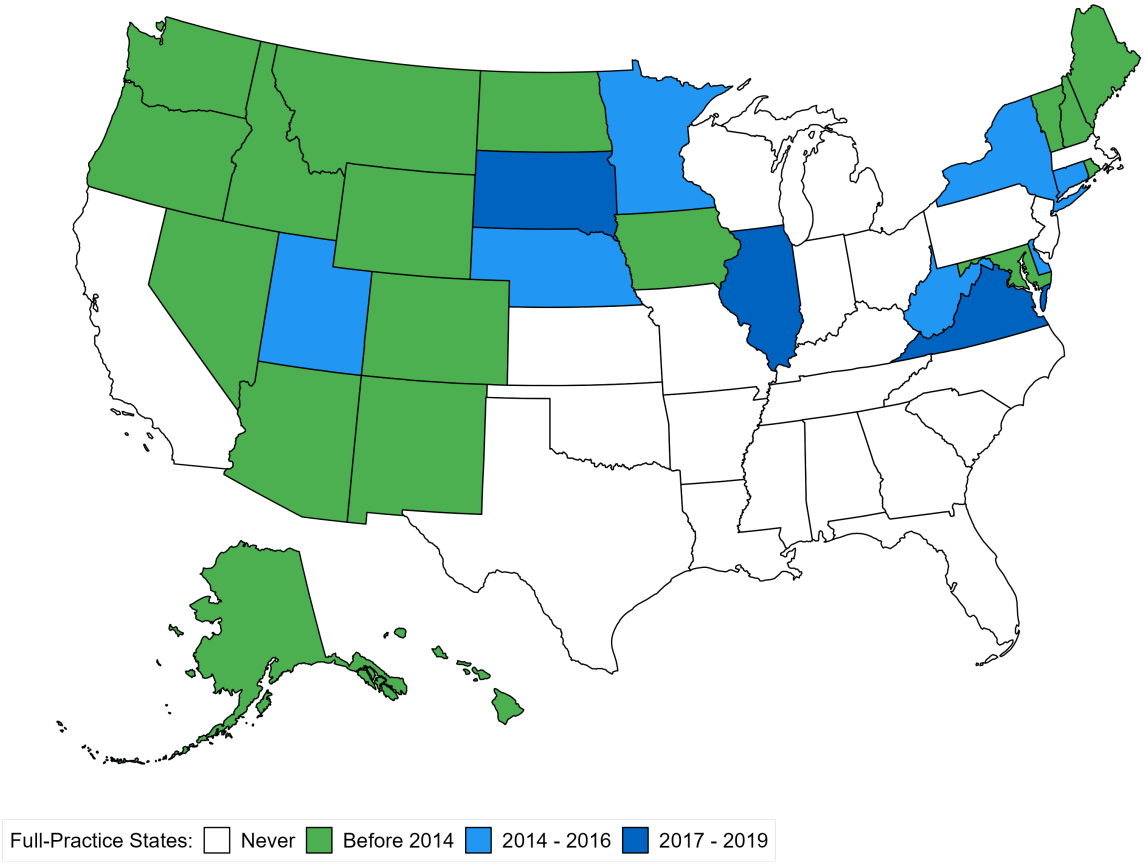


Figure 1. State Scope-of-Practice Law Status

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.

B. Access to OUD Treatment

I use data from the Automation of Reports and Consolidated Orders System (ARCOS), managed by the US Drug Enforcement Administration's Diversion Control Division. ARCOS, established under the Controlled Substance Act of 1971, tracks the distribution of DEA-controlled substances from manufacturers to retailers, including hospitals, pharmacies, and Opioid Treatment Programs (OTPs). The dataset includes detailed records on drug shipments, specifying the drug name (e.g., buprenorphine, oxycodone), National Drug Code,[10] dosages, quantities, and both sender and receiver identities. In addition to ARCOS data, I utilize Medicare Part D Provider and Drug data, which includes spending and utilization information for specific drugs by providers. For each prescriber and drug, the dataset captures the total number of claims and the total days' supply.[11]

Access to treatment for OUD can be categorized into two main channels: OTPs and non-OTP providers. OTPs, or methadone clinics, are federally regulated and authorized to dispense methadone—the only facilities legally permitted to do so for OUD. Methadone is a long-acting opioid agonist, typically requiring supervised daily visits. While OTPs increasingly offer buprenorphine, their unique capacity to dispense methadone and employ specialists with in-depth expertise in addiction medicine positions them to manage severe cases and co-occurring mental health disorders, providing holistic care that includes behavioral therapy. In contrast, non-OTP providers, such as primary care physicians and NPs, can prescribe buprenorphine but cannot dispense methadone. These providers offer more accessible treatment but generally lack the specialized training found in OTPs. Under CARA, NPs gain eligibility to prescribe buprenorphine after completing a 24-hour training course, while physicians need to undergo an eight-hour course. Consequently, the varying levels of expertise between OTPs and non-OTP providers can affect the quality of care, particularly for complex cases.

By combining ARCOS and Medicare Part D data, I construct a comprehensive map of treatment access in 2013, identifying counties with and without access to OTPs and Medicare Part D buprenorphine prescribers. Medicare Part D prescribers represent two-thirds of all active buprenorphine providers, and the number of Medicare Part D in a county strongly predicts the number of eligible buprenorphine providers at that county. This is validated using public request data from DEA (see Appendix A for details). Figure 2 illustrates the geographic distribution of OUD treatment access. Notably, approximately 62% of counties lack any OUD treatment services. Around 13% of the US population resides in a county without a single provider or

[10] Using the National Drug Code, I ensure that buprenorphine is specifically used to treat OUD, rather than for pain management.

[11] Prescribers with 10 or fewer claims for a particular drug are excluded from the dataset.

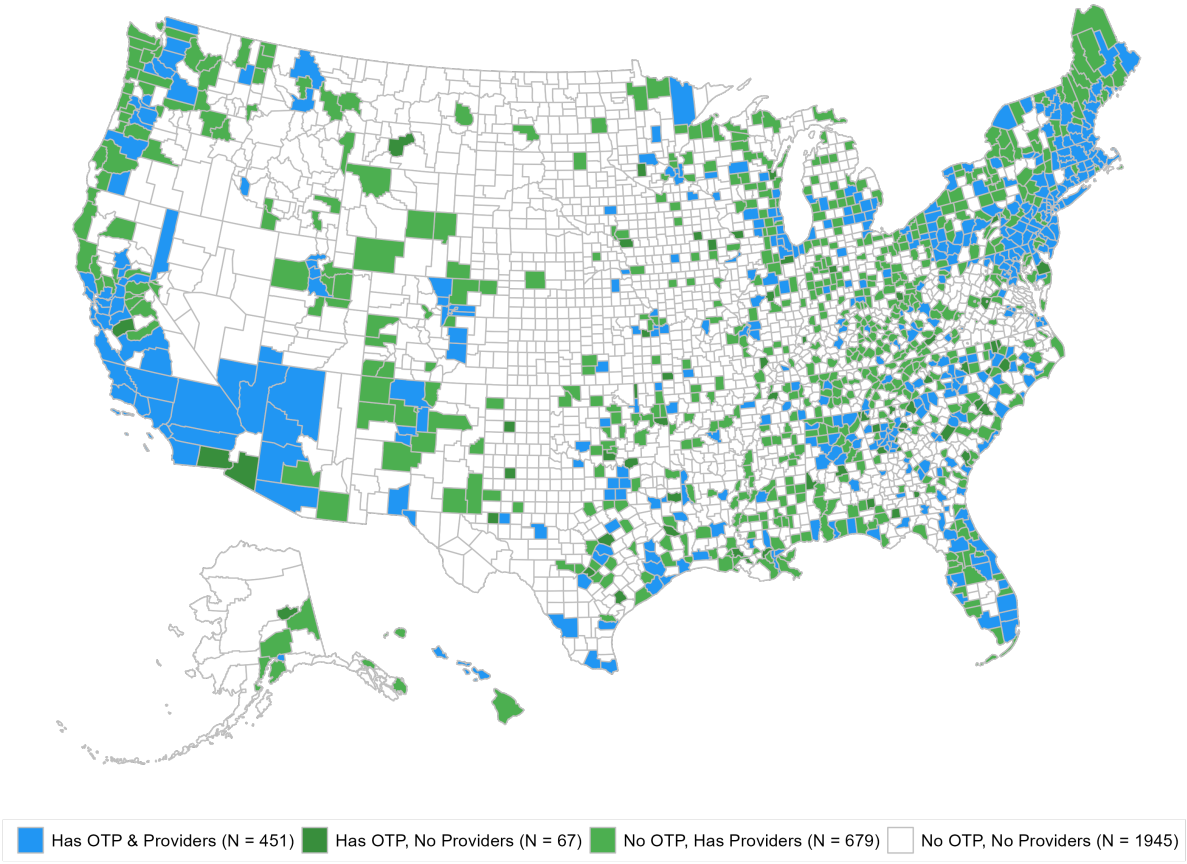


Figure 2. Geographic Distribution of OUD Treatment Access in 2013

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.

OTP, and 31% live in a county without OTPs. Rural areas, even in Appalachia, which has been severely impacted by the opioid epidemic and clearly does not lack demand, still face significant disadvantages in accessing treatment.

In the following sections, I examine regional variations in outcomes across different access categories. The definition of access used here is a simplified proxy; thus, I have noted two important limitations. First, access is measured only on the extensive margin and does not account for provider density; a county with minimal access is still underserved. Second, the reliance on Medicare Part D data may result in some counties being misclassified as lacking access, as not all providers accept Medicare Part D. Despite these limitations, the regional distribution of Medicare Part D prescribers provides valuable insights, as areas with low counts of Medicare Part D providers are likely to have fewer providers overall.

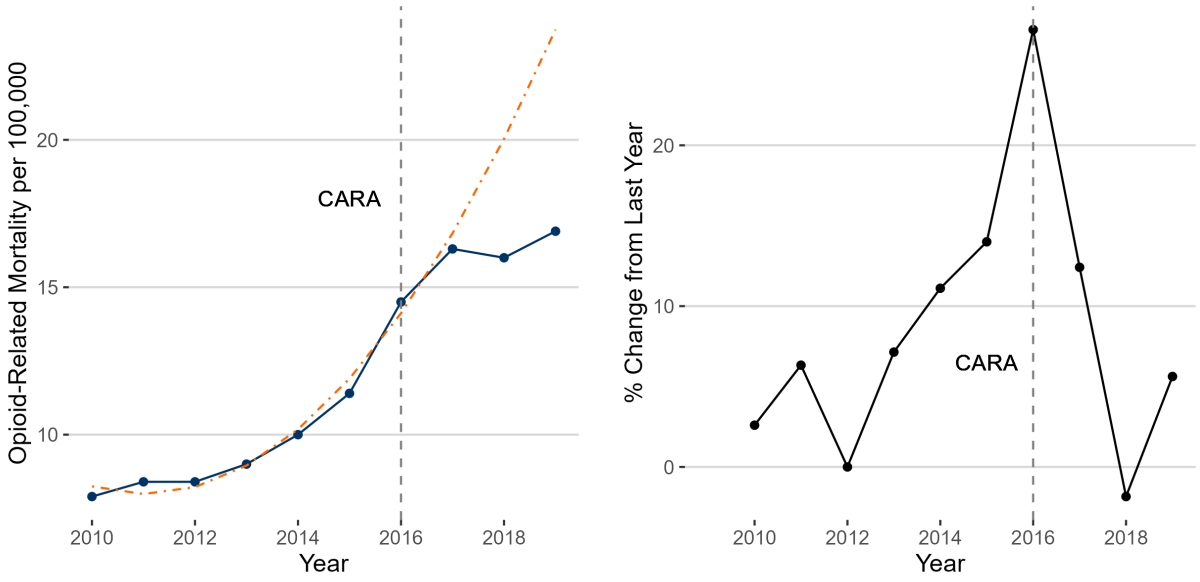
For a more detailed discussion of the regulatory landscape surrounding OUD medications, as well as the medical properties of buprenorphine, methadone, and other relevant drugs, please refer to the Appendix B.B1 and B.B4.

C. Health Outcomes

The health outcome I focus on is opioid-related mortality. The opioid-related mortality data is from the restricted National Vital Statistics System for the years 2013 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, 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, with this trend remaining relatively stable until 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 would 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 highlights



(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 and T40.4, as well as X42, X62, and Y12. The dashed orange line in Figure 3a represents a polynomial fit for the pre-2016 trend (2010-2016). Panel 3b shows the percentage change from the previous year, calculated as $(Y_t - Y_{t-1})/Y_t$.

how much more mortality decreased in full-practice states, which I attribute to the effect of allowing NPs to prescribe buprenorphine independently.

