The Impact of Scope-of-Practice Restrictions on Access to Medical Care

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Abstract

We study the impact of scope-of-practice laws in a highly regulated and important policy setting, the provision of medication-assisted treatment for opioid use disorder. We consider two natural experiments generated by policy changes at the state and federal level that allow nurse practitioners more practice autonomy. Both experiments show that liberalizations of prescribing authority lead to large improvements in access to care. Further, we use rich address-level data to answer key policy questions. Expanding nurse practitioner prescribing authority reduces urban-rural disparities in health care access. Additionally, expanded autonomy increases access to care provided by physicians, driven by complementarities between providers.

State governments use scope-of-practice laws to regulate the practice authority and autonomy of nurse practitioners, physician's assistants, pharmacists and other healthcare providers. Beginning in the late 1980s, more than half of U.S. states have liberalized these laws for nurse practitioners (NPs), allowing them to independently practice in areas like primary care and mental health without physician's supervision or involvement. States relax these rules with the goal of alleviating primary care shortages and increasing access to care. However, these regulations remain a subject of intense debate. Measures liberalizing nurse practitioners' scope-of-practice failed in California in 2015 and 2018 while restrictions were liberalized in Virginia and Illinois in 2019; similar measures are currently being debated in Massachusetts and Pennsylvania.

We consider the way that scope-of-practice regulations have shaped supply and access to medical care in the context of a public health crisis, the opioid epidemic, which has placed considerable strain on the U.S. healthcare system. The scale of the opioid epidemic has increased rapidly over the past two decades: since 1999, approximately half a million people have died due to an opioid overdose (see Appendix Figure A1). Additionally, there are 800,000 Emergency Department visits per year for overdoses. As of 2018, an estimated 2 million people in the United States had opioid use disorder (Center for Behavioral Health Statistics and Quality, 2019). Untreated opioid use disorder is associated with lower labor supply, greater

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criminal activity and increased mortality (see, e.g., Bondurant, Lindo and Swensen, 2018; Case and Deaton, 2015; Harris et al., 2020; Maclean et al., 2020; Swensen, 2015).

A major problem in addressing this crisis has been capacity constraints in the provision of substance use disorder treatment, created by restrictive overlapping regulatory structures. This has been especially true in the provision of medication-assisted treatment, which is considered to be the gold standard of care for opioid use disorder. Delays in treatment are common, especially in rural geographic areas (Oleskowicz et al., 2021). The maximum treatment capacity was only a fraction of the estimated number of individuals with opioid dependence or abuse for most of the past two decades (Jones et al., 2015). Only 24 percent of individuals with opioid use disorder are estimated to have received any substance use disorder treatment, and fewer than 10 percent are believed to have received medication-assisted treatment (Sandoe, Fry and Frank, 2018).

We consider the impact of regulatory changes governing scope-of-practice for nurse practitioners – specifically, autonomy to prescribe and dispense medications used to treat opioid use disorder – on states' ability to respond to the opioid crisis. Given the highly regulated nature of our setting, we are able to exploit rich administrative data on the universe of all prescribers and dispensers of opioid use disorder treatment across all available treatment modalities, to study how these regulations impact access to care. We consider two related natural experiments occurring during different time periods. The first natural experiment affected Opioid Treatment Programs (colloquially known as methadone clinics); the second affected in-office prescribing of a key opioid treatment medication (buprenorphine, often known by its brand name Suboxone). These regulatory changes to nurse practitioner authority were enacted for reasons unrelated to the opioid crisis, making them ideal natural experiments.

In our first experiment, we show that state-level liberalizations of nurse practitioners prescribing autonomy led to a sizable increase in access to medication-assisted treatment in formal Opioid Treatment Programs during the 2006 to 2016 period, with no substitution away from other treatment settings. We estimate that an additional 84,000 patients had access to medication-assisted treatment due to the passage of state laws that granted independent prescriptive authority. The second experiment considers the impact of a major federal regulatory change, the 2016 Comprehensive Addiction and Recovery Act (CARA), which allowed nurse practitioners to receive the same permission as doctors to prescribe opioid treatment medications in outpatient settings. We show that CARA allowed for substance use disorder treatment supply to rapidly scale up in states which had independent prescribing laws for nurse practitioners already in place, compared to those that did not. The results from this natural experiment imply that non-independent practice states would have had at least 390,000 additional treatment spots for individuals with opioid use disorder, had they had independent prescriptive authority laws in place.

This paper contributes to the literature on the ramifications of scope-of-practice laws for the non-physician workforce on health care prices, utilization, and outcomes for patients (Kleiner et al., 2016; Markowitz et al., 2017; Stange, 2014; Spetz et al., 2013; Buchmueller, Miller and Vujicic, 2016; Wing and Marier, 2014). Only a few papers directly examine the effect of scope-of-practice laws for nurse practitioners on health care access. Traczynski and Udalova (2018) find that states with nurse practitioner independence have greater preventive care utilization, reduced emergency room visits, and higher patient-reported sat-

isfaction. Alexander and Schnell (2019) find that prescriptions for medications that affect mental health increase following independent prescriptive authority for nurse practitioners in counties with few practicing psychiatrists. They also show improvements in self-reported mental health. Kuo et al. (2013) find that Medicare patients in states with the least restrictive regulations of nurse practitioners experienced a significantly greater increase in the likelihood of a primary care visit by a nurse practitioner. Connected to our work, McMichael (2021) shows that, contrary to expectations, liberalizing NP scope of practice is associated with a decline in opioid pain reliever prescriptions. We complement these papers by studying access in a setting where we have constructed a comprehensive dataset on the universe of providers of a particular type of medical treatment, opioid use disorder care.

We are also able to specifically test two elements of the policy debate surrounding scope-of-practice laws. Proponents claim that given their lower costs nurse practitioners with increased autonomy would be able to provide more healthcare services, particularly in traditionally underserved areas like rural areas. Since we have address-level data for the universe of substance use disorder treatment providers, our setting is well suited to test if liberalizing nurse practitioner scope-of-practice differentially increases access to care in rural areas. The results from the second natural experiment, the introduction of CARA, show that the increase in access to providers was especially sizeable in rural areas. Given rural areas have faced a burgeoning opioid crisis and large deficit in access to treatment, these results are substantively important.

Opponents of liberalizing scope-of-practice laws emphasize concerns about the quality of healthcare services provided by nurse practitioners. Of specific concern is whether differences in education and training between NPs and physicians might affect the ability of NPs to appropriately prescribe controlled substances. While we cannot directly investigate the relationship between scope-of-practice laws and quality of treatment, we do investigate a related claim that liberalizing NPs scope-of-practice will result in the crowding out of better-trained physicians.[1] This is supported by a small literature on substitutability and crowd-out between licensed health care professionals. For example, Kleiner et al. (2016) and Perry (2009) document that nurse practitioner wages are higher and physician wages are lower in states where NPs have independence in their scope-of-practice, suggesting substitutability.[2]

In our setting, we find no evidence of negative spillovers on access to treatment by a physician. We present novel evidence that the opposite is occurring: in states where nurse practitioners were granted independent prescriptive authority, physicians engage in more substance abuse care. We exploit our rich data to show that these results are driven by complementarities between nurse practitioners and physicians.

The paper proceeds as follows. We first provide background on the opioid treatment market. Next,

[1] The overall impact of scope-of-practice laws on access to quality care could potentially be assessed using mortality from opioid use disorder. Using annual data on county level death attributed to opioid use disorder, we find a very small and insignificant impact on deaths following state-level expansion of nurse practitioner autonomy. There are at least two challenges with using deaths as an outcome. First, county-level deaths attributed to opioid use disorder are a noisy measure of improvements in treatment: many counties in our sample have zero deaths. Second, there is a large unknown lag structure between increased access to treatment and the reduction in death.

[2] There is additional literature investigating the impact of scope-of-practice laws on labor market effects for other licensed medical practitioners and connected occupations. Timmons, Hockenberry and Durrance (2016) find that expansions in chiropractic scope-of-practice are associated with an increase in average chiropractor wages; the physician market is unaffected. Kleiner (2010) find that liberalizing dental hygienists' scope-of-practice authority increases wages and employment growth for hygienists, but lowers dentists' earnings and employment growth.

we discuss scope-of-practice regulations and their liberalization. We present our empirical framework and results on access to care in two phases: in Phase I, we consider access to care in formal Opioid Treatment Programs, and in Phase II, we consider access to office-based treatment. We then use the second natural experiment to directly investigate two key components of the policy debate surrounding expanded scope-of-practice: access to care in underserved areas and physician crowd-out. We conclude with a discussion of the impacts of these laws in addressing the accelerating opioid crisis and other public health emergencies where capacity is constrained.

1 Background

1.1 The Opioid Epidemic and Regulations Governing Access to Treatment

Unlike use disorders for some other drugs of abuse, opioid use disorder is effectively treatable for many patients with medications: methadone (developed in the 1960s), buprenorphine (developed in the late-1990s) or naltrexone (developed in the 1980s). Medication-assisted treatment (MAT), which combines behavioral therapy with one of these medications when appropriate, is considered the gold-standard of treatment for opioid use disorder (Office of the Surgeon General, 2018).

The United States' approach to treating opioid use disorder with MAT is rooted in policies enacted in the 1970s (see Figure 1). The 1974 Narcotic Addict Treatment Act imposed strict rules and burdensome DEA registrations for programs providing methadone maintenance. During this period a publicly-funded system of treatment programs for opioid addiction was established. The resulting highly-regulated "methadone clinics," formally called Opioid Treatment Programs or OTPs, provide treatment by having patients attend a clinic frequently – often, once per day – to obtain their methadone maintenance medication. Opioid Treatment Programs were the only medication-assisted treatment modality available to people with opioid use disorder until the early 2000s.

Medications using buprenorphine as the active ingredient were developed in the late-1990s as an alternative to methadone, and the Drug Addiction Treatment Act of 2000 was passed in anticipation of FDA approval of buprenorphine-based therapy for the treatment of opioid use disorder. This act represented a major liberalization in the regulations surrounding the treatment of opioid use disorder. Physicians could now, after completing modest training requirements, apply for a waiver from the full federal regulatory regime that allows them to prescribe buprenorphine-based MAT in an office setting for up to 30 patients. This change created a structure of opioid use disorder treatment modalities that persists to the present: a network of highly-regulated formal OTPs providing methadone maintenance, and an increasing number of office-based practitioners with waivers that provide treatment with buprenorphine (Appendix Figure A2).

Our research focuses on the role of nurse practitioners in the provision of substance abuse treatment. We first consider Opioid Treatment Programs. In these programs, the role of nurse practitioners is governed by both state and federal laws. Federal accreditation guidelines enacted in 2001, detailed in 42 C.F.R. Part 8, specify certain activities in an OTP must be performed by a physician, but other activities (conduct initial physical examination, administer or dispense opioid treatment medications, and modify patient medication levels) may be performed by nurse practitioners up to the degree permitted by state licensing authorities.

Thus, in states with independent prescriptive authority, nurse practitioners could assume some responsibilities from physicians.[3]

Second, we consider the regulation of office-based treatment. Formal training and a waiver is required to provide treatment in an office-based setting. As documented in Figure 1, waivered physicians could initially only treat 30 opioid use disorder patients at once. Nurse practitioners and other mid-level practitioners were barred entirely from the waiver process. As capacity constraints in treatment became a well-recognized barrier to addressing the spiraling opioid crisis, the patient cap for physicians was raised in 2006 from 30 to 100 patients, and from 100 to 275 patients (with extra training and reporting) in 2016. Finally, in July 2016, the Comprehensive Addiction and Recovery Act (CARA) was passed to remove the federal restrictions prohibiting non-physicians (nurse practitioners and physician assistants) from waivered provision of buprenorphine in an office-based setting. Nurse practitioners' role in the provision of opioid disorder treatment thus experienced a major and immediate shift in early 2017, with their new role delineated by preexisting state-level scope-of-practice laws.

As such, this motivates dividing our study of scope-of-practice laws and access to care into two phases of two natural experiments. Phase I, over the 2006-2016 period, considers the impact of liberalizing state-level scope-of-practice laws for nurse practitioners within the context of formal OTPs. In states with more liberal scope-of-practice nurse practitioners could play an expanded role, relieving supply-side constraints in the physician workforce, potentially reducing costs of operation and increasing capacity. Phase II considers the impact of CARA coming into effect in 2017, where the national pool of nurse practitioners was granted immediate ability to provide medication-assisted treatment in an office setting after applying for a buprenorphine waiver. We expect the value of this new practice freedom for nurse practitioners to vary directly based on state licensing laws: in some states, nurse practitioners may freely provide opioid use disorder treatment, and in others they still require physician supervision or involvement over their provision of opioid use disorder care.

1.2 Scope-of-Practice Laws Governing Nurse Practitioners

The nurse practitioner credential was created in the mid-1960s in order to address the shortage of primary care providers across the United States (Sarzynski and Barry, 2019). Currently more than 325,000 nurse practitioners are licensed to practice in the United States (American Association of Nurse Practitioners, 2021). Compared with registered nurses, nurse practitioners receive more advanced education and specialized training, which enables them to expand their practice into various specialties such as primary care, acute care, and mental health. In general, both physicians and NPs can write prescriptions, conduct physical exams, order and interpret tests, diagnose illnesses, and sign death certificates. How substitutable nurse practitioners are for physicians is determined, in part, by the scope-of-practice laws in their state of practice.

Scope-of-practice laws govern how and what health care providers can do, and specify the necessary amount of physician involvement. States can mandate that NPs consult with physicians before performing

[3]Reflecting the importance of nurse practitioners in OTPs, in 2015, during a broader effort to expand treatment access, regulators considered removing all remaining federally-imposed restrictions (leaving nurse practitioner scope-of-practice inside OTPs entirely to regulation by state authorities). They instead outlined an exemption process. Treatment programs described this decision as a "huge disappointment" (ATForum, 2015).

procedures, physicians review or cosign all NP prescriptions, restrict prescriptions of certain medications, and impose limits on private or Medicaid reimbursement and hospital privileges. In this study, we focus on regulations governing nurse practitioner prescriptive authority, which determine the conditions under which nurse practitioners can prescribe medications, including those used in treatment of opioid use disorder.[4]

States vary widely in the rules governing prescriptive authority for NPs.[5] In states with independent prescriptive authority, nurse practitioners are allowed to prescribe drugs without any physician supervision, delegation, or collaboration. For our first natural experiment, we define a state as having independent prescriptive authority if nurse practitioners are permitted to independently prescribe up to Schedule II, allowing them to dispense the medications used by OTPs: methadone and buprenorphine. For the second natural experiment, we define independent prescriptive authority as authority to prescribe buprenorphine, i.e., independent authority up to Schedule III.[6]

Data on nurse practitioners' independent prescriptive authority are obtained from The Nurse Practitioner's Annual Legislative Update from 1989 to 2019 and cross checked with the statutory language governing nurse practitioners' prescriptive authority (Phillips, 2020). There are alternative statutory classifications and timings used in the literature on scope-of-practice (McMichael and Markowitz, 2020); we differ slightly in a few cases, in part because our study specifically focuses on controlled substances prescriptive authority.[7] In Appendix Table A2 we show that our results are robust to classifications used by others in this literature.

The first states to grant independent prescriptive authority to nurse practitioners were Alaska and Washington D.C. in the late 1980s. By the year 2000, NPs in ten states could write prescriptions without supervision from a physician. As shown in Table 1 (and Appendix Figure A3), during the first phase of the study, twelve states passed laws granting independent prescribing authority for both buprenorphine and methadone: Hawaii (2009), Colorado and Maryland (2010), North Dakota and Vermont (2011), Rhode Island (2013), Connecticut (2014), Minnesota, Nebraska, and New York (2015), Delaware and Utah (2016).

There are several potential driving forces behind the liberalization of scope-of-practice laws governing nurse practitioners. Expanding scope-of-practice may allow states to meet increasing demand for health care providers and address problems with access in underserved areas, and may also lower health care costs

[4]Scope-of-practice regulations are often grouped into two categories: laws governing prescriptive authority and laws governing practice authority. Practice authority governs NP autonomy over elements of practice such as the evaluation of patients and the ordering and interpreting of diagnostic tests. Given the ability to write prescriptions for drugs is a necessary component of medication-assisted treatment, we focus on prescriptive as opposed to practice authority. In practice the authorities are often bundled, every state except West Virginia that grants prescriptive authority also grants practice authority. In column (1) of Appendix Table A1, we show that our results are robust to excluding West Virginia from the sample.

[5]For example, Alabama requires NPs who prescribe medications to be under on-site supervision by a physician for at least 10% of their hours. In Tennessee, a collaborative physician with NP prescribers is not required to be on-site, but must personally review and sign 20% of their charts within 30 days.

[6]Schedule I drugs are the most restricted while Schedule V are the least; the location of a controlled substance in the schedule is determined by the Controlled Substances Act of 1970. Both state and federal regulations rely on the schedule classifications for regulating prescribing. Specifically, nurse practitioner independent prescribing authority is oftentimes restricted to certain lower levels of the Schedule.

[7]In several states, nurse practitioners are granted full prescriptive authority except for carve-outs specifically related to scheduled substances. For example, Washington authorized nurse practitioner prescriptive authority in 2001 except for Schedule II-IV (which continued to require a joint practice agreement with physicians until 2005 with the passage of House Bill 1479). Therefore, we treat Washington as having granted authority in 2005 instead of 2001.

since NPs are paid less than physicians for providing the same services (Cassidy, 2012). However, there are concerns that NPs due to their lesser training do not provide care of the same quality as physicians and this concern has played a key role in the legislative debates (Robeznieks, 2020).[8]

Relative political strengths of physician's groups play a key role in the passage of laws liberalizing scope-of-practice for non-physicians. McMichael (2017) finds that spending on elections by physician groups increases the probability that the state retains restrictive scope-of-practice laws for NPs, while higher spending by hospital groups or nursing groups has the opposite effect. Traczynski and Udalova (2018) find no evidence that state health care utilization or health outcomes predict the timing of legislative change.

In our setting, we argue that the passage of these laws does not relate to demand generated by the opioid epidemic. Prior to 2016, federal restrictions barred NPs from participating office-based opioid use disorder treatment regardless of state scope-of-practice, and thus it is unlikely that states prioritized altering scope-of-practice laws as a tool to address the opioid epidemic during this period. Publications discussing state legislative options to tackle the opioid epidemic before 2016 contained numerous policy proposals and model laws, and occasionally mentioned the relevance to state governments of federal buprenorphine restrictions, but none mention lifting state-level nurse practitioner scope-of-practice restrictions as a specific area of state legislative interest (Grogan et al., 2020; Hendrikson and Blackman, 2014; National Conference of State Legislatures, 2013). As shown in Table 1, states that passed independent prescriptive authority include states like Maryland and Rhode Island that were hard hit by the opioid epidemic as well as states where the opioid death rate is much lower (i.e. North Dakota and Nebraska).