III. Methods

A. Event Study Differences-in-Differences

To examine the impact of allowing NP to prescribe buprenorphine independently, I estimate an event-study regression. In constructing these event studies, I focus exclusively on states that did not modify their scope-of-practice laws during the study period. The time of CARA implementation is used to distinguish between pre- and post-implementation periods ($k = 2015$). CARA was signed into law on July 22, 2016 and its implementation did not occur until October 2017.[12] The control group consists of units within states with restricted practice authority ($Treat = 0$), while the treatment group comprises units within states with full practice authority ($Treat = 1$). The outcome variable of interest, Y_{it}, is observed at either the state or county-year level. The model is specified as follows:

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

In this model, τ_k^{did} captures the effect of allowing NPs to prescribe buprenorphine independently across different years. The vector X_{it} includes standard demographic variables at the state or county level, such as gender, race, age, income, educational attainment, unemployment and poverty rate. Crucially, X_{it} also incorporates state-level regulations that likely influence opioid prescription patterns, including Naloxone Overdose Prevention Laws (enhancing access to naloxone), Involuntary Commitment for Substance Use (targeting arrestees), Informed Consent for Opioid Prescribing Laws, State Laws Limiting Opioid Prescriptions, and Prescription Drug Monitoring Programs. Importantly, I verify that allowing NP to prescribe buprenorphine independently does not coincide with the timing of adopting these laws (see Table C2). Additionally, ϕ_i and ψ_t represent unit- and year-fixed effects, respectively.

[12] https://apps.deadiversion.usdoj.gov/RAPR/raprQualifyingPractitionersByState.xhtml#no-back-button, Accessed: 08/26/2024

B. *Event Study Synthetic Differences-in-Differences*

I implement a synthetic DiD approach as described in Arkhangelsky et al. (2021), with the outcome residualized by covariates (X_{it}). I extend this method to an event study framework to enhance the visual presentation of the results and compare to the previous estimate, τ_k^{did} coefficient from Equation 1. The interpretation of the estimates is the same across two estimates. First, I run a fixed effect model,

$$Y_{st} = X_{st}\beta + \gamma_t + \delta_s + u_{st} \tag{2}$$

I then residualize the outcome variable as follows,[13]

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

Let there be N units, with N_{co} control units in restricted practice states and $N_{tr} = N - N_{co}$ treated units exposed to the treatment after time T_{pre}. The synthetic control weights, $\hat{\omega}_i$, are chosen to align the pre-treatment trends in the outcomes of unexposed units with those of the exposed units, ensuring 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 $t = 1, \ldots, T_{pre}$. Time weights, $\hat{\lambda}_t$, are similarly constructed 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 unit j in the treatment group is then is, $\tilde{Y}_{jt}^{co} = \sum_{i=1}^{N_{co}} \hat{\omega}_i \tilde{Y}_{it}$. For each period t, the difference between treated units and their synthetic controls, relative to the baseline difference, represents the event study-style average treatment effect on the treated, τ_t^{sdid}:

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

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 $\hat{\lambda}_t$, leading to the following baselines:

[13]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 the findings by Kranz (2023), I opt for the residualization with fixed effects.

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

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

The unit weights in the event study specification are the same as those in Arkhangelsky et al. (2021), as the unit weights only depend on pre-trends. However, one could argue that time weights may need adjustment. While the basic approach averages the outcome variables post-treatment, the event study assigns a distinct treatment effect to each year, potentially necessitating a change to time weights for each post-treatment period. To address this, I recalculate the weights by incorporating all pre-treatment periods and adding only one post-exposure period at a time for all post-treatment periods. This adjustment does not alter the results.

C. Interpreation of The Treatment

As illustrated by Figure 4, CARA impacts the treatment landscape in two distinct ways, contingent on whether NPs operate under a collaborative arrangement with physicians or practice independently. In states where NPs work collaboratively with physicians, either in full-practice or restricted-practice environments, they can only obtain a waiver if their collaborating or supervising physicians also have a waiver. This limits their ability to prescribe buprenophrine. Even if this increases the prescribing capacity within a physician's office, it does not introduce new patient treatment locations. In contrast, in conjunction with state-level NP practice laws, CARA enables NPs in full-practice states to prescribe buprenorphine independently. For independently practicing NPs, offering buprenorphine treatment creates new treatment locations for patients. This regulatory shift effectively expands treatment access for individuals with OUD by adding options that were previously unavailable in full-practice states.

Furthermore, independent NPs have stronger incentives to attract patients, as they manage their own patient base, which may lead them to offer buprenorphine to draw in new patients. Combining the mechanical differences between NP full- and restricted-practice states and the incentive structures, I expect more NPs to prescribe buprenorphine in full-practice states. Additionally, with NPs offering buprenorphine, primary care physicians may have a strategic incentive to prescribe it as well, aligning their treatment offerings to remain competitive. In fact, primary care physicians may begin prescribing buprenorphine preemptively, anticipating NP entry into the market, as I find in this paper. Overall, this policy is likely to significantly expand treatment availability in NP full-practice states, more so than in restricted-practice states.

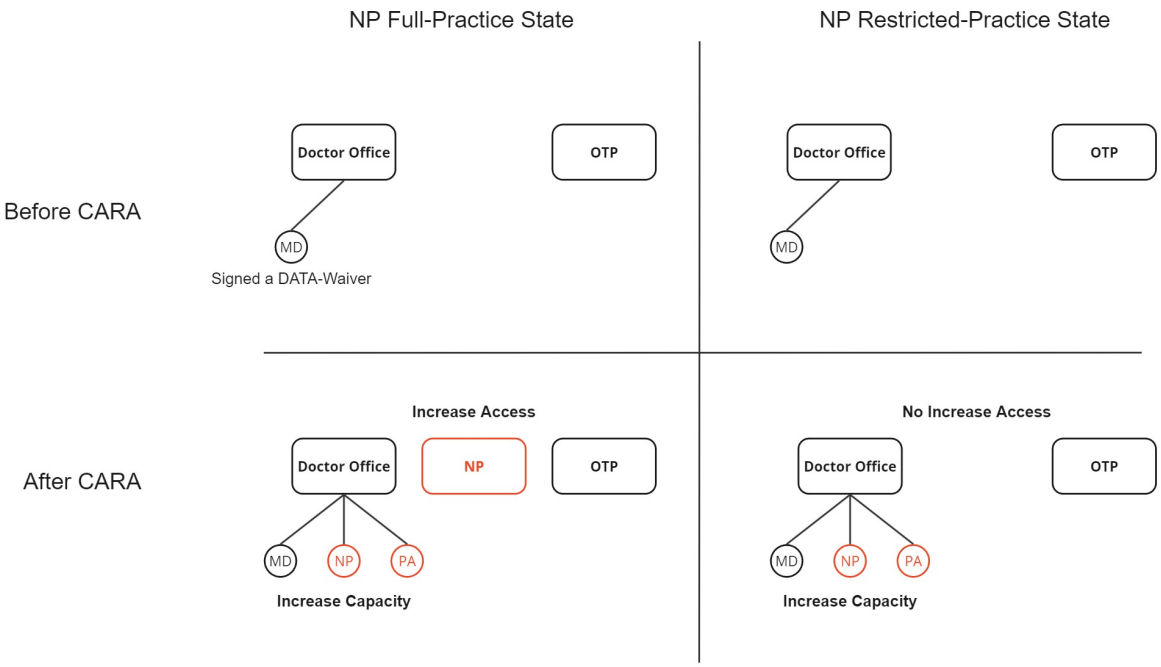


Figure 4. CARA Intended Effect

D. Identification Assumptions

The primary concern with applying a DiD approach is the potential violation of the parallel trends assumption. This assumption posits that, in the absence of treatment, the outcomes of interest would have evolved similarly for both treatment and control groups, conditional on control variables. In this study, the assumption relies on the premise that states not permitting independent NP prescribing serve as credible counterfactuals for states that have expanded NP prescriptive authority.

Given that CARA is a federal policy, not governed by individual states, I argue that states' decisions to allow NPs to practice independently are not made in response to localized opioid issues, as prior to CARA, NPs could not prescribe buprenorphine. However, this reasoning does not apply to states that transitioned from restricted- to full-practice status post-CARA. As a result, I exclude three states that transitioned to full-practice status after 2015 from this analysis. Even if the parallel trends assumption is violated, the synthetic DiD estimator remains consistent as long as the weighting of units and times creates a synthetic control that satisfies the common trends assumption, conditional on control variables. Violation of the parallel trends

assumption can be visually inspected; ideally, τ_t for $t < 2015$ is insignificant. Indeed, the later analysis shows such, particularly using the synthetic DiD.

Second, this study addresses the issue of states transitioning from restricted to full practice.[14] Based on the literature on heterogeneous treatment timing in DiD, I exclude states (Illinois, South Dakota, and Virginia) that transitioned from restricted to full practice post-CARA. Additionally, to ensure a stable policy environment for analysis, I focus on states that did not alter their scope-of-practice laws during the study period, excluding Connecticut, Delaware, Minnesota, Nebraska, New York, Utah, and West Virginia.[15] Since the full impact of changing scope-of-practice laws may take time to materialize, allowing NPs sufficient time to establish new practices, I isolate the treatment effect of enhanced access.

Finally, another common concern in DiD analysis is the anticipation effect. In this context, the anticipation effect does not influence patient choice, since it is also unlikely that patients would defer treatment in anticipation of NPs being able to prescribe buprenorphine in the future. The same logic applies to NPs not entering the market before the law's implementation. However, I acknowledge the possibility of anticipation effects among non-NP providers. With the law passed in 2016 but not effective until 2017, these providers may have acted during this period to capitalize on the unsaturated market before NPs roll out buprenorphine treatment. To account for this anticipation effect, the reference year is at 2015.

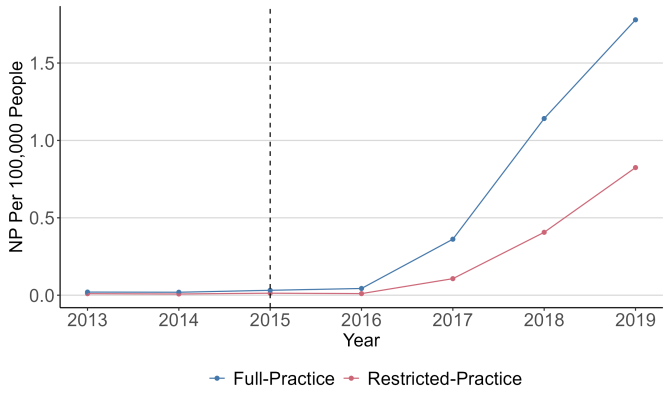
IV. Main Results

The following subsections present the main findings. I highlight three key results: the independent prescribing authority for NPs leads to increased NP entry into the market, more buprenorphine being dispensed through retail channels, and reduced opioid-related mortality.

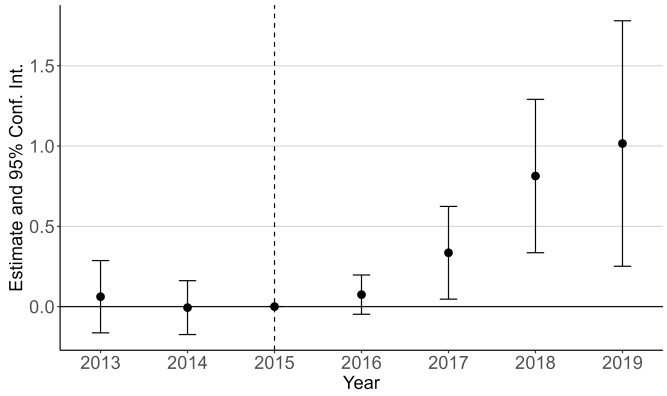
A. Increasing Number of NPs Prescribing Buprenorphine

Figure 5a illustrates the annual average number of NPs prescribing buprenorphine in full-practice versus restricted-practice states. Before 2016, NPs were generally unable to prescribe buprenorphine, with limited exceptions.[16] The increase in NP prescribers is evident in both full-practice and restricted-practice states, though the expansion is significantly greater in full-practice states. This difference aligns with expectations, as NPs in restricted-practice states are limited to prescribing under a physician's supervision. The stronger growth in full-practice

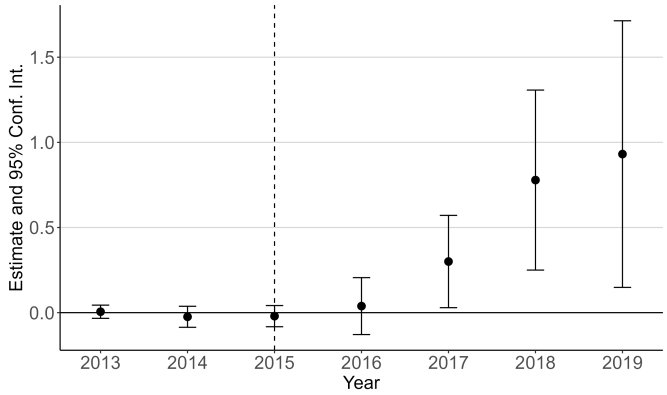
[14] No full-practice states reverted to restricted practice during the study period.
[15] In the robustness section, I include these states also as treatment states, the results are robust.
[16] NPs could petition to prescribe controlled substances in regions with a demonstrated shortage of primary care physicians, but the burden of proof was on the NPs.