When CARA came into effect in 2017, twenty-five states and Washington, D.C. had independent prescriptive authority for nurse practitioners, which allowed NPs to immediately prescribe buprenorphine independently after obtaining a waiver. In the remaining 25 states nurse practitioners can obtain buprenorphine waivers but require physician involvement in NP prescribing behavior: 16 states require NPs to collaborate with doctors when writing prescriptions while nine states require physicians' direct supervision and delegation.[9] [10]

Although there has been a general trend towards liberalizing scope-of-practice laws for NPs and other medical practitioners, there is an active policy debate around the appropriate level of practice authority. These tensions can be observed in recent California state legislative debates on two failed bills to expand practice authority to NPs. Proponents of the bills argued they would increase access to care, especially in more rural and underserved parts of California (Aguilera, 2020). Opponents argued that the bill would "[allow] lesser trained practitioners to practice medicine without providing adequate patient protections and medical standards," and, overall, "do nothing to improve access to care" (California Medical Association, 2015).

[8] Evidence suggests that there are no difference in health outcomes between patients treated by nurse practitioners instead of physicians (Horrocks, Anderson and Salisbury, 2002; Mundinger et al., 2000; Naylor and Kurtzman, 2010).

[9] In Tennessee, nurse practitioners are explicitly prohibited from prescribing buprenorphine, even with physician oversight, despite the relaxation in federal regulations.

[10] Once CARA was passed in 2016, the ability of nurse practitioners to independently treat opioid addiction with buprenorphine became an explicit concern in legislative discussions. We exclude South Dakota, which switched to independent prescriptive authority in 2017, from the second natural experiment, as a precaution against an endogenous policy response. In Appendix Table A1, we show our results are robust to further excluding Illinois and Virginia which passed independent prescriptive authority in 2019.

2 Data

2.1 Access to Treatment inside Opioid Treatment Programs

Our data on usage of medication-assisted treatment in formal Opioid Treatment Programs comes from the Automated Reports and Consolidated Ordering System, which are yearly national reports on transactions of controlled substances collected by the Drug Enforcement Administration (U.S. Department of Justice Drug Enforcement Administration, 2016). For each state we extract the data on all grams dispensed of methadone and buprenorphine by OTPs using Report 5, which breaks down controlled substance dispensing by source; this represents a census of all buprenorphine and methadone dispensed in the United States. OTPs were first listed as a source in 2006, thus our first natural experiment will cover the time period between 2006 and 2016.

2.2 Access to Office-based Medication-assisted Treatment

Data for our measure of access to office-based medication-assisted treatment with buprenorphine comes from Substance Abuse and Mental Health Services Administration (SAMHSA), obtained by a Freedom of Information Act request. As discussed in Section 1.1, practitioners must obtain a waiver from SAMHSA in order to provide office-based treatment for opioid use disorder using buprenorphine, and SAMHSA publishes a Treatment Locator on its website that contains the name and address of practitioners who are available to provide office-based medication-assisted treatment. We requested the complete data on all listed practitioners, and were given data on all listed practitioners as of December 2019. In addition to what is available on the SAMHSA website, this data contains practitioner's type (MD/DO, NP, PA), current patient limit, date when most recent waiver and all past waivers were granted, alongside patient limits at each waiver date.

We obtained data on all practitioners waivered to prescribe buprenorphine as of 2019, including those who opt out of being listed on the SAMHSA Treatment Locator. We focus our analysis on practitioners who opt into the Treatment Locator, because being listed on the Treatment Locator reflects a practitioners' willingness to take on new patients, and thus we believe is a superior proxy for treatment supply.[11] Thus we interpret our results as the impact of independent prescriptive authority on the accessibility of office-based medication-assisted treatment for potential patients who have not been able to access buprenorphine treatment yet.

We use practitioner initial waiver date to impute the stock of operating practitioners in each quarter starting in 2013.[12] We used the information on county when available and zip code to map each practitioner

[11] We exclude providers who obtain a waiver but who are not listed on the Treatment Locator, because holding a waiver does not always reflect real capacity. For instance, practitioners may obtain waivers to treat a small number of patients in their existing practice but will not accept further opioid use disorder patients. Lin et al. (2019) document that many waivered practitioners do not prescribe close to their limit. The data provided on non-listed providers is lower-quality, but we conduct robustness checks of our main results including the unlisted providers and find qualitatively similar but noisier results.

[12] One concern with our measure of stock of practitioners is that we miss practitioners who were listed on the Treatment Locator in the past, but were not listed in 2019, and thus are excluded from our measure of historical practitioner stock. This may happen because a practitioner retires; additionally, according to an officer from SAMHSA, when practitioners reach the eligible patient limit and cannot accept new patients, they sometimes delist themselves. While we expect these kinds of practitioner exits from

to their county of practice using a cleaned version of the address data; this enables sub-analysis for rural, underserved areas. The total number of operating practitioners in each quarter at the county level is the cumulative number of practitioners with buprenorphine waivers as of the end of that quarter.

Finally, we extract address-level practitioner data from the National Provider Identifier/National Plan and Provider Enumeration System (NPI/NPPES) and the Medicare Provider Enrollment, Chain, and Ownership System (PECOS) to create a rich dataset that covers the universe of all physicians and NPs. We use locational and billing information in these datasets to determine if a physician has a co-practicing relationship with an NP, and match onto this physician panel our waiver data from SAMHSA. This gives us a dataset with co-practice and waiver information for over 1 million physicians. See Data Appendix 7 for more details on the construction of these new data resources, which we are making publicly available.

3 Phase I Natural Experiment: Access to Medication-assisted Treatment in Opioid Treatment Programs

We first investigate the role of state-level laws governing independent prescriptive authority for nurse practitioners on treatment access until 2016. During this time, nurse practitioners could provide medication-assisted treatment only inside highly-regulated, non-office-based Opioid Treatment Programs (colloquially known as "methadone clinics"), as governed by state scope-of-practice laws. If more permissive regulations governing NPs prescriptive authority reduce the cost of running Opioid Treatment Programs, access to medication-assisted treatment should increase following the passage of independent prescriptive authority.

The generalized difference-in-differences empirical model that we will employ is:

$$Y_{st} = \delta(IPA_{st}) + \gamma_s + \lambda_t + X'_{st}\beta + \varepsilon_{st} \tag{1}$$

where Y_{st} is our measure of access: total dispensing of medication for opioid use disorder treatment in Opioid Treatment Programs per 100,000 people in state s and year t.[13] IPA_{st} is a time-varying binary indicator that denotes if a state has independent prescriptive authority.[14] γ_s is a set of state fixed effects, and λ_t is a set of year fixed effects. X'_{st} includes two proxies for demand for treatment: the state-level opioid overdose death rate in 2006, and an indicator for if the state has expanded Medicaid by year t (Meinhofer and Witman,

our analysis sample to be infrequent, they may bias our findings. To investigate this issue, we were able to obtain the registry of all publicly-listed waivered providers on the SAMHSA Treatment Locator in 2013, as this year was available in a snapshot on the Internet Archive Wayback Machine. This represents a true measure of the stock of practitioners in 2013, and we combine this data with the stock of practitioners in 2019 to estimate a simple two-period version of our main results. See Appendix Table A3. These results are very similar to the 2019 data point from our event study, estimated according to Equation (4), and presented in Table 3. Each approach suggests that in IPA states after the introduction of CARA, there were about 5 additional waivered providers per 100,000 people by 2019, relative to non-IPA states.

[13] Specifically, we measure dispensing in grams per capita using morphine milligram equivalent conversions to obtain total buprenorphine and methadone dispensed; the conversion ratios are 8 milligrams of methadone are equivalent to 40 milligrams of buprenorphine. One months' supply of buprenorphine is typically 240-480 milligrams, and one months' supply of methadone is typically 900-3600 milligrams (ASAM, 2015).

[14] Our data for this analysis is annual. Laws become effective part way through the year, thus for each state we exclude the first year that independent prescriptive authority turns on from this analysis. Results are robust to including these omitted years in the analysis.

2018).[15] Also included in X_{st} are time-varying measures of the unemployment rate, the age and racial composition of the state, and an indicator for the presence of an OTP in the state.[16] δ is the coefficient of interest, which estimates the impact of nurse practitioner independent prescriptive authority on dispensing of medications for opioid abuse treatment. Standard errors are clustered at the state level.

Further, we implement a dynamic treatment effect design to study the impact of independent prescriptive authority over time. This also allows us to conduct a falsification test on our identifying assumptions by estimating leads of the impact of the law and examining them for evidence of pre-trends in the adopting versus non-adopting states.

The dynamic treatment effect model is:

$$Y_{st} = \sum_{\tau=\tau_0}^{\tau_1} \delta_\tau D_{st,\tau} + \gamma_s + \lambda_t + X'_{st}\beta + \varepsilon_{st} \tag{2}$$

where s is state and t is year and $\tau \in [< -4, -4, ..., -1, 1, ...4, > 4]$. $D_{st,\tau}$ are leads and lags of the year of passage of nurse practitioner independent prescriptive authority. Here, δ_τ capture the dynamic effects of being $t = \tau$ years before or after the year of implementation (the year of passage is the leave-out year). When τ is negative, δ_τ captures any pre-trend of granting independent prescriptive authority on access to care. Positive values of τ estimate the evolution of independent prescriptive authority on access to medication for opioid use disorder over time relative to the year of passage. All other variables are defined as in Equation (1).

We first consider the impact of state-level liberalization of nurse practitioners prescriptive authority on access to treatment within OTPs, according to Equation (1). The results are displayed in Table 2 column (1). The passage of independent prescriptive authority into state law is associated with a significant increase in access to medication for opioid use disorder: an additional 9,331 morphine equivalent grams of MAT per 100,000 people. This effect is sizable: during this period, the mean yearly amount of dispensing from OTPs at the state-level was 24,300 grams morphine equivalent, and total dispensing of MAT was around 66,000 grams morphine equivalent. Given the population of independent prescriptive authority states of around 87 million people, and assuming a standard dose of medication and a typical course of treatment of 6 months, this represented enough medication to treat an additional 82,000 people each year.[17]

The results from the dynamic model of nurse practitioner independent prescriptive authority with leads and lags according to Equation (2), are shown graphically in Figure 2. The estimates for the leading in-

[15] Following the literature, we utilize CDC National Vital Statistics System data to construct the opioid overdose death rate control variable, using underlying cause of death codes X40-X44, X60-X64, X85, and Y10-Y14, and multiple cause of death codes T40.1-T40.4 and T40.6.