(a) Mean Trends



(b) Dynamic DiD Results



(c) Dynamic Synthetic DiD Results

Figure 5. Effect on the Number of Buprenorphine Prescribing NPs

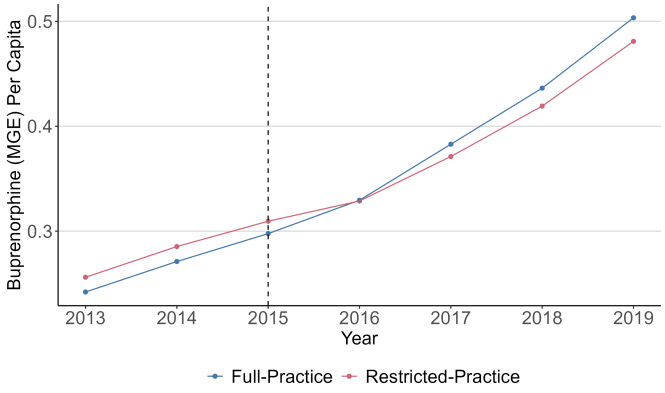
Note: The outcome of interest in Figure 5 is the number of NPs per 100,000 people. Subfigure (a) presents the raw trends, displaying the state-level averages of NPs per 100,000 people in states with full-practice authority versus restricted-practice authority from 2013 to 2019. Subfigure (b) illustrates the estimated coefficients and 95% confidence intervals derived from Equation 1, which follows a standard event study design. Standard errors are clustered at the state level. Subfigure (c) shows the estimated coefficients obtained from the synthetic DiD approach, as specified in Equation 4, with standard deviations computed via bootstrap resampling.

states likely reflects greater incentives to prescribe buprenorphine, given their autonomy. Figure 5b captures these differences in NP expansion between full-practice and restricted-practice states using the standard difference-in-differences approach (Equation 1). Figure 5c shows similar results using a synthetic DiD (Equation 4). The estimates in both figures are comparable, as expected. The synthetic DiD design is preferred for dealing with potential parallel trends assumption violations. Allowing NPs to prescribe buprenorphine independently lead to substantial growth in the number of NP prescribers, with nearly one additional NP per 100,000 people by 2019. For context, in 2015, there were, on average, only 3.5 active buprenorphine prescribers per 100,000 people in full-practice states. This increase represents a 27% expansion in the pool of buprenorphine providers compared to pre-CARA levels.

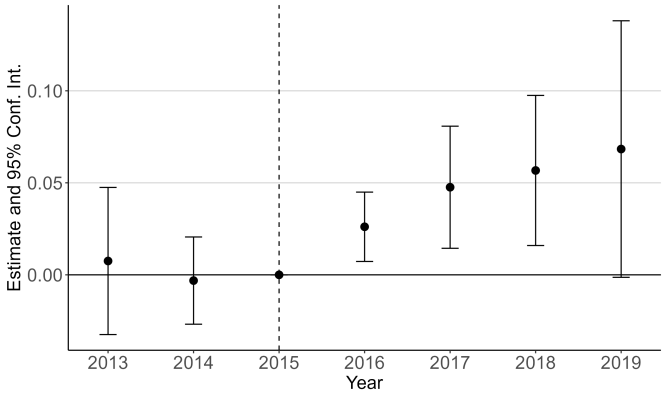
To what extent can Medicare Part D findings be interpreted and extrapolated to the broader population? First, these results serve as a robustness check, reinforcing the conclusion that the policy broadly increased buprenorphine dispensation in the next subsection. This reflects an expansion in the number of prescribers rather than merely intensified prescribing by a few. Second, concerns about selection bias—where Medicare Part D prescribers might treat an older demographic—are less problematic in the context of OUD. If selection bias is present, the estimated effect may even be conservative, as this sample excludes prescribers more likely to treat younger patients, who are more prone to OUD than the 65+ population. Prescribers willing to treat Medicare patients are generally willing to treat younger populations as well, given that focusing solely on older patients for buprenorphine prescriptions would be a poor business decision. In general, Medicare Part D providers represent roughly two-thirds of active buprenorphine prescribers, and their numbers correlate strongly with overall buprenorphine provider numbers at the county level, as shown in Appendix A. Therefore, I can use Medicare Part D as a representative sample and apply the findings to the general population with confidence.

In later sections, I will examine how NP entry affects competition and health outcomes, particularly in markets with varying levels of competition. The effects are likely to differ between markets with minimal competition and more concentrated ones. Market expansion could have a substantial impact in areas lacking providers, as the introduction of new providers is salient to patients in underserved regions. In more competitive markets, the increased presence of NPs may heighten competition, potentially leading new providers to prescribe higher dosages to attract patients.

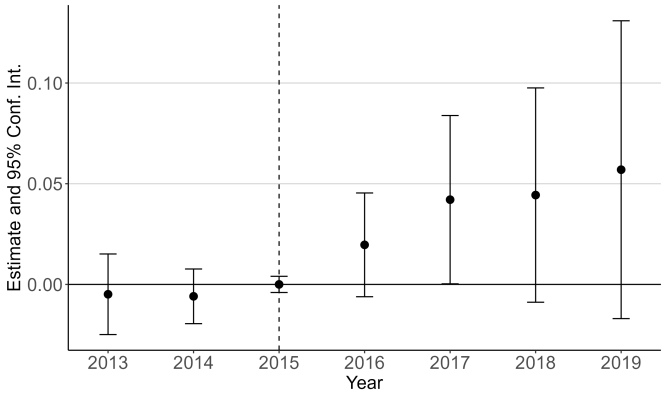
For now, I will focus on the main effects at the state level before exploring the heterogeneous impacts of allowing NPs to prescribe independently. The next two subsections present estimates in a consistent format, similar to Figure 5, including raw trends, event study results, and synthetic event study results.



(a) Mean Trends



(b) Dynamic DiD Results



(c) Dynamic Synthetic DiD Results

Figure 6. Effect on the Buprenorphine Dispensed Per Capita

Note: The observation is at the state level. The outcome of interest in Figure 6 is buprenorphine dispensation, measured in morphine gram equivalents per capita. The construction of this figure follows the same methodology as Figure 5.

B. Increasing Buprenorphine Volumes

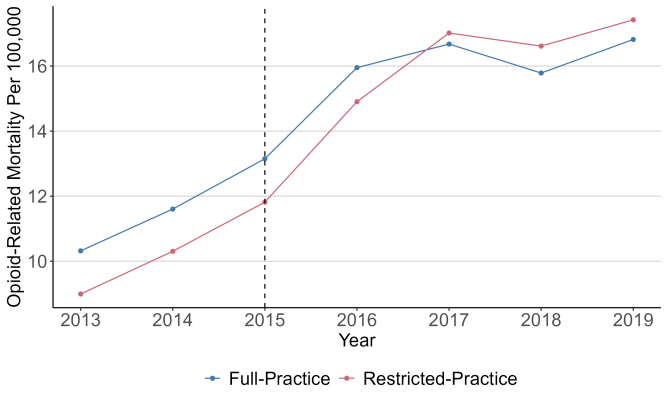
The previous subsection demonstrates the rise in the number of NPs prescribing buprenorphine, suggesting that treatment availability for OUD patients has expanded. The natural next step is to examine whether this increased availability translated into a higher volume of buprenorphine (only for OUD) being dispensed. Figure 6a presents the per capita buprenorphine dispensed, measured in morphine gram equivalents, across both full-practice and restricted-practice states. Notably, before 2015, restricted-practice states exhibited higher buprenorphine dispensation. However, this trend reverses following the passage of CARA, with full-practice states dispensing more buprenorphine. To quantify these shifts, Figure 6b provides estimates from Equation 1 and Figure 6c shows that full-practice states experienced a nearly 16% increase in buprenorphine dispensing by 2019 compared to 2015 levels, using synthetic event study DiD (Equation 4). The rise of buprenorphine volume is evident in 2016, before NPs being authorized to prescribe buprenorphine. The anticipated entry of NPs likely incentivized other providers to begin prescribing buprenorphine sooner. By 2016, providers were already aware of the upcoming legislation allowing NPs to prescribe buprenorphine, effective in 2017, prompting them to take preemptive action to mitigate future competition. This anticipation effect is illustrated in Figure C2, which shows a notable increase in non-NP providers entering the market in 2016, followed by a surge in NP entries in 2017.

Understanding the increase in buprenorphine dispensation is complex. On one hand, the rise in NP prescribing logically improves patient access to treatment, encouraging more individuals to seek help and consequently leading to higher buprenorphine dispensation. However, this general increase in buprenorphine might mask a tendency among some prescribers to favor higher doses with fewer checkups—reminiscent of the early 2000s prescription opioid crisis. In some cases, patients may also co-consume substances like fentanyl or heroin, further complicating the picture.

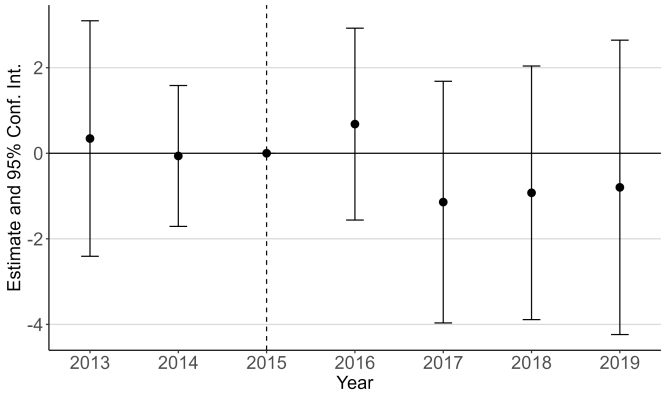
As discussed in later sections on perverse provider incentives, regions with high prescriber competition often experience shifts in prescribing patterns. In these competitive markets, providers may increasingly favor larger quantities of buprenorphine per prescription, suggesting that market incentives could drive prescribers to prioritize volume over long-term recovery outcomes.

C. Decrease Opioid-Related Mortality

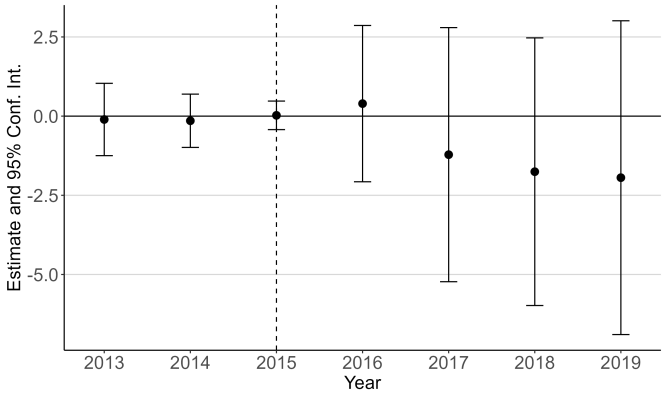
A key question for this policy analysis is whether allowing NPs to prescribe buprenorphine independently leads to improved health outcomes, specifically in terms of opioid-related mortality. Figure 7a illustrates the average trend of opioid-related mortality rates per 100,000 individuals across both full-practice and restricted-practice states. Prior to 2016, full-practice states expe-



(a) Mean Trends



(b) Dynamic DiD Results



(c) Dynamic Synthetic DiD Results

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

Note: The observation is at the state level. The outcome of interest in Figure 7 is opioid-related mortality per 100,000. The construction of this figure follows the same methodology as Figure 5.

rienced higher opioid-related mortality rates. The implementation of CARA had a beneficial effect in both groups of states, particularly in mitigating the upward trajectory of opioid-related deaths. Notably, the reduction in mortality is more pronounced in the full-practice states. This likely reflects these states' more substantial treatment expansion.

To quantify the impact of allowing NPs to prescribe buprenorphine independently on mortality, Figure 7b presents estimates derived from Equation 1, and Figure 7c further illustrates similar results using estimates from Equation 4. Both figures show a clear downward shift in opioid-related deaths. By 2019, as depicted in Figure 7c, there is an 11% reduction in opioid overdose rates compared to 2016 levels. Although the state-level estimate is not statistically significant, when the analysis is conducted at the county level, as shown in Figure C3, the results become significant, with a comparable magnitude, about 13% reduction in opioid-related mortality.

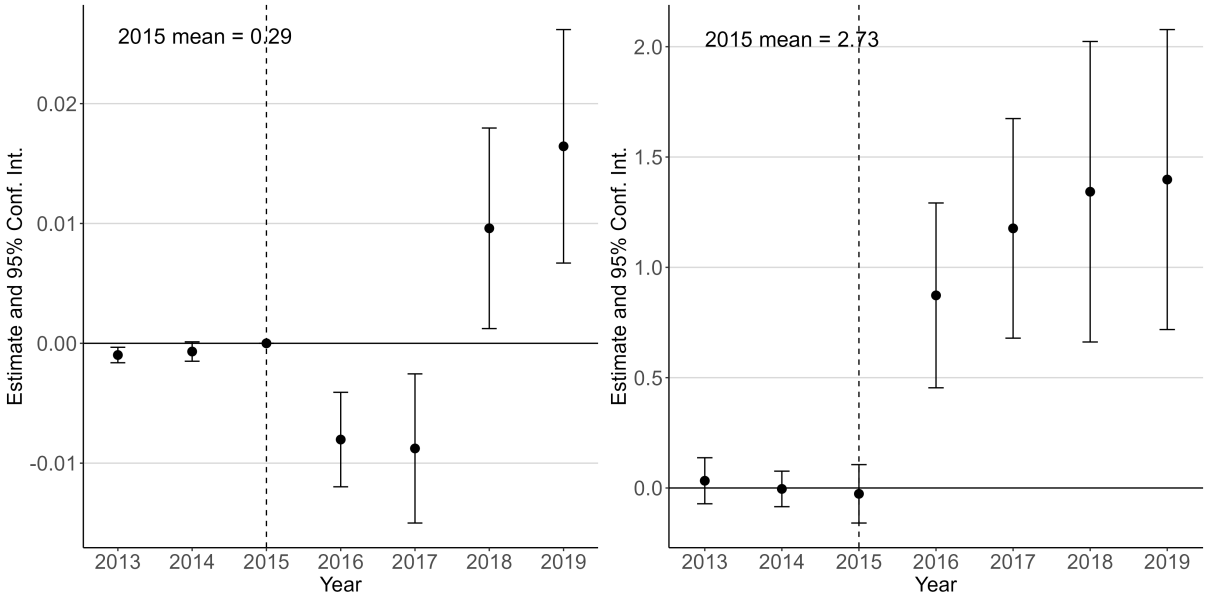
The state-level estimates are insignificant, while county-level estimates are significant, as state-level analysis masks substantial heterogeneity across counties. As shown later, mortality reduction is most pronounced in areas with little to no provider access, whereas counties with higher availability experience minimal impact on opioid-related mortality. This highlights considerable heterogeneity in how NP entry affects health outcomes, with the impact varying by region depending on existing prescriber availability.

V. Unintended Consequences

This section unfolds in three parts. First, I present evidence of potential moral hazard, where the availability of buprenorphine, which reduces overdose risk, may inadvertently lower the incentive to avoid opioid misuse. This is supported by survey data on past-year illicit drug misuse and an increase in pharmacy-dispensed opioid painkillers, such as oxycodone and hydrocodone, that fueled the early stages of the opioid epidemic. Second, the entry of NPs into the market and their ability to prescribe buprenorphine has intensified competition among prescribers. As a direct consequence of market expansion, the reduction in mortality is concentrated in areas where it is most needed. In counties already well-served by buprenorphine providers, the impact on mortality is minimal. Lastly, this increased competition appears to have influenced prescriber behavior, leading to a rise in the number of days supplied per prescription in counties with the most treatment availability.

A. Moral Hazards: Increase Misuse

I now delve into the potential moral hazard arising from buprenorphine use in OUD treatment. Buprenorphine has a dual role as both an opioid receptor agonist and a partial antagonist. When



(a) Oxycodone & Hydrocodone Dispensation Per Capita

(b) Survey-Reported Illicit Drug Use Rate

Figure 8. Evidence of Moral Hazard, Increasing Opioid Misuse

Note: Figures 8a and 8b are estimated using the synthetic DiD approach, as specified in Equation 4. The dependent variable in Figure 8a is the county-year aggregated dispensation of Oxycodone and Hydrocodone by pharmacies. In Figure 8b, the dependent variable is the state-level estimate of past-year illicit drug use from the National Survey on Drug Use and Health. To interpret it as the current-year illicit drug use, I adjust the survey year by adding one. The confidence intervals are calculated using 1,000 bootstrap iterations.

combined with naloxone (as in the common formulation Suboxone, which contains a 4:1 ratio of buprenorphine to naloxone), the naloxone acts as an opioid antagonist to reverse overdoses. However, this dual agonist/antagonist nature of buprenorphine may paradoxically reduce the incentive for patients to completely discontinue opioid misuse.

First, I analyze pharmacy dispensation data for oxycodone and hydrocodone at the county-year level. In full-practice states, NPs are allowed to prescribe opioids independently, under the same regulations that govern other controlled substances. These regulations differ from those governing buprenorphine under the Drug Addiction Treatment Act, meaning CARA does not directly affect NP prescribing behavior for oxycodone and hydrocodone. As shown in Figure 8a, there was a significant increase—approximately 6% above 2015 levels—in the dispensation of these drugs in full-practice states after CARA was implemented. Importantly, increases in oxycodone and hydrocodone dispensation do not inherently imply greater opioid misuse, as both have valid medical uses. However, it seems improbable that post-CARA, a surge in physical injuries requiring opioids emerged specifically in full-practice states. Despite stricter opioid dispensing policies, misuse of oxycodone and hydrocodone persists, and these drugs account for approximately a quarter of all opioid-related mortality. Given this, it is likely that a portion of the increase in dispensation for these opioids translates into non-medical use. The dips observed in 2016 and 2017 (Figure 8a) may also reflect variations in competition; during this period, relatively few prescribers were newly certified, while each subsequent year saw a steady increase in prescriber numbers.

Additionally, Figure 8b presents state-level estimates of illicit drug use per 100,000 individuals based on survey data. By 2019, the misuse rate in full-practice states had risen by nearly 20% compared to 2016 levels. Although part of this increase could be linked to a 2016 change in survey methodology that boosted response rates and widened gaps between treatment and control states, the continued rise after 2016 indicates that the survey changes alone do not explain the increase. Using the same dataset, I also examine the effect of survey-reported painkiller misuse, most likely related to prescription opioids. Figure C4 shows state-level estimates of painkiller misuse per 100,000 individuals. Although the trend lacks statistical significance, it is not declining, which implies a steady OUD patient population size. This suggests that reductions in opioid-related mortality may stem more from substitution or co-consumption of buprenorphine, which lowers overdose risk, than from decreased painkiller misuse.

This analysis aligns with the moral hazard findings of Doleac and Mukherjee (2022), which linked increased over-the-counter naloxone access to higher opioid-related deaths. However, my findings show mortality can still decreases while misuse unchanged or increased, This mortality reduction can be attributed to the distinct benefits of Suboxone, which combines buprenorphine

to reduce cravings and naloxone to mitigate overdose risks. Even if buprenorphine is diverted to illicit markets, its relatively safe profile makes it a preferable alternative to more dangerous opioids like fentanyl or heroin. Replacing daily opioid use with buprenorphine improves health outcomes by reducing both cravings and overdose risks—an outcome not achievable with naloxone alone, which only temporarily reverses overdoses without addressing addiction. Buprenorphine thus emerges as a safer harm reduction strategy, yielding benefits even when used outside of prescribed settings, such as through illicit self-medication.

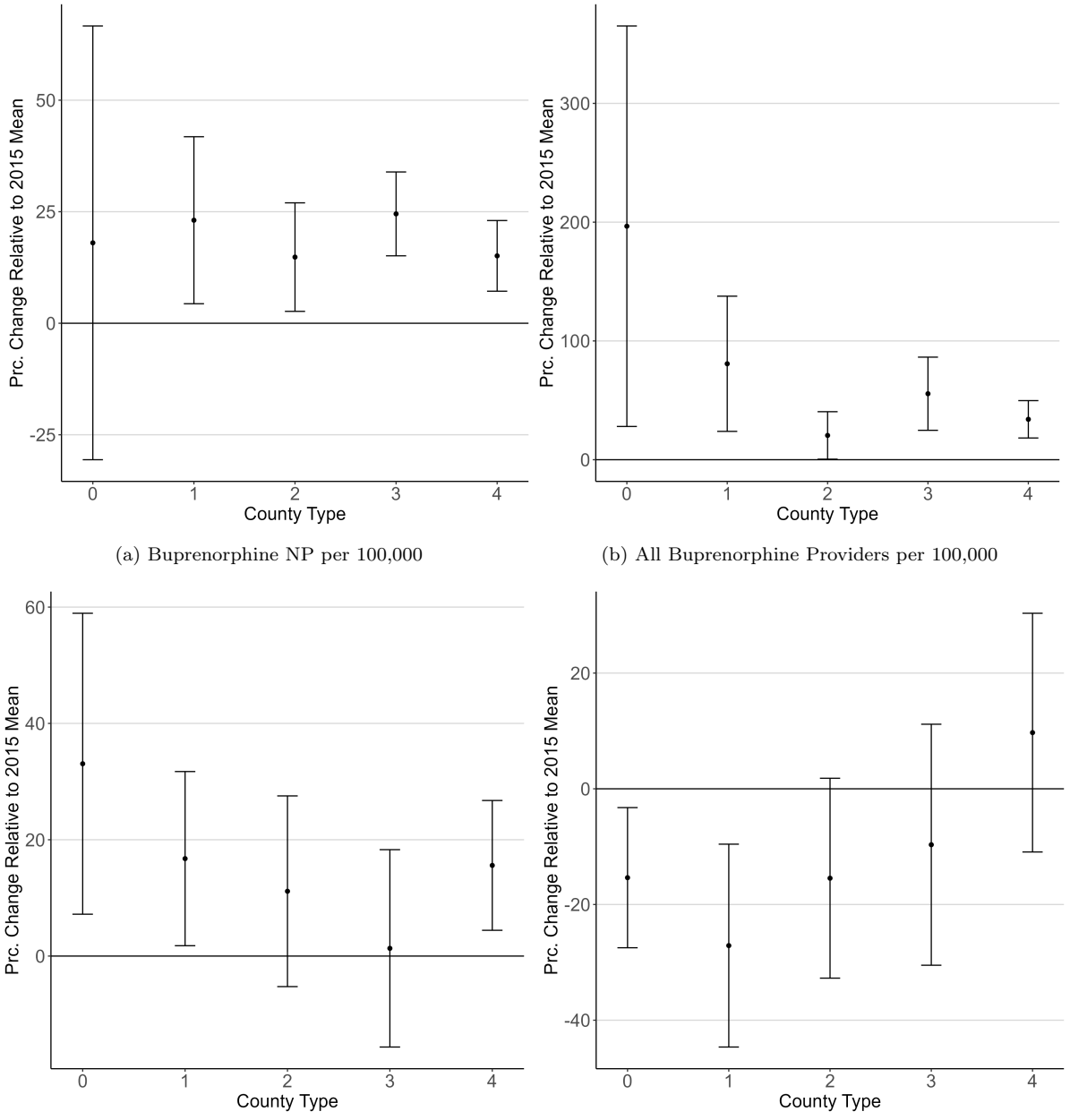
B. Is Competition Good?

I now turn to the consequence of allowing NPs to prescribe buprenorphine to other providers, namely competition. Allowing NPs to prescribe buprenorphine independently sharply increases competition. How do other providers react? Do they also now provide buprenorphine? What is the consequence of health outcomes in a county, namely opioid-related mortality?

Similar to my setting, while not looking at OUD treatment, Currie, Li, and Schnell (2023) highlight that NP autonomy can lead to increased opioid prescriptions by general practitioners, potentially exacerbating misuse. Their finding coincides with the previous moral hazard stories. However, specific to OUD treatment, the problem is that many places are underserved; in fact, no prescriber would prescribe buprenorphine. More providers do not translate to intense competition in those places. Whereas in places with availability, increased competition might create a perverse incentive to attract patients by overprescribing.

Using a synthetic DiD approach, I estimate the impact of allowing NPs to prescribe buprenorphine independently on four key outcomes across various levels of competition: the number of buprenorphine-prescribing NPs per 100,000 population, the total number of buprenorphine prescribers (including NPs) per 100,000, dispensed buprenorphine per capita and opioid-related mortality per 100,000. The level of competition is categorized into three general types, as illustrated in Figure 2: (1) no access (counties without buprenorphine providers and OTPs), (2) single access to buprenorphine providers (counties without OTPs), and (3) access to both providers and OTPs. Within the access categories, I further differentiate between counties with above and below the median number of providers.