[16] We believe that regulation governing nurse prescriptive authority should impact the intensive as opposed to the extensive margin. Very few new OTPs open in a given year, and it is unlikely that laws governing scope-of-practice for nurse practitioners would induce the creation of a new OTP. To verify this, in Appendix Table A4, we estimate Equation (1) with the per-capita number of OTPs as the independent variable. We show that there is no relationship between independent prescriptive authority and the number of OTPs.

[17] A one month's supply of buprenorphine is about 14,400 mg morphine equivalent, and a one month's supply of methadone is about 18,000 mg morphine equivalent. During this period methadone represented 64% of the MAT market on average, so we use 16,700 mg morphine equivalent for a one month's supply. We multiply by 6 (≈100,000 mg=100 g) to determine a typical course of treatment dosage is 100 grams. Given the population in IPA states, our results suggest there are 87,000,000*9,331/100,000 = 8,117,970 extra grams of MAT. 8,117,970 /100 = (81,180) extra courses of treatment.

dicators are small in magnitude and significantly indistinguishable from zero, suggesting no differential pre-trends in the provision of methadone and buprenorphine within OTPs in states that passed independent prescriptive authority versus states which did not. Figure 2 shows that granting independent prescriptive authority to nurse practitioners has an effect on access to medication for opioid use disorder that increases over time. There is little effect in the first full year following the implementation of independent prescriptive authority. By the second year after implementation, dispensing increases by around 8,000 grams per 100,000 people and further increases to around 15,000 grams for the third year and beyond.

Our results are suggestive that total access to medication-assisted treatment increased following the liberalization of laws governing nurse practitioner independent prescriptive authority. However, there could be crowd-out effects in office-based treatment that happens outside of OTPs. In states where OTPs were more able to increase capacity to meet demands from the opioid crisis, the office-based buprenorphine market may not have grown as quickly. We check for this potential crowd-out of non-OTP medication-assisted therapy by estimating Equation (1) when the dependent variable is total dispensing from all non-OTP sources. The coefficient on independent prescriptive authority shown in Table 2 column (2), is positive, statistically insignificant, and relatively small in terms of magnitude. We interpret this to indicate that there are no meaningful crowd-out effects.

Overall the results from the first natural experiment suggest the liberalization of the scope-of-practice laws on nurse practitioners has a large effect on access to medication-assisted treatment. As such the OTP sector, the only sector in which nurse practitioners could provide medication-assisted treatment, expanded faster in states with independent prescriptive authority for nurse practitioners.

4 Phase II Natural Experiment: Access to Office-based Buprenorphine Treatment

We next investigate how the passage of the federal Comprehensive Addiction and Recovery Act (CARA) interacts with existing state-level licensing laws to impact access to treatment for opioid use disorder. CARA enabled nurse practitioners to obtain buprenorphine waivers and treat up to 30 patients in an office-based setting, bounded by pre-existing state scope-of-practice laws.

The difference-in-differences empirical model that we will employ is:

$$Y_{cst} = \alpha + \beta IPA_s + \sigma\ Post\ CARA_t + \theta(IPA_s \times Post\ CARA_t) + \mu X_{cst} + \varepsilon_{cst} \tag{3}$$

Our sample for this analysis begins in 2013 and ends in 2019. Y_{cst} is our measure of access: the total number of buprenorphine-waivered practitioners per 100,000 people in county c located in state s in quarter t. IPA_s is an indicator variable that takes a 1 if the county is located in a state with independent prescriptive authority in place prior to 2017. $Post\ CARA_t$ is an indicator for observations after CARA (i.e., after Q4 2016). X_{cst} includes a measure of the opioid overdose death rate in each county prior to CARA (the average over 2006 to 2016), a time-varying indicators for Medicaid expansion, the county unemployment rate, and county-level demographic characteristics. θ is the coefficient of interest, which estimates the impact of CARA on access

to office-based providers in states with independent prescriptive authority for nurse practitioners relative to those without. The key identification assumption of our difference-in-differences empirical framework is that the trend in the number of operating practitioners would, in the absence of CARA, be the same in states that already had independent prescriptive authority in place when compared to states that did not. While the variation is at the state level, the analysis is conducted at the county level to later conduct a sub-analysis by county urban-rural status. All regression results are weighted by the fraction of county population to state population, which is equivalent to an unweighted state-level regression. Standard errors are clustered at the state level.

We also implement an event study design to assess how access to waivered practitioners evolves over time. The event-study model is:

$$Y_{cst} = \alpha + \beta IPA_s + \lambda_t + \sum_{\tau=-3}^{3} \delta_\tau * IPA_s * CARA_{\tau,t} + \mu X_{cst} + \varepsilon_{cst} \tag{4}$$

δ_τ are the coefficients of interest: $\tau \in [-3,-1]$ represent the three years prior to the passage of CARA. These leading interaction terms are included as a falsification test for the parallel trends identifying assumption. The lagged interaction terms, δ_τ from $\tau \in [1,3]$, allow us to study the dynamic effects of CARA on access to treatment providers according to independent prescriptive authority status from 2017-2019.[18] All other variables are defined as in Equation (3).

The results from Equation (3) are displayed in Table 3 column (1). After CARA, states with independent prescriptive authority have 3.3 more buprenorphine-waivered providers per 100,000 people. This is a sizable effect: representing 81% more providers than the 4.1 providers added after CARA in non-independent prescriptive authority states. Both proxies for drug demand, the pre-2016 county-level drug overdose death rate, and the Medicaid expansion indicator are strong predictors of the number of buprenorphine-waivered providers in a county.

The corresponding event study, which estimates the leads and lags of the implementation of CARA across independent prescriptive authority status according to Equation (4), is presented in Table 3 and visualized in Figure 3. The point estimates for the leading indicators are small and precisely estimated as statistically indistinguishable from zero suggesting no differential pre-trends in providers in IPA versus non-IPA states that might be driving our results. The figure shows that the differential effect of CARA in independent prescriptive authority states is rapidly increasing over time, from 1.2 practitioners per 100,000 in 2017 to 5.4 in 2019. These regression results map intuitively onto the unadjusted time-series data depicted in Appendix Figure A2: prior to CARA, states were on a similar path, and after CARA, there was an immediate differential impact in states with more liberal laws regarding nurse practitioners' scope-of-practice.

Taken together, these results strongly suggest that the liberalization of nurse practitioners' ability to provide opioid use disorder treatment under the Comprehensive Addiction and Recovery Act had strong effects

[18] There are several reasons why the full impact of the regulatory change may take time to manifest. First, before they can officially apply for a waiver to become a buprenorphine-waived practitioner NPs must undergo no fewer than 24 hours of training and pass an exam. It then takes 45 days for SAMHSA to review the waiver application. Additionally, opening a clinic entails renting property, hiring staff, purchasing malpractice insurance, and setting up security.

on total access to office-based providers in states where nurse practitioners have prescriptive autonomy.[19] A simple back-of-the-envelope calculation is suggestive of the broader importance of these state-level decisions. Table 3 shows the difference between non-IPA and IPA states growing rapidly each year with no sign of abatement. In 2019, independent prescriptive authority states had an additional 5.4 providers per 100,000. Given that each provider is waivered to treat at least 30 patients, this increase represents at least 13,000 additional practitioners and 390,000 additional treatment spots.

5 Policy Issue I: Access to Medication-assisted Treatment in Underserved Areas

Expanding scope of practice for nurse practitioners is often cited in policy debates as a way to close the primary care gap for geographically-underserved communities, because there are higher densities of nurse practitioners in rural areas than physicians (Graves et al., 2016). This point seems particularly salient in the context of the opioid epidemic, as a key concern has been the way it affects rural, underserved areas. Further, a historic emphasis on Opioid Treatment Programs has concentrated treatment options in urban areas, making office-based access to buprenorphine especially critical. Our setting uniquely positions us to investigate this question empirically. Evidence on differential access has been scant due to data limitations on provider practice location. Because we have address-level data on the practice location for the universe of buprenorphine-assisted treatment providers, we can provide one of the first direct tests of the argument that liberalizing scope-of-practice increases access to care in underserved areas.[20]

We utilize the empirical framework in section 2 to consider the effect of independent prescriptive authority for nurse practitioners across county urbanicity. Specifically, we use 2013 NCHS urbanicity classifications to divide our county-level sample into six separate sub-analyses: 1) large central metro counties, 2) large fringe metro, 3) medium metro, 4) small metro counties, 5) micropolitan counties, and 6) non-core/rural counties. In Table 4, we first present some basic summary statistics to characterize the scope of the opioid epidemic and access to treatment across urban and rural areas prior to the implementation of CARA. While the opioid overdose death rate is similar across all types of counties, more than twice as many providers per capita offered substance abuse treatment in the most urban areas compared to the more rural areas. We calculate the ratio of treatment provider availability relative to the pre-period overdose death rate to show that treatment access relative to demand is significantly lower the more rural a county is. Thus, prior to CARA, opioid use disorder treatment access, like other aspects of health care, was characterized by strong geographic disparities.

Table 5 presents regression results for all waivered providers by urbanicity using the difference-in-

[19] There is a significant medical literature on the effectiveness of MAT at preventing opioid harms and opioid overdose deaths (Fullerton et al., 2014). There are few studies on the impact of changing the restrictiveness of laws surrounding MAT provision. One study considered a period when there were no prescribing restrictions for buprenorphine in France, and found that overdose deaths fell by nearly 80 percent in that period (Fatseas and Auriacombe, 2007).

[20] As discussed, OTPs tend to be located only in urban areas. We conducted exploratory analyses on the urban versus rural impacts of independent prescriptive authority in OTPs in the Phase I natural experiment above, but found limited OTP-based MAT prescribing in rural areas across both types of states. Due to the geographic concentration of clinics, these laws had little ability to increase rural access prior to CARA.

differences design presented in Equation (3) across the six groups of counties. We highlight two results. First, the coefficient on post-CARA, in the most urban areas was nearly double that of the most rural areas. In the absence of CARA, the pre-existing geographic disparities in access to treatment shown in Table 4 would have only worsened in this period. By contrast, the coefficient on the interaction term between independent prescriptive authority and post-CARA does not obviously vary by urbanicity; additional treatment providers in IPA states were geographically dispersed, with every type of geographic area seeing a 3-4 provider increase per 100,000 residents.

Thus allowing NPs to prescribe MAT independently in a office-based setting has the effect of significantly mitigating what otherwise would have been worsening geographic disparities in access. In order to quantify this effect, we calculate a "relative effect" from the coefficients of interest: (prescriptive authority*post-CARA)/(post-CARA). As can be seen in the final row of Table 5, the relative effect increases with rurality, from 72% in urban area to 131% in the most rural areas.

As discussed previously, an open policy debate around scope-of-practice for nurse practitioners has been whether they will actually practice in underserved areas and assist in relieving disparities in access to health care, or whether nurse practitioners will mostly concentrate in desirable urban areas as physicians do. We are among the first to demonstrate that access to providers does increase disproportionately in underserved areas due to greater nurse practitioner freedom.

6 Policy Issue II: Physician Crowd Out

Finally, we consider whether the expansion of prescribing authority to nurse practitioners may have had unintended negative consequences by crowding out physician care, which may be of higher quality. A small literature suggests that increasing nurse practitioner practice authority or autonomy may crowd out physicians providing complementary services, due to their lower costs. However, two factors make our setting unusual. First, this market is characterized by unmet demand, because physicians may not expand past the patient caps imposed by the waiver program. This unmet demand may be met by nurse practitioners without any crowd out of existing physicians.

Second, physicians offering buprenorphine substance abuse treatment are bound by "cross-coverage" requirements: another waivered provider must be available to provide care if the treating provider is not available.[21] This rule means that other waivered providers are complements in the production process. Once nurse practitioners become able to obtain waivers, physicians may partner with them to meet cross-coverage requirements. Thus physicians who already practiced alongside NPs may be better-positioned to provide waivered substance abuse treatment at the time when NPs were granted the ability to provide waivered buprenorphine care.

To test the impact of granting nurse practitioners the right to treat patients under the buprenorphine waiver program on access to physicians, we first use the SAMHSA practitioner data to re-estimate Equations (3) and (4) disaggregated by practitioner type, considering nurse practitioners and physicians separately. The

[21] Comments from physicians to SAMHSA regarding their proposed 2016 Final Rule frequently cited cross-coverage requirements as a major barrier to providing office-based medication-assisted treatment – see Federal Register, Proposed Rule 03/30/2016, "Medication Assisted Treatment for Opioid Use Disorders."

results for this exercise, presented with our main results for all practitioners, are shown in Table 6 and Figure 4.[22]

In column (2) of Table 6, we show, unsurprisingly, that the number of waivered NPs increases post-CARA in states with independent prescriptive authority. Additionally, Figure 4 shows that access to NP-provided opioid use disorder care in IPA states grows significantly over time after CARA implementation. These results on access to office-based treatment provided by nurse practitioners complement recent work documenting the important role nurse practitioners have played post-CARA in expanding access to office-based buprenorphine treatment. Specifically, Spetz et al. (2019) showed that a larger share of the NPs workforce obtained a waiver in states with less restrictive regulations. Using the SAMSA practitioner data, Barnett, Lee and Frank (2019) document that following CARA, 286 counties in the U.S had acquired at least one waivered mid-level practitioner (an NP or a PA).

While NPs make up the majority of the top-line increase in access to waivered providers, column (3) of Table 6 demonstrates an increase in the number of physicians obtaining waivers as well. The increase represents about 1.1 additional physicians providing treatment per 100,000 population, or about 1/3 of the total gain in waivered practitioners. As shown in Figure 4, precisely estimated leading indicators suggest this increase in physicians is not being driven by differential pre-trends, but rather appears to be a causal result of prescriptive autonomy for nurse practitioners. The finding that there is no physician crowd-out, and in fact, an increase in access to physician care, is in sharp contrast with a model of occupational licensing between workers who are partial substitutes.

To unpack the surprising finding that nurse practitioner prescribing authority has a positive impact on access to physician care, we constructed a dataset that linked the universe of over 1 million physicians and 350,000 nurse practitioners to determine their co-practicing relationships. (We described this unique and rich data in the Data Appendix). If the cross-coverage rules have created a production process where nurse practitioners become complements to physicians after the passage of CARA, we would expect to see the observed increase in waivers accruing only to physicians who are co-practicing with nurse practitioners.[23] To test this, we estimate a set of physician-level regressions to understand which physicians are obtaining buprenorphine waivers post-CARA.

Specifically, we estimate the following linear probability model, disaggregating physicians by practice composition:

$$Y_{ist} = \alpha + \beta IPA_s + \sigma\ Post\ CARA_t + \theta(IPA_s \times Post\ CARA_t) + \mu X_{ist} + \varepsilon_{ist} \tag{5}$$

Y_{ist} is a binary indicator for whether physician i practicing in state s in quarter t is waivered to provide office-based buprenorphine treatment. IPA_s and $Post\ CARA_t$ are as above in Equation (3). X_{ist} is a vector

[22] "All practitioners," as above, includes all practitioners eligible to receive waivers: physicians, nurse practitioners, and physician assistants. We have also estimated Equation (3) separately for physician assistants. We see a statistically significant increase in access to physician assistants in IPA states following CARA. This is not surprising, since physician assistants also gained waiver access under CARA and state licensing laws governing nurse practitioners are highly correlated with those governing physician assistants

[23] Before conducting this exercise, we check that the co-practice decision itself is not endogenous to the policies under study. As shown in Appendix Table A5, there is no evidence that the co-practice decision responds to the interaction of CARA and IPA.

of physician and state-level controls, where physician controls include physician practice size, gender, year graduated from medical school, and physician practice specialties, and state-level controls include an indicator for state-level Medicaid expansion and the state-level crude opioid overdose death rate averaged over 2006-2016. We estimate Equation (5) and the corresponding event studies that are directly analogous to Equation (4) for three separate groups of physicians: all physicians, physicians who co-practice with at least one nurse practitioner in a given quarter, and those who do not.[24]

First, we use our new physician-level data to check our previous finding that access to physician care increases following CARA. The results for all physicians are depicted in column (1) of Table 7, and confirm that access to waivered physicians is greater in independent prescriptive authority states. The 0.00274 percentage point increase on a pre-period mean of 0.0282 represents an approximately 10 % increase in the probability that a given physician has obtained a waiver to treat opioid use disorder in-office. The equivalent dynamic specification depicted in Figure 5 suggests that by 2019, IPA states had at least an additional 1,800 waivered physicians. Again, leads in this new dataset are estimated to be indistinguishable from zero, confirming that this increase in physician access is not being driven by underlying differential pre-trends.

As discussed above, NP prescriptive authority might influence the decision of physicians to offer in-office opioid use disorder treatment because NPs in states with independent prescriptive authority are newly enabled to provide cross-coverage by CARA, relaxing a key capacity constraint. We test this by estimating our model of physician waiver adoption, disaggregated by physician co-practice status. As shown in columns (2) and (3) of Table 7, the post-CARA increase in access to physicians is driven entirely by physicians who co-practice with NPs – there is a meaningful and statistically significant increase in the probability of co-practicing physicians obtaining a waiver, while the effect for physicians who do not co-practice is precisely estimated to be zero. There are similar baseline waiver rates across the two physician subsamples. Leading indicators presented in the event study analogue in Figure 5 show no differential pre-trends for either group of physicians, suggesting a causal impact of CARA only on the co-practicing physicians. The dynamic lags presented in Figure 5 reinforce the finding of increased access only among co-practicing physicians: there is no increase in waiver adoption among physicians who do not co-practice with NPs observed over 3 years post-CARA, whereas waiver adoption increases year-on-year for the co-practicing physicians.[25] These results are highly suggestive that capacity constraints and cross coverage requirements cause physicians and NPs to be complements rather than substitutes in the production of opioid use disorder care.

[24] We restrict the sample to physicians who (a) appear in PECOS, and who (b) are in a specialty where a physician might decide to engage in office-based opioid use disorder treatment. See the Data Appendix for more detail.

[25] We also explore mechanisms by exploiting the richness of the physician panel, which includes specialty. We expect increases in office-based treatment to be concentrated among family practitioners who have patients in their daily practice with opioid use disorder, and must decide whether to treat these patients in their office or refer out to an addiction specialist. Cross-coverage rules might be especially constraining in these settings, as another physician may not be available or willing. We test this theory by splitting physicians into four groups by specialty and co-practice status, presenting event-study results in Appendix Figure A5. It shows that our main results, that physician waiver adoption increases post-CARA, are driven almost entirely by family practice physicians who co-practice with a nurse practitioner in IPA states. This increase is large in magnitude: a 1.2 percentage point increase in the probability a family practice physician obtains a waiver by 2019, compared to a pre-period mean of 2 percent.

7 Conclusion

In this study we have considered the ways in which scope-of-practice occupational licensing decisions affect the provision of health care. Specifically, this study provides two experiments on the impact of reducing barriers to entry to medical practice, in a context – treatment for opioid use disorder – where supply is constrained, and demand persistently outstrips supply. Though many of our details are specific to the opioid use disorder setting, many aspects of medical care in the United States suffer from access problems created by an under-supply of physicians. This is especially true in underserved geographic areas and populations.