For clarity, I designate counties without any access in 2013 as "county type 0." Counties with only buprenorphine providers and below the median number of providers per 100,000 population (of counties with only buprenorphine providers) are classified as "county type 1," while those above the median are classified as "county type 2." Similarly, for counties with access to both buprenorphine providers and OTPs, I designate those below the median number



(a) Buprenorphine NP per 100,000

(b) All Buprenorphine Providers per 100,000

(c) Dispensed Buprenorphine per Capita

(d) Opioid-Related Mortality per 100,000

Figure 9. Heterogeneous County Competition Effect by County Type

Note: Figure displays the percentage change relative to the 2015 mean across four county types: Type 0 represents counties with no access to buprenorphine providers or OTPs; Type 1 includes counties with access to buprenorphine providers only (below median); Type 2 includes counties with access to buprenorphine providers only (above median); Type 3 encompasses counties with access to both buprenorphine providers and OTPs (below median); and Type 4 includes counties with access to both providers and OTPs (above median). Outcomes measured are (a) buprenorphine NPs per 100,000, (b) total buprenorphine providers per 100,000, (c) buprenorphine dispensed per capita, and (d) opioid-related mortality per 100,000. All the outcomes are normalized to 2015 mean. Error bars represent 95% confidence intervals.

of buprenorphine prescribers as "county type 3" and those above as "county type 4." This classification is not arbitrary; as shown in Table C3, competition intensifies from county type 0 to county type 4, with an increasing number of buprenorphine providers at each level.

Figure 9 employs a synthetic DiD approach to analyze outcomes normalized to the 2015 mean.[17] The interpretation reflects the percentage change relative to this mean. Subfigure 9a shows that the increase in buprenorphine prescribers is approximately 20% due to NPs alone, regardless of competition level. Subfigure 9b is similarly normalized for all buprenorphine providers per 100,000. It shows that treatment expansion is not limited to NPs; non-NP providers also contribute significantly. Generally, as competition increases, the expansion of treatment availability diminishes, with the most substantial growth occurring in counties classified as Type 0 and Type 1. This pattern is further illustrated in Subfigure 9c, which depicts the percent change in buprenorphine dispensed per capita relative to the 2015 mean. Increased provider availability correlates with higher buprenorphine dispensation; however, Type 4 counties, which are the most competitive, also show a notable increase in dispensed buprenorphine. As previously discussed, greater buprenorphine dispensation is associated with reductions in opioid-related mortality, as shown in Subfigure 9d. Interestingly, Type 4 counties stand out again, exhibiting increased opioid-related mortality despite their higher dispensation of buprenorphine. I also include Table C3 in the Appendix to present these results in detail.

Using Medicare Part D data for county-type classification involves two caveats. First, Type 0 counties may include some with access to buprenorphine providers, leading to potential misclassification. Given the trend of higher competition leading to less treatment expansion and reduced benefits, this could mean the effect is underestimated, potentially masking larger reductions in opioid-related mortality for Type 0 counties. Second, although county type definitions rely on Medicare Part D prescribers rather than all buprenorphine providers, Medicare Part D data closely predicts overall provider numbers, as shown in Appendix A. Therefore, while county types are classified using Medicare Part D providers, competition differences between county types likely reflect the broader buprenorphine provider landscape.

The impact of expanding treatment options varies by existing access levels. In underserved areas, the entry of new providers fills critical care gaps, leading to significant reductions in opioid-related mortality. However, the marginal benefit of adding more providers diminishes in regions with greater treatment availability. This suggests that simply increasing the number of prescribers may not suffice to improve outcomes in well-served areas. Counterintuitively, higher buprenorphine dispensation is linked to increased opioid-related mortality, prompting an

[17]For Subfigure 9a, the normalization is based on all buprenorphine prescribers per 100,000 in 2015. In that year, most counties had zero prescribers, as NPs generally could not prescribe.

examination of prescribing behaviors in these counties. The following section will explore how heightened competition among providers can sometimes incentivize practices that counteract intended public health goals, potentially contributing to overprescribing and undermining efforts to curb opioid misuse.

C. *Alter Provider Behavior*

In the previous section, I demonstrated that varying levels of availability can limit the effectiveness of efforts to reduce mortality. Moreover, I now suggest a mechanism that could further inhibit mortality reduction: the tendency for new entrants to overprescribe buprenorphine due to excessive competition.

To explore this effect, I investigate whether new prescribers shift in prescribing behavior, particularly focusing on the number of days per prescription. This is calculated by dividing the total days' supply of buprenorphine by the total number of buprenorphine prescriptions. This metric is critical, as prescribers generally avoid issuing excessive refills, opting to monitor patients periodically regardless of location. The distribution of days supplied reveals three distinct peaks—at 7, 14, and 28 days—with prescriptions rarely exceeding 30 days, as shown in Figure C5. After 2016, a noticeable trend emerges: more prescribers choose shorter prescriptions, particularly 7- and 14-day supplies, while the frequency of 28-day prescriptions declines. This suggests that new entrants favor a more conservative approach to prescribing longer durations. There are several reasons why prescribers avoid issuing long prescriptions. First, shorter prescriptions allow for more frequent monitoring of patients' progress, facilitating adjustments to dosages when necessary. Additionally, buprenorphine, being an opioid, is prone to diversion, making it essential to limit the quantity dispensed to reduce the risk of misuse. Let $Days\ Supplied_{it}$ represent the outcome for prescriber i in year t. I estimate the following equation:

$$Days\ Supplied_{it} = \beta_1 Treat_{it} + \beta_2 Treat_{it} \times New\ Entrant_i + X_{ct}\delta + L_{st}\gamma + \phi_i + \psi_t + \epsilon_{it} \tag{6}$$

Equation 6 represents an individual-level, two-way fixed effects model. Here, $Treat_{it} = 1$ if a prescriber is in a state with full practice authority for NPs after 2016. $NewEntrant_i$ refers to prescribers who began prescribing buprenorphine after 2016.[18] This variable specifically captures new entrants in the buprenorphine market, not new healthcare providers in general. For example, a family practice doctor who previously treated patients for primary care but begins prescribing buprenorphine after 2016 is considered a new entrant by this definition. In fact, most

[18] I also define $NewEntrant_i$ dynamically based on the first year a prescriber starts prescribing buprenorphine. The results remain consistent across different definitions.

Table 1— Impact of Independent Prescriptive Authority on Prescribing Behavior

	Days Supplied per Prescription			
	Full Sample		Providers & OTPs Top 50%	
	(1)	(2)	(3)	(4)
NP Indep. Bupe.	-0.144	-0.152	-0.371	-0.391
	(0.166)	(0.168)	(0.245)	(0.246)
NP Indep. Bupe. × New Entrant		0.674		4.613*
		(1.131)		(2.581)
Individual Fixed Effects	✓	✓	✓	✓
Year Fixed Effects	✓	✓	✓	✓
County-Level Controls	✓	✓	✓	✓
State-Level Opioid Laws	✓	✓	✓	✓
Mean of Dependent Variable	22.3	22.3	21.5	21.5
Observations	41,254	41,254	20,128	20,128
Adj. R^2	0.784	0.784	0.789	0.789
$\beta_1 + \beta_2$		0.521		4.222
P-value (F-test: $\beta_1 + \beta_2 = 0$)		0.595		0.071

Note: Observations are at the individual prescriber level. Standard errors are clustered at the provider level. All regressions include individual fixed effects, year fixed effects, county-level demographics, and state-level opioid laws as specified in Equation 6. Columns (3) and (4) use the same classification as before, Table C3 Column (6). The classification pertains to prescribers located in counties that had access to both buprenorphine providers and OTPs in 2013 and were above the median in the number of buprenorphine-prescribing providers in those counties. The outcome of interest is the average days supplied per prescription, calculated as the total days of supply divided by the number of claims, based on data from the Medicare Part D Provider and Drug Dataset. $^*p < 0.1$

new entrants were active before 2016 and only began prescribing buprenorphine afterward. X_{ct} includes county-level demographic controls for the prescriber's location, and L_{st} encompasses state-level laws affecting opioid prescribing behaviors. These covariates are consistent with those used in previous analyses, such as in Equation 1.

The primary focus here is on β_2, which captures the effect of being a new entrant in a state where NPs are now allowed to prescribe buprenorphine. We would expect β_2 to be insignificant, as treating OUD patients should follow standardized guidelines, and overprescribing (providing too many refills) is generally avoided due to the addictive nature of the substance. I exclude observations for years and prescribers who did not prescribe buprenorphine, as $Days\ Supplied_{it}$ is missing for those cases. This imbalance does not pose a problem for the model. The identification for β_2 relies on comparing the days supplied by incumbents to those of new entrants in the post-CARA period. Additionally, I limit the analysis to post-2016 data to avoid leaving out the new entrants before 2016, though this reduces statistical power by dropping half of the observations. Nonetheless, the magnitude of the regression results, presented in Table C4, remain consistent, albeit with slightly diminished statistical power.

Table 1 provides empirical support for this hypothesis. Columns (1) and (2) show that allowing NPs to prescribe buprenorphine has no significant effect on prescribing behavior using the full sample. However, the results differ when focusing on prescribers in the most competitive counties—those with both access to OTPs and a higher number of providers than the median county. As discussed in the previous subsection, these regions experience negligible impacts on opioid-related mortality. The likely reason, as described earlier, is that market expansion effects are limited in areas with abundant supply. I suggest that another force might be at play: allowing NPs to prescribe buprenorphine may create excessive competition, leading new entrants to increase the number of days supplied per prescription to attract patients. This analysis reveals that, while incumbents do not alter their prescribing behavior, new entrants in competitive markets increase the days supplied by approximately 4.6 days per prescription—representing a 21% increase from pre-2016 levels.

This increase in days supplied is not due to a lack of knowledge among new entrants about OUD treatment standards; if that were the case, Column (2) should show similar effects. Instead, the data suggests that competition drives this behavior; new entrants deliberately prescribe more buprenorphine. Notably, half of all buprenorphine providers are located in these competitive counties in 2013. Deviating from standard treatment guidelines can worsen patient health outcomes, which might explain the worsening opioid-related mortality observed in these counties, as discussed in the previous section. This deviation primarily stems from new NP entrants rather than new non-NP providers. As shown in Table C5, new NP entrants deviate from standard prescribing practices by nearly ten days, estimating using provider type subsamples.

To ensure these findings are not driven by chance, I also examine Lisinopril—an antihypertensive medication commonly prescribed to manage high blood pressure and one of the most frequently prescribed drugs in the Medicare Part D dataset. Using the same regression framework as in Equation 6, I analyze the days supplied per Lisinopril prescription among providers who also prescribe buprenorphine, mirroring the results layout with that of Table 1 in Table C6. The results are insignificant across all county types, indicating that prescribers do not generally increase days supplied outside of buprenorphine prescriptions.

These results likely extend to the broader prescriber population. Buprenorphine guidelines for OUD are notably strict compared to other medications, making extended prescriptions uncommon. For instance, as shown in Table C6, the mean prescription length for Lisinopril is approximately 55 days—double that of buprenorphine. Deviations from these standards within the Medicare Part D population are thus meaningful even within this sample. Given these stringent guidelines, it is unlikely that prescribers who deviate from Medicare standards would refrain from doing so for younger, generally healthier populations.

VI. Robustness Check

First, I assess whether any specific state drives the findings. To do this, I exclude one state from the set of NP full-practice states at a time and re-estimate Equation 4 on that sample. This step confirms that no single state disproportionately influences the results, as seen in Figure C6.

Second, I examine the robustness of the results to varying definitions of NP full-practice states. In the primary specification, I exclude states that transitioned to NP full practice between 2014 and 2016—Utah, Nebraska, Minnesota, New York, West Virginia, Delaware, and Connecticut. I now classify these states as treated in my sample. Additionally, I expand the definition of NP full-practice states to include those where NPs can practice separately, even if they are in collaborative arrangements, provided they do not require on-site physician supervision.[19] The results remain robust across these alternative definitions, as shown in Figure C7.

Finally, to address concerns about potential violations of the parallel trends assumption, I extend the pre-treatment period to 2010. As before, I exclude states that experienced transitions between 2010 and 2019 to maintain a stable policy environment. Using the canonical event study specification, as outlined in Equation 1, I show in Figure C8 that, even without employing the synthetic DiD method, the parallel trends assumption holds well, conditional on observables.

VII. Discussion

CARA undeniably achieves its primary objective: expanding access to treatment for OUD. The law emphasizes "access" and "availability" 53 times, reflecting its central focus. CARA's policies extend beyond simply enabling NPs to prescribe buprenorphine; they also increase funding for OTPs and patient support. Figure C1 shows that 477 counties now gain access to OUD treatment compared to 2013 levels. Allowing NPs to prescribe buprenorphine contributes significantly to this expansion, especially in underserved regions.