Because treatment for opioid use disorder is so heavily regulated, we are able to exploit unusually rich data. Specifically, we have administrative data on the universe of all prescribers and dispensers of opioid use disorder treatment across all available treatment modalities, as well as a full accounting of all actual prescribing activity. This represents a complete accounting of all supply-side economic activity in this space, allowing for us to understand how state-level policy decisions have interacted with federal rules to shape and constrain the development of the supply side of the market for medication-assisted treatment.

Our first natural experiment investigates the impact of states granting nurse practitioners increased scope-of-practice on access to treatment for opioid use disorder in the Opioid Treatment Program setting. We estimate that state-level passage of independent prescriptive authority significantly increased treatment availability, reflected by a sizable increase in the dispensing of medication-assisted treatment. Our next natural experiment explores the impact of a federal change in the scope-of-practice for nurse practitioners brought about by the Comprehensive Addiction and Recovery Act. This act granted nurse practitioners the sudden ability to apply for a waiver to provide medication-assisted treatment with buprenorphine in an office setting– and intersected with pre-existing state level regulations on the degree of autonomy in NP scope-of-practice. Our estimates imply that the total number of office-based opioid use disorder treatment providers in 2019 would be around 25% higher in states without prescriptive authority if they were to adopt independent prescriptive authority for nurse practitioners.

We also consider two key points raised in legislative debates in favor of expanded practice authority for medical providers. Proponents argue that increasing autonomy for nurses will enhance their ability to provide care to underserved communities and rural areas, where there are disparities in access health care. We find support for this claim: independent prescriptive authority for nurse practitioners lessened the geographic disparity in access to office-based care. Opponents of expanded practice authority argue that it will erode quality in part due to the substitution of less-credentialled providers. We find evidence to the contrary. Physicians meaningfully increase their provision of opioid use disorder treatment in states where nurse practitioners gain independent authority to provide office-based care, likely due to the ability of nurse practitioners to relax cross-coverage constraints.

Our results show that both federal and state scope-of-practice restrictions have significantly hampered the ability of the United States to respond to the demands of the escalating opioid crisis. Federal regulations on provider requirements to prescribe buprenorphine were liberalized in April 2021, and our evidence suggests this will meaningfully increase access to care (Facher, 2021). Similar lessons may apply in the current COVID-19 health crisis: after years of failed legislative attempts, Massachusetts temporarily granted nurse practitioners full practice authority in March 2020; similar temporary liberalizations were enacted across

the United States. The results of our study suggest that these liberalizations will expand access to critical care and prevent unnecessary deaths.

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Figures and Tables

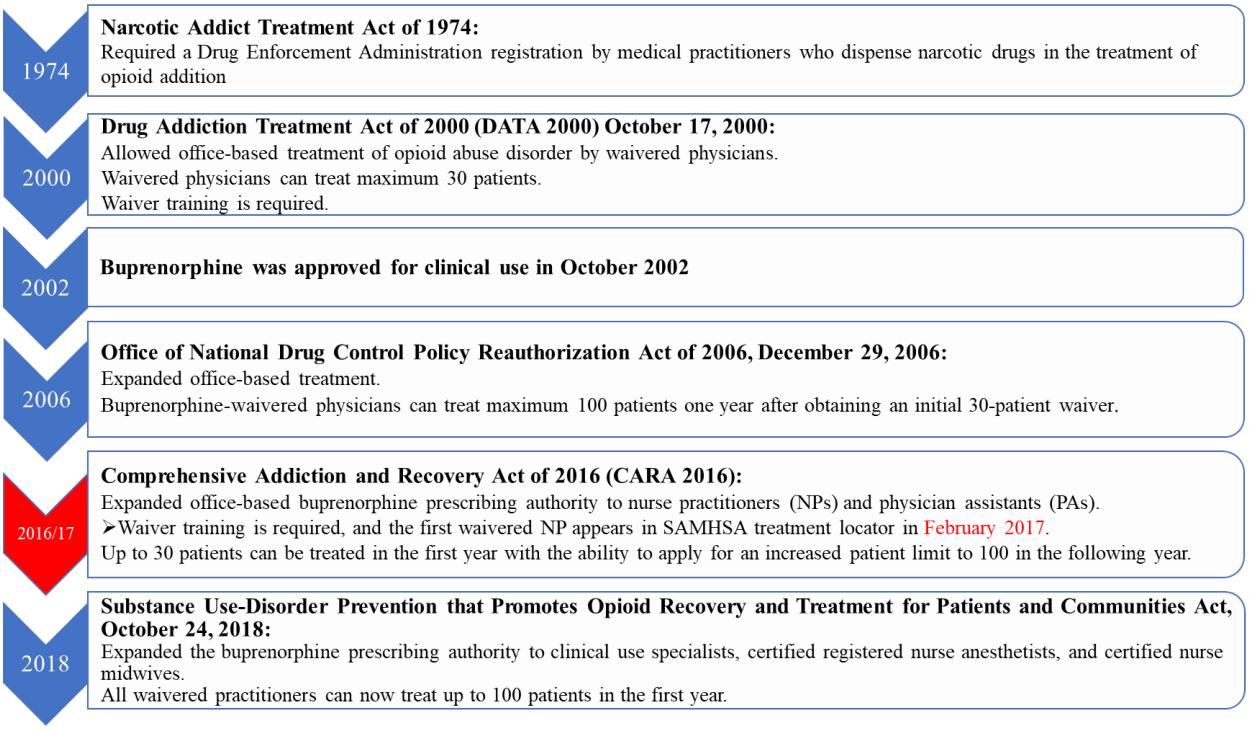

Figure 1: Laws Governing Medication-Assisted Treatment for Opioid Use Disorder: History

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Table 1: Summary Statistics for States with Independent Prescriptive Authority

	Year state grants NP independent prescriptive authority	Methadone and buprenorphine dispensed per 100,000 from OTPs in 2006	Average annual opioid overdose death rate per 100,000 (2006-2016)
Alaska	1987	5,255	9.62
District of Columbia	1989	61,097	10.06
Montana	1991	0	5.88
New Hampshire	1991	14,153	14.75
Wyoming	1992	0	7.15
New Mexico	1993	20,704	14.23
Oregon	1993	23,455	8.91
Iowa	1994	2,997	4.89
Arizona	1996	20,646	8.81
Maine	1996	54,767	10.43
Idaho	2004	0	4.86
Washington	2005	21,523	9.93
Hawaii	2009	9,519	4.78
Colorado	2010	10,308	8.06
Maryland	2010	50,518	13.34
North Dakota	2011	0	3.09
Vermont	2011	13,505	9.77
Nevada*	2013	21,091	14.95
Rhode Island	2013	76,385	15.39
Connecticut	2014	57,463	10.32
Minnesota	2015	5,771	5.11
Nebraska	2015	2,839	2.61
New York	2015	43,927	7.83
Delaware	2016	33,464	10.51
Utah$	2016	33,422	14.11
West Virginia*	2016	55,363	24.87
IPA states		28,515	9.38
Non-IPA states		16,053	7.44
All states		19,358	7.95

Notes: The data on independent prescriptive authority came from The Nurse Practitioner's annual APRN legislative update from 1989 to 2019 and crosschecked with nurse practitioners' scope-of-practice laws and regulations by state from American Association of Nurse Practitioners' webpage and ScopeOfPracticePolicy.org. The implementation year is defined as the year states grant NPs independent prescriptive authority to prescribe controlled substances without any physician's involvement. We use the 2006-2016 time period for our identification strategy. *Indicates states that do not allow NPs to prescribe methadone (Schedule II) independently. $Utah restricts NPs on prescribing methadone or buprenorphine (Schedule II or III controlled substances) in pain clinics. For the purpose of the table IPA states are classified according to their Schedule III rules when CARA passed in 2016.

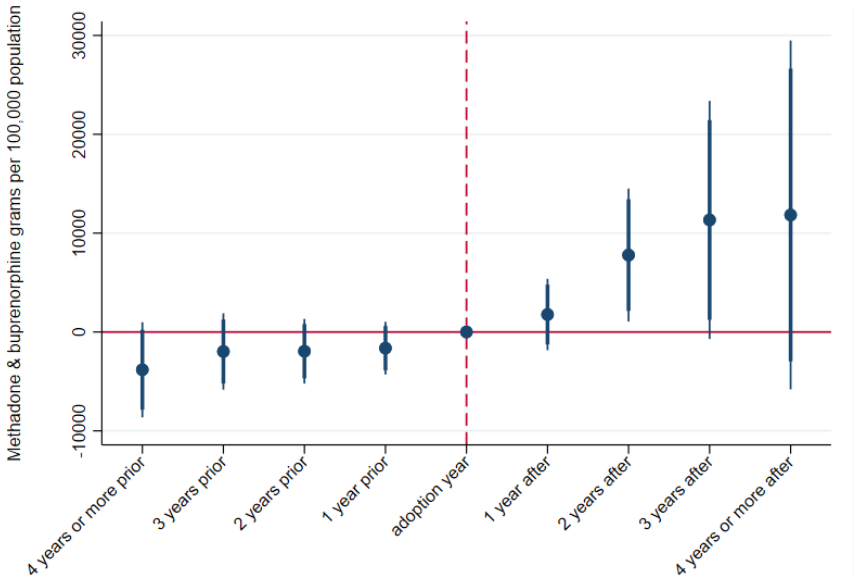

Figure 2: Dynamic Treatment Effect of Independent Prescriptive Authority on Dispensing of Medication-Assisted Treatment in Formal Opioid Treatment Programs

Note: The figure plots coefficients from a dynamic event study analysis. Event time is defined relative to the year a state first grants nurse practitioners the authority to independently prescribe methadone or buprenorphine. See Equation 2 for a description of the model. Thin bars represent 95% confidence intervals and thick bars represent 90% confidence intervals.

Table 2: The Impact of Independent Prescriptive Authority on Access to Medication-Assisted Treatment in Formal Opioid Treatment Programs (OTPs)

Morphine equivalent grams of methadone and buprenorphine dispensed per 100,000	(1) OTPs	(2) Non-OTPs
Independent prescriptive authority	9,330.5	2,491.5
	(4,555.7)	(5,848.4)
Medicaid expansion	3,041.7	7,804.5
	(2,366.8)	(4,804.9)
Opioid death rate in 2006	7,501.2	-8,039.2
	(6,661.4)	(13,531.7)
State fixed effect	Yes	Yes
Year fixed effect	Yes	Yes
Observations (state years)	549	549
Within group R-squared	0.537	0.598
Dependent variable mean	24,334	41,675

Notes: Independent prescriptive authority is a time varying indicator that denotes if a state allows nurse practitioners to prescribe methadone or buprenorphine (Schedule II or III controlled substances). All regressions include the following time-varying state-level demographic characteristics: unemployment rate, proportions of the population of White, Black, and Hispanic ethnicity, and proportions of the population whose ages are from 21 to 40, 41 to 60, and 61 and above, and an indicator for the presence of OTPs in the state. Non-OTPs include dispensing from pharmacies, hospitals, practitioners, and teaching institutions. All standard errors are clustered at state level.

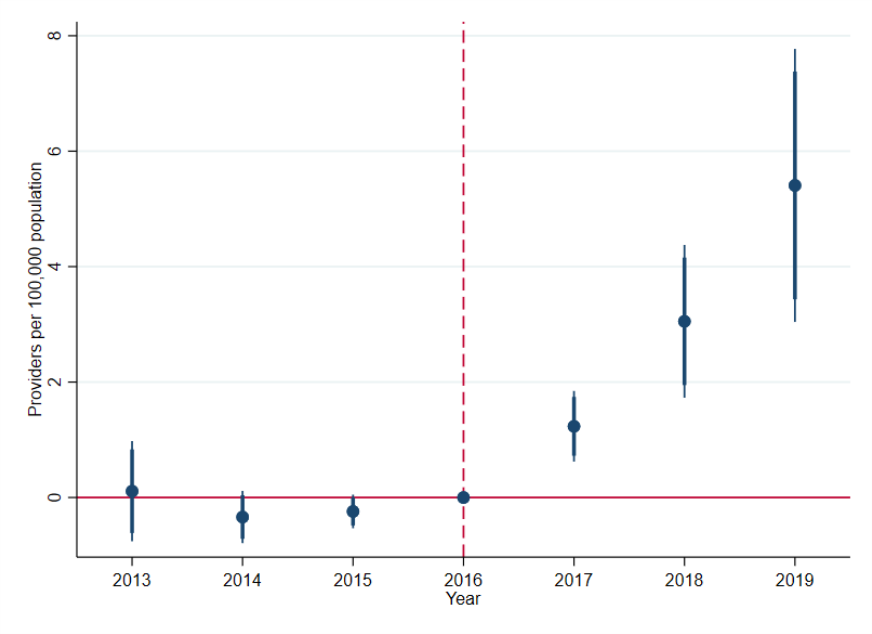

Figure 3: Event Study of the Effect of CARA and Independent Prescriptive Authority Status on Access to Office-Based Treatment Providers

Note: The figure plots coefficients from an event study analysis. Event time is defined relative to the year that CARA passed (2016) and nurse practitioners were granted the ability to prescribe buprenorphine subject to state law. Providers per 100,000 reflects the total number of providers in a county who were waivered to provide office-based buprenorphine treatment. See the text and Equation 4 for a description of the model. Thin bars represent 95% confidence intervals and thick bars represent 90% confidence intervals.

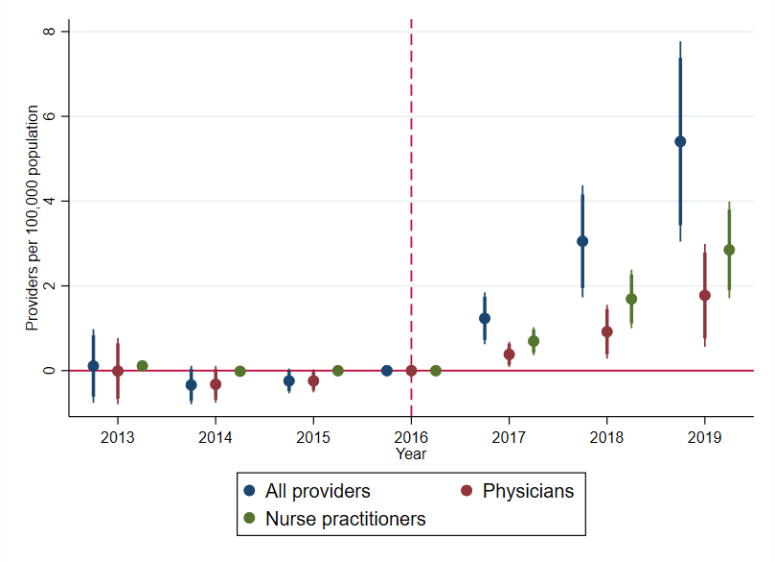

Figure 4: Event Study of Effect of CARA and Prescriptive Authority on Access to Office-Based Treatment by Provider Type

Note: The figure plots coefficients from an event study analysis. Event time is defined relative to the year that CARA passed (2016) and nurse practitioners were granted the ability to prescribe buprenorphine subject to state law. The models are estimated for three different sample of waivered practitioners: all (physicians, nurse practitioners, and physician assistants), physicians and nurse practitioners. See the text and Equation 4 for a description of the model. Thin bars represent 95% confidence intervals and thick bars represent 90% confidence intervals.

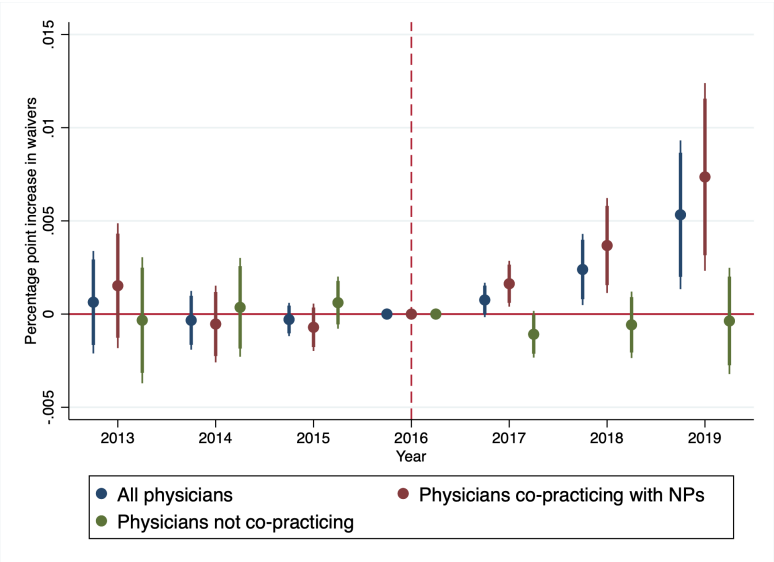

Figure 5: Event Study of the Effect of CARA and NP Independent Prescriptive Authority on Physician Probability of Obtaining a Waiver, by Co-Practice Status and for All Physicians

Note: The figure plots coefficients from an event study analysis. Event time is defined relative to the year that CARA passed (2016) and nurse practitioners were granted the ability to prescribe buprenorphine subject to state law. Data is the SAMHSA waiver data merged onto the NPI/NPPES panel of physician-NP co-practice relationships. The models are estimated for three different samples of waivered physicians: all, physicians co-practicing with a nurse practitioner and physicians who do not co-practice and nurse practitioners. See the text for a description of the data and model. Thin bars represent 95% confidence intervals and thick bars represent 90% confidence intervals.

Table 3: The Impact of CARA and Independent Prescriptive Authority Status on Access to Office-Based Treatment Providers

Providers per 100,000	(1)	(2)
Prescriptive authority*Post CARA	3.327	
	(0.816)	
Prescriptive authority*Three years pre CARA		0.110
		(0.432)
Prescriptive authority*Two years pre CARA		-0.339
		(0.225)
Prescriptive authority*One year pre CARA		-0.242
		(0.145)
Prescriptive authority*One year post CARA		1.233
		(0.304)
Prescriptive authority*Two years post CARA		3.052
		(0.659)
Prescriptive authority*Three years post CARA		5.407
		(1.177)
Post CARA	4.131	
	(0.442)	
Prescriptive authority	-0.381	-0.192
	(0.620)	(0.728)
Medicaid expansion	1.400	1.109
	(0.577)	(0.763)
Crude opioid death rate (2006-2016)	0.374	0.376
	(0.047)	(0.047)
Observations	86,240	86,240
Adjusted R-squared	0.363	0.424
Pre-period mean (2013-2016)	2.812	2.812

Notes: Providers per 100,000 reflects the number of providers in a county, who were waivered to provide office-based buprenorphine treatment. Prescriptive authority is an indicator that denotes if a state allowed nurse practitioners to prescribe buprenorphine (Schedule III controlled substances) in 2016. All regressions include the following time-varying county-level demographic characteristics: unemployment rate, proportions of the population of White, Black, and Hispanic ethnicity, and proportions of the population whose ages are from 21 to 40, 41 to 60, and 61 and above. Column (2) also includes the full set of year fixed effects. All standard errors are clustered at state level. All regression results are weighted by the fraction of county to state population.