However, the results suggest that overall reductions in opioid-related mortality are primarily occurring in regions with limited access to treatment, which are often smaller in population. The majority of OUD patients likely reside in urban areas with greater treatment access, where reductions are less evident. Moreover, it is concerning that while opioid-related mortality has decreased, other indicators—such as oxycodone dispensation, illicit drug use rates, and painkiller misuse rates—have not decreased and, in some cases, have risen. This trend aligns with concerns raised in the introduction about the substitution of one addiction for another. However, reducing

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

mortality through substitution from fentanyl to buprenorphine is not insignificant; each life saved is a meaningful outcome.

Yet, while the emphasis on reducing mortality is critical, policymakers should also consider improving patients' quality of life. Throughout this paper, the focus has largely been on expanding treatment access, often without addressing the quality of care. Quality of care is essential to meaningful recovery. To illustrate, a patient with a complex condition, like a herniated disc, would typically be referred to an orthopedic specialist rather than treated solely by an NP, who is often focused on primary care. Similarly, in OUD recovery, NPs play a crucial role in expanding access to treatment, but patients with severe or complex cases often require the specialized expertise of addiction medicine professionals.

The Hub-and-Spoke model, pioneered in Vermont, presents a promising solution. Similar to the airline industry, this model positions NPs and primary care physicians as the "Spokes," who handle routine cases and refer more severe cases to the "Hubs"—OTPs staffed by addiction specialists. This referral system mirrors the standard practice of first seeing a primary care physician before being referred to a specialist and could significantly improve the quality of OUD treatment. Although currently adopted in only a few states, broader implementation of this model would balance the need for both access and high-quality care in OUD treatment.

Another critical development is the recent 2023 Omnibus Bill, which removed all prior restrictions on buprenorphine prescribing for DEA-registered providers, effectively treating buprenorphine like any other controlled substance. By lifting these limitations, the bill aims to further expand access. However, this expansion warrants caution. While increased availability is likely to continue reducing opioid-related mortality, as suggested by this paper, the impact may be modest. Many prescribers have already begun prescribing buprenorphine under CARA, and additional prescribers in areas with existing access are likely to yield only marginal health benefits. Although this paper does not formally examine it, the increased availability of buprenorphine could potentially crowd out OTPs, especially if OUD patients do not prioritize the additional services OTPs offer, such as therapy and counseling.

VIII. Conclusion

In conclusion, this study examines a critical aspect of CARA—granting NPs the authority to prescribe buprenorphine—as part of a federal strategy to address the opioid crisis. By leveraging a quasi-experimental design that combines this authorization with existing state-level NP prescriptive authority, I find that allowing NPs to prescribe independently significantly increases the number of prescribers, boosts buprenorphine usage, and notably reduces opioid-related fatalities.

However, this policy also presents unintended consequences. First, independent prescribing authority raises concerns about moral hazard, as increased buprenorphine availability might inadvertently encourage illicit drug use and elevate the dispensation of opioids such as oxycodone and hydrocodone. Second, NP entry into underserved markets attracts additional providers, significantly reducing mortality in areas lacking adequate treatment access. Conversely, the influx of NPs heightens competition in regions with better access, altering prescribing behaviors to include more days supplied per prescription.

This paper adds to the literature on healthcare competition by highlighting the dual impact of provider entry. While competition can enhance access and outcomes in underserved areas, it may also create perverse incentives in markets with sufficient prescriber capacity, leading to unintended consequences. Thus, competition acts as a double-edged sword, producing both positive and negative effects depending on local market conditions.

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 (dividing 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.

Table A1— 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). $^{***}p < 0.01$

In Table A1, the number of Medicare Part D prescribers strongly predicts the number of active buprenorphine prescribers at the county level, with 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 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.

Institutional Details

B1. 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.[20]

Methadone, a full opioid agonist with a long half-life,[21] 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 it is a full opioid agonist. Methadone is solely distributed through OTPs, requiring patients to visit clinics for their doses regularly or stay inpatients. 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 practice scope, making it less regulated than buprenorphine or methadone. Primarily, it is utilized for

[20] 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.

[21] Methadone has a relatively long half-life (24–36 hours or longer). Steady-state serum levels generally do not reach 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.

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 the buprenorphine and methadone prescription when used for treating OUD, which separates them from other controlled 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 to be eligible under the Drug Addiction Treatment Act.[22] However, methadone regulation remained unchanged.

B2. 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.[23] 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.

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.

[22]Despite CARA's inclusivity towards 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.

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

B3. Nurse Practitioner Practice Authority and the Impact of CARA

Scope-of-practice laws for NPs vary greatly across states. Following McMichael and Markowitz (2023), states are classified as either full-practice or restricted-practice based on whether NPs can set up independent practices without physician collaboration or supervision. Before 2014, 19 states, including D.C., allowed NPs to independently prescribe Schedule II-V controlled substances. From 2014 to 2019, an additional 10 states transitioned to full-practice status, indicating an expansion of NP prescriptive authority nationwide. However, several states, particularly in the South and large states like California, Texas, and Florida, continue to restrict NP independence.

Despite variations in practice authority and geographical location, the overall landscape of healthcare providers remains similar across states. Table C1 presents the 2015 number of health providers and buprenorphine prescribers per 100,000 people. GPs outnumber NPs across all states, suggesting NPs likely complement GPs, with significant variation in the NP-to-GP ratio. For example, Massachusetts has a high ratio of 0.99, while Hawaii has a low ratio of 0.13. One might expect states granting full practice authority to NPs to have a higher number of NPs compared to restricted practice states. However, the difference in the number of NPs between these two types of states is relatively small and not statistically significant, indicating that practice authority's influence on NP numbers is modest. In terms of buprenorphine providers, NP full-practice states have more buprenorphine prescribers than NP-restricted practice states. This is likely skewed by two outliers in the NP full practice states—Maine and Vermont—with 11.73 and 12.62 buprenorphine prescribers per 100,000 people.

CARA impacts NP prescribing in two significant ways, depending on whether NPs work under a collaborative arrangement with physicians or independently practice. For NPs in collaborative arrangements with physicians, either in full practice states or restricted practice states, they can only obtain the waiver if their collaborating or supervising physicians also have a waiver. This increases the prescribing capacity within a doctor's office but does not create new treatment options for consumers, as patients would still visit the same doctor's office. This effect is consistent across all states and applies to all NPs working under a collaborative arrangement. Second, CARA, in conjunction with state-level NP practice laws, allows NPs to prescribe buprenorphine independently in states with full practice authority. Since NPs cannot practice independently in restricted practice states, this effect is exclusive to states with full practice authority. This change adds more treatment locations for OUD patients, as these options did not exist before CARA.

B4. Drug Dictionary

In addition to the primary medications for OUD, such as methadone, buprenorphine, and naltrexone discussed in Section B.B1, 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 an 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, 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 (MAT) programs, which integrate medication with counseling and behavioral therapies for a comprehensive approach to addiction recovery.

Additional Figures and Tables

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

Table C1— 2015 State Level Health Providers Landscape

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— Timing to Adopting Other Laws

	Naloxone Overdose Prevention Law (1)	Involuntary Commitment Substance Use (2)	Opioid Prescription Limit (3)	PDMP (4)	Inform Consent (5)
Indep. Bupe.	0.035	-0.198	-0.025	0.018	-0.058
	(0.117)	(0.100)	(0.089)	(0.018)	(0.085)
Fixed-effects					
State	Yes	Yes	Yes	Yes	Yes
Year	Yes	Yes	Yes	Yes	Yes
Observations	287	287	287	287	287
R^2	0.584	0.689	0.591	0.166	0.621

Note: The standard error is clustered at the state level. All observations are state-level. All laws are collected through the Prescription Drug Abuse Policy System (https://pdaps.org/)

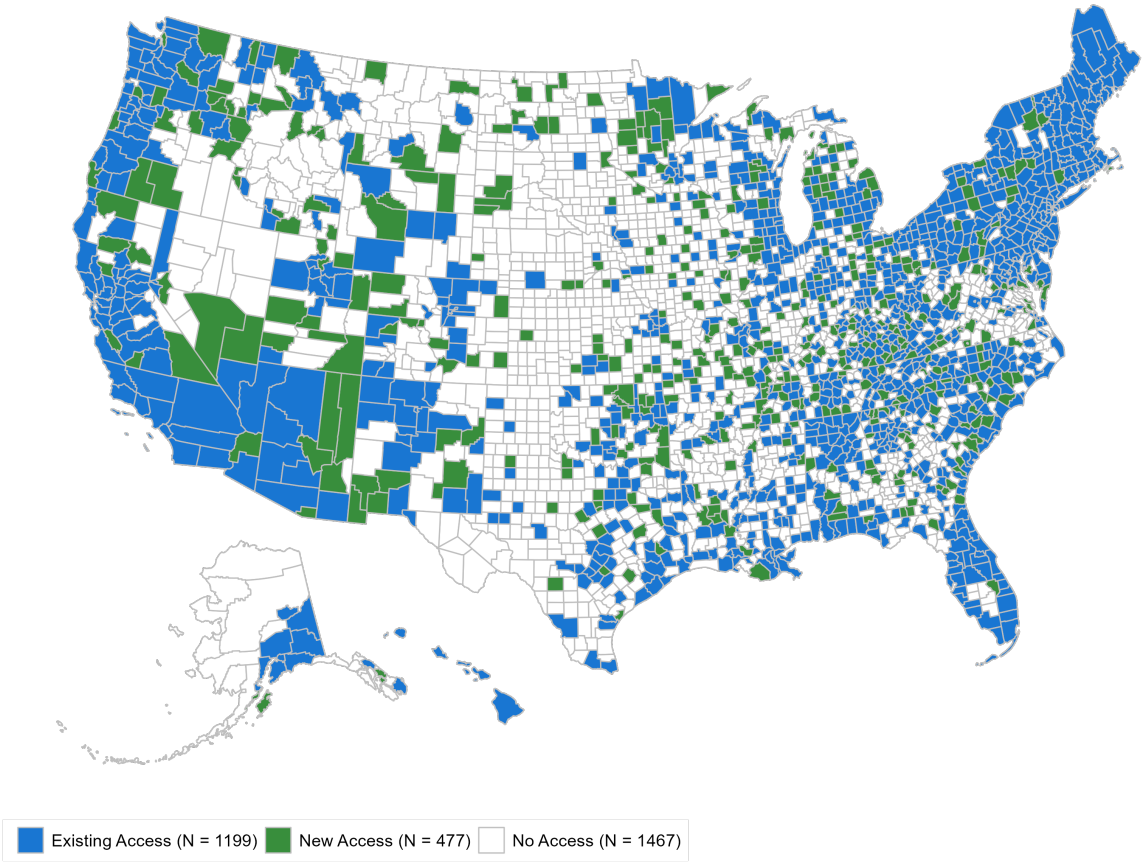


Figure C1. County Gained Access in 2019 Compare to 2013

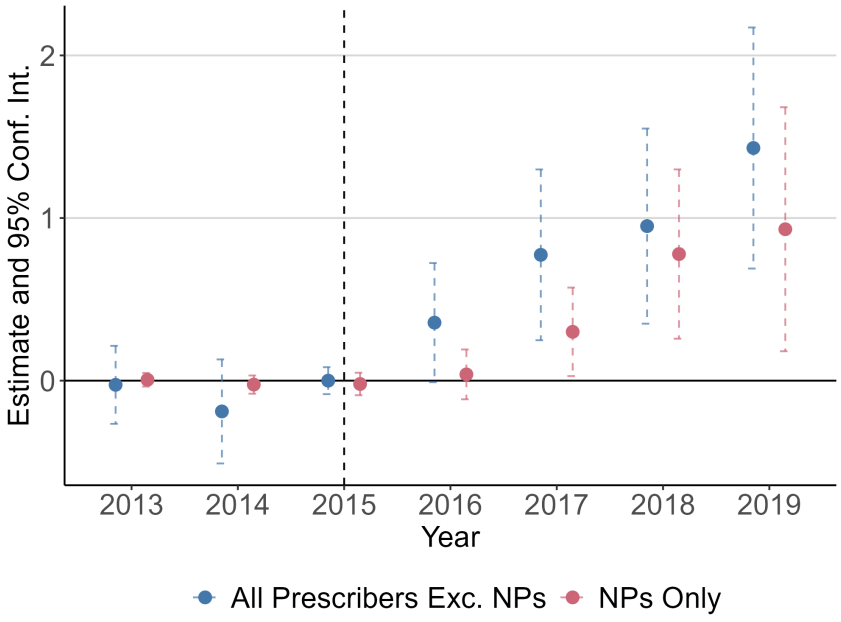
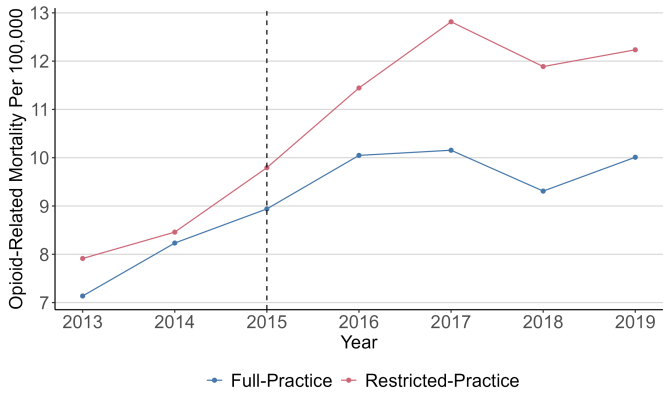
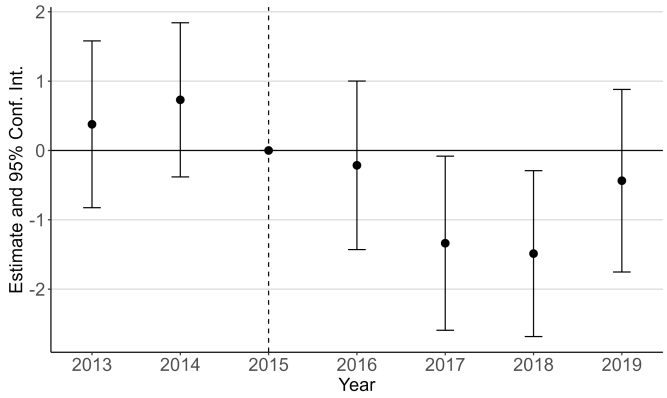


Figure C2. Defensive Entries by Other Prescribers

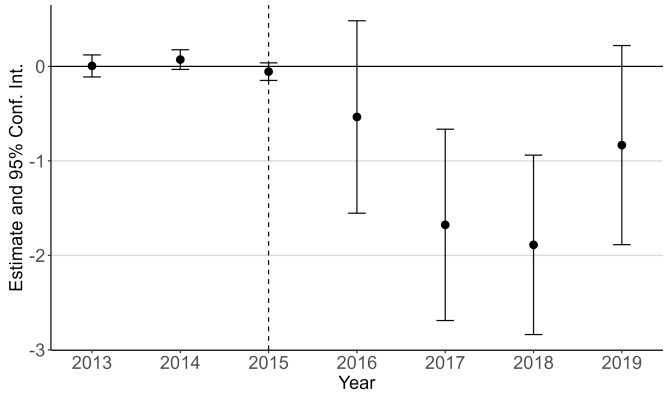
Note: The observation is at the state level. The outcome of interest is the number of all buprenorphine prescribers, excluding NPs, per 100,000 and the number of NPs per 100,000. The standard errors are estimated via bootstrap.



(a) Mean Trends



(b) Dynamic DiD Results



(c) Dynamic Synthetic DiD Results

Figure C3. Effect on the Buprenorphine Dispensed Per Capita

Note: The outcome of interest in Figure 6 is opioid-related mortality, measured in morphine gram equivalents per capita. The construction of this figure follows the same methodology as Figure 5. The difference of this Figure between and Figure 7

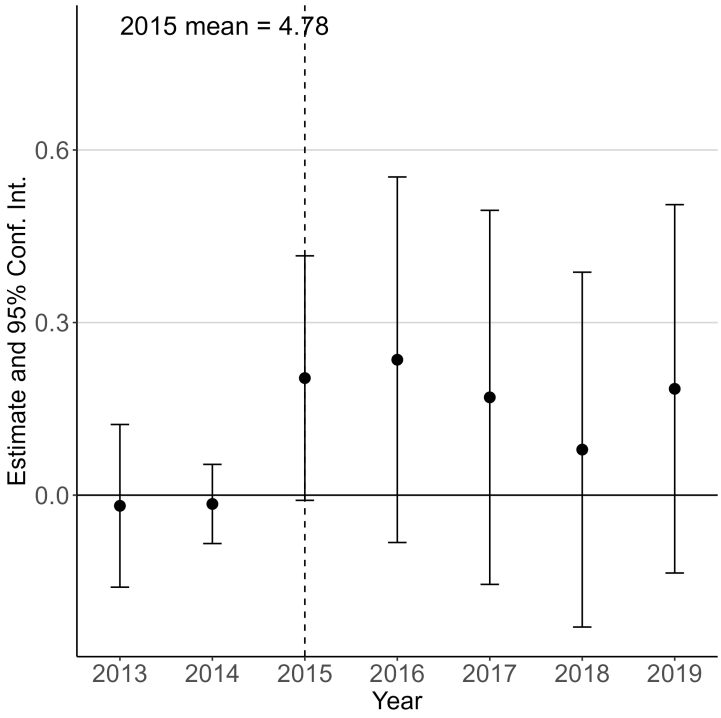


Figure C4. Survey-Reported Pain Killer Misuse Rate

Note: The standard errors are clustered at the state level. The observation is at the state level. The outcome of interest is pain killer misuse from the National Survey on Drug Use and Health. The construction is the same as in Figure 8b.

Table C3— Heteregenous Comeptition Synthetic DiD Results

County Type		**0**	**1**	**2**	**3**	**4**
	Full Sample	**No Access**	**Only Providers**		**Providers & OTPs**	
			Bottom 50%	**Above 50%**	**Bottom 50%**	**Top 50%**
	(1)	(2)	(3)	(4)	(5)	(6)
Panel a. Buprenorphine Prescribing NP per 100,000						
Estimate	0.08	0.05	0.34*	0.97*	0.34*	0.99*
s.e.	(0.10)	(0.07)	(0.14)	(0.41)	(0.06)	(0.31)
2015 Mean	0.00	0.00	0.03	0.02	0.01	0.03
Panel b. Buprenorphine Prescribers per 100,000						
Estimate	0.84*	0.58*	1.19*	1.34*	0.77*	2.24*
s.e.	(0.16)	(0.18)	(0.27)	(0.60)	(0.21)	(0.63)
2015 Mean	1.39	0.28	1.84	5.76	1.29	4.78
Prc. Change	+60%	+207%	+65%	+23%	+60%	+52%
Panel c. Pharmacy Dispensed Buprenorphine per Capita						
Estimate	0.028*	0.022*	0.041*	0.047	0.003	0.095*
s.e.	(0.008)	(0.010)	(0.016)	(0.033)	(0.018)	(0.031)
2015 Mean	0.243	0.136	0.338	0.599	0.215	0.583
Prc. Change	+11.5%	+16.2%	+12.1%	+7.8%	+1.4%	+16.3%
Panel d. Opioid-Related Mortality per 100,000						
Estimate	-1.23*	-1.05*	-2.48*	-2.08	-1.18	1.86
s.e.	(0.35)	(0.48)	(0.75)	(1.11)	(1.25)	(2.20)
2015 Mean	9.57	8.03	11.56	11.96	10.26	15.97
Prc. Change	-12.9%	-13.1%	-21.4%	-17.4%	-11.5%	+11.6%
2013 Mean Bupe. Prescrs.	1.70	0.00	1.76	2.24	5.63	12.45
# Treated County	582	392	50	56	38	39
# Untreated County	1921	1170	212	197	143	139

Note: Observations are at the county level. The full sample is divided into five groups, as represented in columns (2) through (6), with group classifications fixed at 2013 levels. "No Access" refers to counties with no Medicare Part D providers who prescribed buprenorphine in 2013. "Only Providers" denotes counties with access to buprenorphine prescribers but no OTPs; this category is further divided into counties with below-median (column 3) or above-median (column 4) buprenorphine prescribers per 100,000 population. "Providers & OTPs" refers to counties with both buprenorphine prescribers and OTP access; this group is similarly divided into below-median (column 5) and above-median (column 6) buprenorphine prescribers per 100,000 population. All synthetic DiD results account for county-level demographic covariates and state-level regulations that could influence prescribing behaviors. Standard errors are estimated using 1,000 bootstrap iterations. $^*p < 0.05$

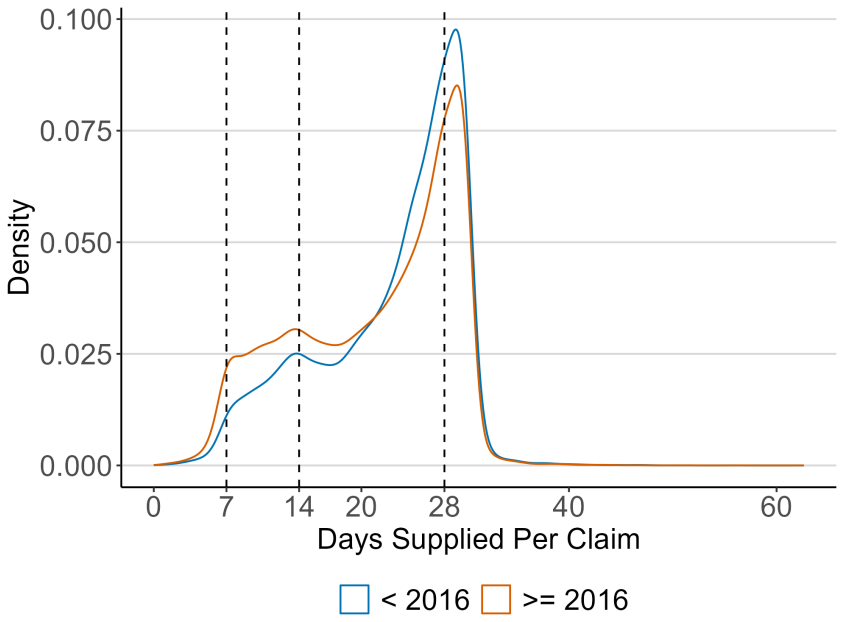
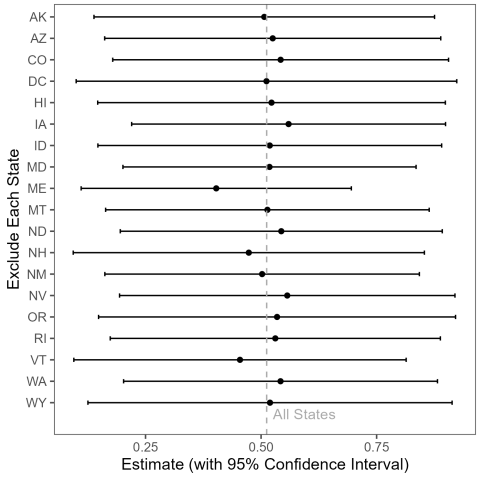
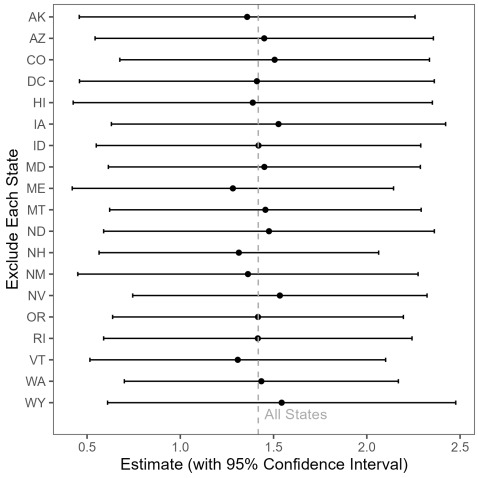


Figure C5. Distribution of Days per Claim at the Provider Level

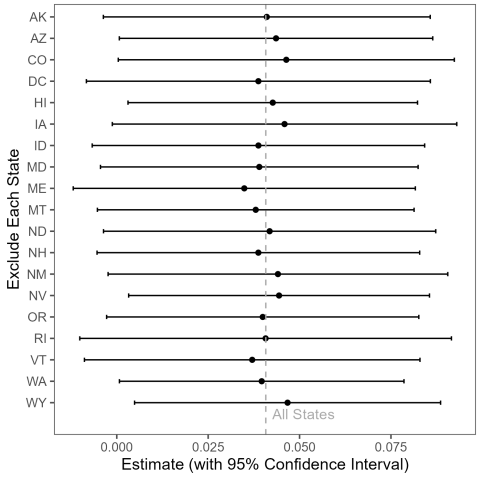
Note: This figure shows the provider-level distribution of days supplied per Claims at the provider level and breaks into before 2016 and after 2016.



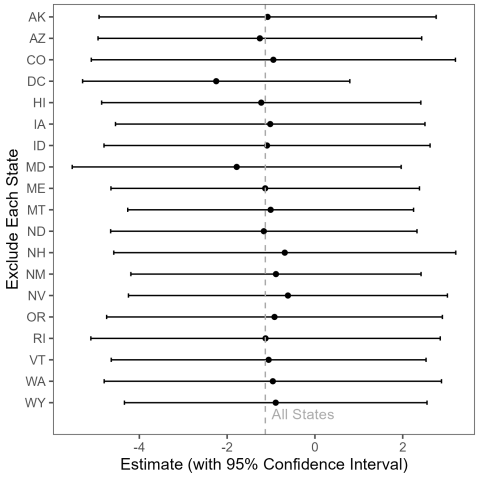
(a) Number of NP per 100,000



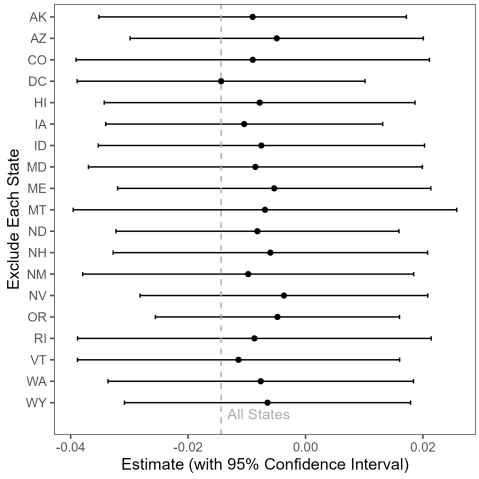
(b) Number of Bupe. Prescribers per 100,000



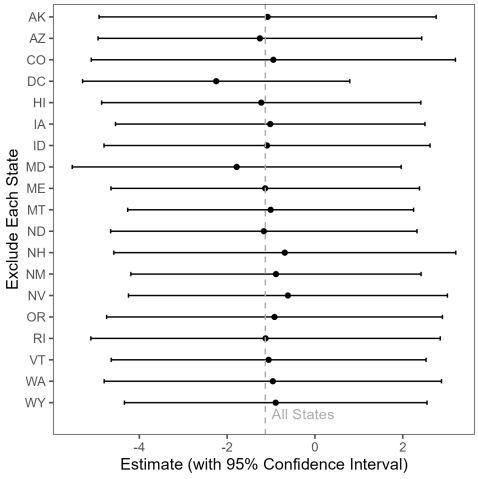
(c) Bupe Dispensation Per Capita



(d) Opioid-Related Mortality per 100,000



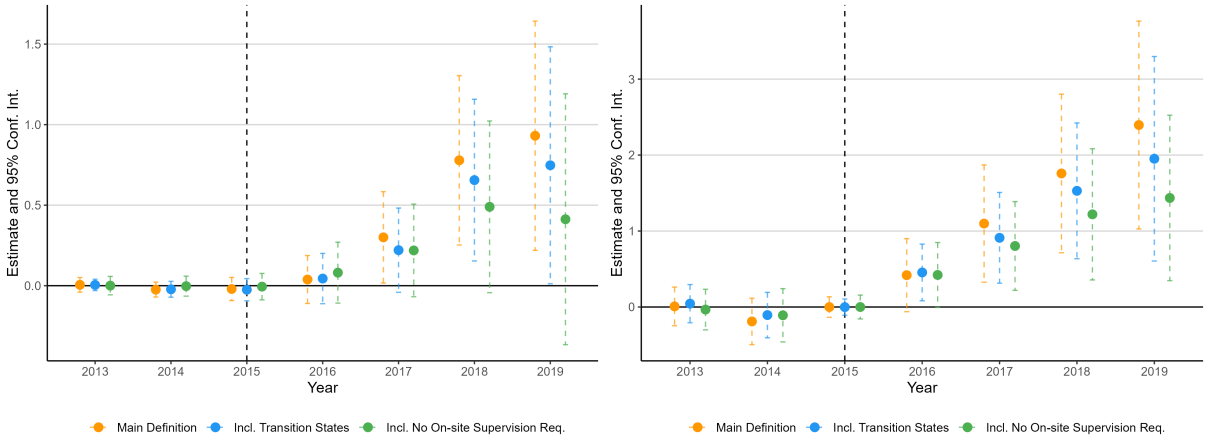
(e) Oxy/Hydro-codone Dispensation Per Capita



(f) Survey-Reported Illicit Drug Use Rate

Figure C6. Robustness Check: Leave One Out

Note: This robustness check involves re-estimating Equation 4 by sequentially removing one state at a time. The grey dashed line represents the estimate using all states. Confidence intervals are calculated via bootstrapping.



(a) Number of NP per 100,000

(b) Number of Bupe. Prescribers per 100,000

(c) Bupe Dispensation Per Capita

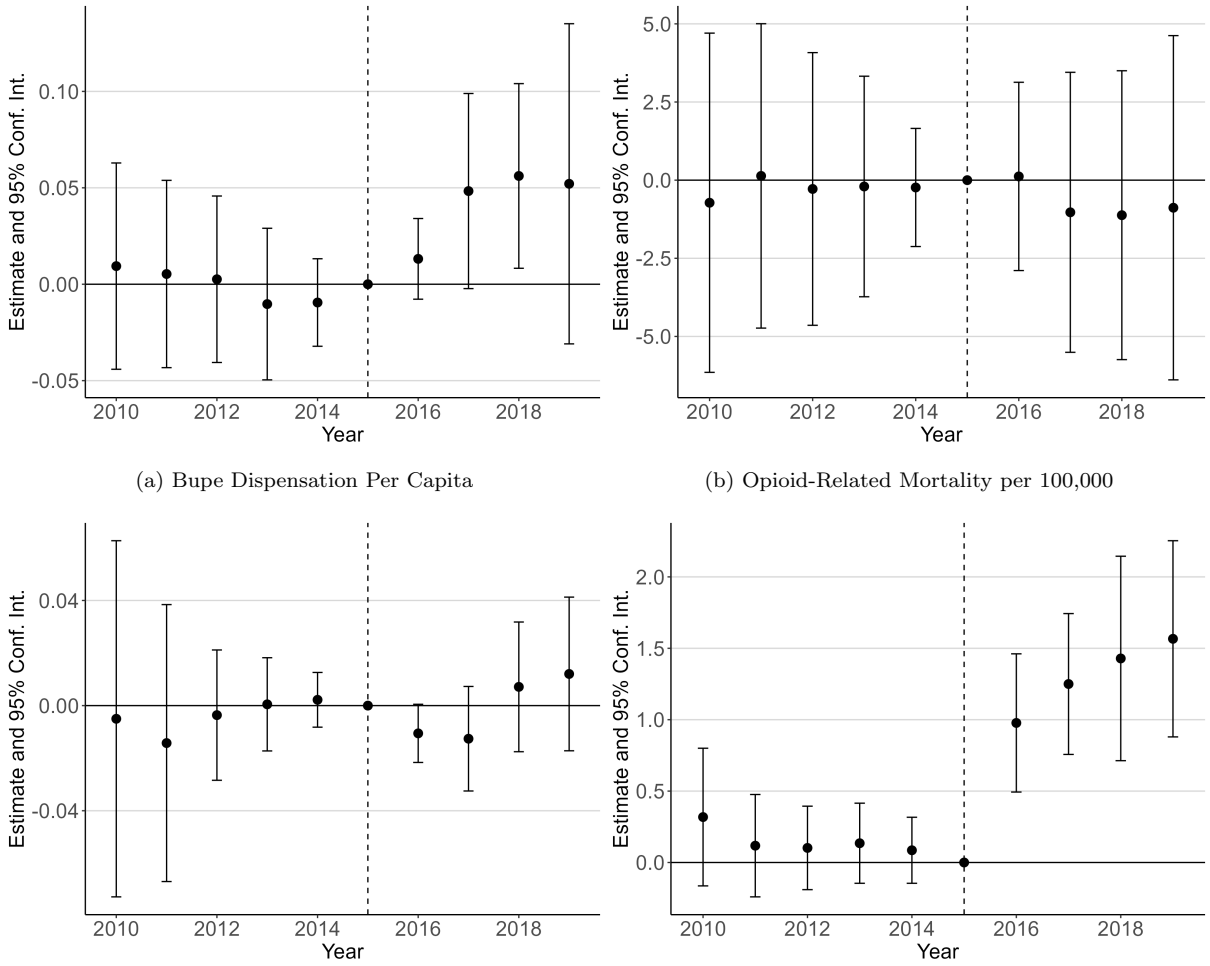
(d) Opioid-Related Mortality per 100,000

(e) Oxy/Hydro-codone Dispensation Per Capita

(f) Survey-Reported Illicit Drug Use Rate

Figure C7. Robustness Check: Alternate Definition of Treatment States

Note: This robustness check estimates Equation 4 using alternative definitions of treatment states. "Main Definition" reflects the preferred definition used in the paper. "Incl. Transition States" includes states transitioning to NP full-practice status between 2013 and 2016 as treatment states. "Incl. No On-Site Supervision" adds states that require no on-site physician supervision in NP restricted-practice states as treatment states. Confidence intervals are calculated via bootstrapping.



(a) Bupe Dispensation Per Capita

(b) Opioid-Related Mortality per 100,000

(c) Oxy/Hydro-codone Dispensation Per Capita

(d) Survey-Reported Illicit Drug Use Rate

Figure C8. Robustness Check: Prolonged Pre-Treatment Periods

Note: Data are at the state-year level, with standard errors clustered at the state level. This robustness check extends the pre-treatment period to assess potential violations of the parallel trends assumption, using Equation 1.

Table C4— Impact of Independent Prescriptive Authority on Prescribing Behavior

	Days Supplied per Prescription *(After 2016)*			
	Full Sample		Providers & OTPs Top 50%	
	(1)	(2)	(3)	(4)
NP Indep. Bupe.	0.800	0.797	0.168	-0.847
	(0.784)	(1.016)	(1.479)	(1.601)
NP Indep. Bupe. × New Entrant		0.010		5.022*
		(1.499)		(3.007)
Individual Fixed Effects	✓	✓	✓	✓
Year Fixed Effects	✓	✓	✓	✓
County-Level Controls	✓	✓	✓	✓
State-Level Opioid Laws	✓	✓	✓	✓
Mean of Dependent Variable	20.2	20.2	19.8	19.8
Observations	22,813	22,813	10,677	10,677
Adj. R^2	0.837	0.837	0.846	0.846
$\beta_1 + \beta_2$		0.807		4.175
P-value (F-test: $\beta_1 + \beta_2 = 0$)		0.697		0.234

Note: The table construction is the same as Table 1. The only difference is that this table only looks after the periods after 2016.

Table C5— NPs vs. Non-NP Providers Within Highly Competitive Counties

	Days Supplied per Prescription *Providers & OTPs Top 50%*			
	NP		Non-NP	
	(1)	(2)	(3)	(4)
NP Indep. Bupe.	2.520	1.693	-0.392	-0.408*
	(2.659)	(2.855)	(0.247)	(0.247)
NP Indep. Bupe. × New Entrant		8.002**		5.435
		(3.912)		(3.694)
Individual Fixed Effects	✓	✓	✓	✓
Year Fixed Effects	✓	✓	✓	✓
County-Level Controls	✓	✓	✓	✓
State-Level Opioid Laws	✓	✓	✓	✓
Mean of Dependent Variable	24.5	24.5	21.2	21.2
Observations	1,735	1,735	18,393	18,393
Adj. R^2	0.827	0.827	0.777	0.777
$\beta_1 + \beta_2$		9.695		5.027
P-value (F-test: $\beta_1 + \beta_2 = 0$)		0.002		0.098

Note: The construction of this table mirrors that of Table 1. The key distinction is that this table focuses exclusively on counties classified as Type 4 and examines separate subsamples for NPs and non-NP providers.

Table C6— Impact of Independent Prescriptive Authority on Prescribing Behavior of Lisinopril

	Days Supplied per Prescription *Lisinopril*			
	Full Sample		Providers & OTPs Top 50%	
	(1)	(2)	(3)	(4)
NP Indep. Bupe.	0.297	0.344	0.756	0.744
	(0.438)	(0.442)	(0.649)	(0.650)
NP Indep. Bupe. × New Entrant		-4.258		2.146
		(2.955)		(7.697)
Individual Fixed Effects	✓	✓	✓	✓
Year Fixed Effects	✓	✓	✓	✓
County-Level Controls	✓	✓	✓	✓
State-Level Opioid Laws	✓	✓	✓	✓
Mean of Dependent Variable	55.4	55.4	53.6	53.6
Observations	21,958	21,958	10,220	10,220
Adj. R^2	0.854	0.854	0.855	0.855
$\beta_1 + \beta_2$		-3.913		2.890
P-value (F-test: $\beta_1 + \beta_2 = 0$)		0.303		0.488

Note: Observations are at the individual prescriber level. Standard errors are clustered at the provider level. All regressions include individual fixed effects, year fixed effects, county-level demographics, and state-level opioid laws as specified in Equation 6. Columns (3) and (4) use the same classification as before, Table C3 Column (6). The classification pertains to prescribers located in counties that had access to both buprenorphine providers and OTPs in 2013 and were above the median in the number of buprenorphine-prescribing providers in those counties. The outcome of interest is the average days supplied per prescription of Lisinopril, calculated as the total days of supply divided by the number of claims, based on data from the Medicare Part D Provider and Drug Dataset.

*

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