Table 4: Descriptive Information of Access to Office-Based Treatment Providers by Urbanicity

	Large metro	Fringe metro	Medium metro	Small metro	Micropolitan	Rural
The number of waivered providers per 100,000	6.02	5.31	4.9	4.41	3.22	2.55
Opioid overdose death rates	2.74	2.87	2.87	2.36	2.47	2.18
Ratio of providers to overdose deaths	2.2	1.85	1.71	1.87	1.3	1.17
Number of counties	68	368	372	358	641	1,335

Notes: The data on waivered providers come from SAMHSA and the data of opioid overdose deaths come from CDC WONDER online database. Waivered providers per 100,000 reflects the number of providers in a county, who were waivered to provide office-based buprenorphine treatment. For both number of waivered practitioners and opioid overdose death rates, the table reports the average for the years 2013 to 2016.

Table 5: The Impact of CARA and Independent Prescriptive Authority Status on Access to Office-Based Treatment Providers by Urbanicity

Providers per 100,000	(1) Large metro	(2) Fringe metro	(3) Medium metro	(4) Small metro	(5) Micropolitan	(6) Rural
Prescriptive authority*Post CARA	3.858	2.446	2.469	4.516	3.590	3.819
	(1.572)	(0.818)	(1.116)	(1.125)	(1.216)	(1.609)
Prescriptive authority	-1.361	-0.891	-0.467	-2.022	-0.087	1.419
	(1.133)	(0.601)	(1.051)	(0.828)	(0.777)	(1.251)
Post CARA	5.417	3.446	4.487	3.791	3.745	2.929
	(0.864)	(0.559)	(0.460)	(0.374)	(0.477)	(0.772)
Medicaid expansion	1.767	2.437	1.435	0.109	0.809	0.674
	(0.819)	(0.537)	(0.842)	(0.637)	(0.683)	(1.307)
Crude opioid death rate (2006-2016)	0.520	0.223	0.489	0.371	0.251	0.243
	(0.151)	(0.072)	(0.059)	(0.039)	(0.061)	(0.149)
Observations	1,904	10,304	10,444	9,800	17,584	36,204
Adjusted R	0.531	0.455	0.469	0.383	0.320	0.197
Relative effect	0.712	0.710	0.550	1.191	0.959	1.304

Notes: Providers per 100,000 reflects the number of providers in a county, who were waivered to provide office-based buprenorphine treatment. Prescriptive authority is an indicator that denotes if a state allowed nurse practitioners to prescribe buprenorphine (Schedule III controlled substances) in 2016. Each column is a separate regression with county urbanicity classified following the 2013 NCHS urbanicity classifications. Regressions include the following time-varying county-level demographic characteristics: unemployment rate, proportions of the population of White, Black, and Hispanic ethnicity, and proportions of the population whose ages are from 21 to 40, 41 to 60, and 61 and above. Relative effect is defined as (Prescriptive authority*Post CARA)/(Post CARA). All standard errors are clustered at state level. All regression results are weighted by the fraction of county population.

Table 6: The Impact of CARA and Independent Prescriptive Authority Status on Access to Office-Based Treatment by Provider Type

Providers per 100,000	(1)	(2)	(3)
	All	Nurse Practitioner	Physician
Prescriptive authority*Post CARA	3.327	1.723	1.146
	(0.816)	(0.350)	(0.462)
Post CARA	4.131	1.314	2.554
	(0.442)	(0.199)	(0.256)
Prescriptive authority	-0.381	-0.155	-0.193
	(0.620)	(0.0843)	(0.584)
Medicaid expansion	1.400	0.296	1.077
	(0.577)	(0.0956)	(0.524)
Crude opioid death rate (2006-2016)	0.374	0.0473	0.320
	(0.0469)	(0.00917)	(0.0391)
Observations	86,240	86,240	86,240
Adjusted R-squared	0.363	0.299	0.318
Pre-period mean(2013-2016)	2.812	0.000	2.811

Notes: Providers per 100,000 reflects the number of providers in a county, who were waivered to provide office-based buprenorphine treatment. Column (1) considers all providers (nurse practitioners, physicians, and physician assistants), column (2) considers only nurse practitioners, column (3) considers only physicians. Prescriptive authority is an indicator that denotes if a state allowed nurse practitioners to prescribe buprenorphine (Schedule III controlled substances) in 2016. Regressions include the following time-varying county-level demographic characteristics: unemployment rate, proportions of the population of White, Black, and Hispanic ethnicity, and proportions of the population whose ages are from 21 to 40, 41 to 60, and 61 and above. All standard errors are clustered at state level. All regression results are weighted by the fraction of county to state population.

Table 7: The Impact of CARA and Independent Prescriptive Authority Status on Physician Waiver Adoption, by Co-Practice Status

Probability physician obtains waiver	(1) All physicians	(2) Physicians co-practicing with NPs	(3) Physicians not co-practicing with NPs
Prescriptive authority*Post CARA	0.00274	0.00420	-0.00102
	(0.00148)	(0.00183)	(0.00129)
Prescriptive authority	-0.00102	-0.00101	-0.000497
	(0.00308)	(0.00288)	(0.00358)
Post CARA	0.0148	0.0145	0.0142
	(0.00112)	(0.00123)	(0.00138)
Medicaid expansion	0.00309	0.00400	0.00161
	(0.00221)	(0.00214)	(0.00290)
Crude opioid death rate (2006-2016)	0.00106	0.00116	0.000934
	(0.000302)	(0.000310)	(0.000347)
Observations	9,332,839	5,809,468	3,523,371
Adjusted R-squared	0.095	0.084	0.114
Pre-period mean (2013-2016)	0.0282	0.0249	0.0328

Notes: The outcome is a binary indicator of whether a physician is waivered to provide office-based buprenorphine treatment. Column (1) considers all physicians, column (2) considers only physicians who co-practice with at least one nurse practitioner, column (3) includes physicians who do not co-practice with nurse practitioners. Prescriptive authority is an indicator that denotes if a state allowed nurse practitioners to prescribe buprenorphine (Schedule III controlled substances) in 2016. Data is the SAMHSA waiver data merged onto the NPI/NPPES panel of physician-NP co-practice relationships. All regressions include physician controls for practice size, gender, graduation year from medical school, and specialty, and the sample is restricted to physicians who appear in PECOS and who are in a specialty that sometimes engages in office-based opioid use disorder treatment. Robust standard errors clustered at the state level.

Appendix

Table A1: Results for CARA and Independent Prescriptive Authority on Access to Office-based Treatment Using Alternative Samples

Providers per 100,000	(1) Limit to states with both practice and prescriptive authority	(2) Limit to states that passed independent prescriptive authority prior CARA
Prescriptive authority*Post CARA	3.074	3.225
	(0.861)	(0.840)
Post CARA	4.399	4.210
	(0.452)	(0.482)
Prescriptive authority	-0.157	-0.591
	(0.618)	(0.618)
Medicaid expansion	1.337	1.494
	(0.578)	(0.587)
Crude opioid death rate (2006-2016)	0.386	0.374
	(0.0453)	(0.0476)
Observations	86,240	79,632
Adjusted R-squared	0.362	0.366

Notes: Column (1) excludes West Virginia which grants prescriptive but not practice authority from the sample. Column (2) excludes Illinois and Virginia who passed the independent prescriptive authority in 2019. Regression results are weighted by the fraction of county to state population. Demographic characteristics included: unemployment rate, proportions of the population of White, Black, and Hispanic ethnicity, and proportions of the population whose ages are from 21 to 40, 41 to 60, and 61 and above.

Table A2: The Impact of Independent Prescriptive Authority on Access to Medication-assisted Treatment in Formal Opioid Treatment Programs (OTPs) Using Alternative Classification of Timing of Independent Prescriptive Authority

	(1)	(2)
Morphine equivalent grams of methadone and buprenorphine dispensed per 100,000	Traczynski & Udalova (2018)	McMichael & Markowitz (2021)
Independent prescriptive authority	9,189.0	10,007.0
	(4,669.3)	(4,276.1)
Medicaid expansion	2,935.0	2,765.3
	(2,342.0)	(2,322.3)
Opioid death rate in 2006	4,355.9	6,431.0
	(7,528.6)	(6,214.7)
State fixed effect	Yes	Yes
Year fixed effect	Yes	Yes
Observations (state years)	550	548
Within group R-squared	0.535	0.548

Notes: Column 1 uses Traczynski & Udalova (2018) classification of independent prescriptive authority. Column 2 uses McMichael & Markowitz (2021) classification of independent prescriptive authority. All regressions omit state-year in which independent prescriptive authority passed. Regressions include the following time-varying state-level demographic characteristics: unemployment rate, proportions of the population of White, Black, and Hispanic ethnicity, and proportions of the population whose ages are from 21 to 40, 41 to 60, and 61 and above, and an indicator for the presence of OTPs in the state. Methadone and buprenorphine are converted to morphine equivalents in grams: the ratios used are methadone equals 8 morphine equivalents and buprenorphine equals 40 morphine equivalents. Standard errors are clustered at state level.

Table A3: Robustness of results on the Impact of CARA and Independent Prescriptive Authority Status on Access to Treatment Providers, Accounting for Delisted Providers

Providers per 100,000	(1)
Prescriptive authority*2019	4.948
	(1.654)
2019	6.428
	(0.709)
Prescriptive authority	-0.369
	(0.639)
Medicaid expansion	4.582
	(1.364)
Crude opioid death rate (2006-2016)	0.457
	(0.0672)
Observations	6,160
Adjusted R-squared	0.500

Notes: The table present results from a two-period panel – 2013 and 2019 – estimated according to Equation (3). For both years the outcome variable is all practitioners listed on the SAMSHA Treatment Locator Website. Data for 2013 was obtained from a snapshot on the Internet Archive Wayback Machine. All standard errors are clustered at state level. All regression results are weighted by the fraction of county to state population. Regressions include the following county-level demographic characteristics: unemployment rate, proportions of the population of White, Black, and Hispanic ethnicity, and proportions of the population whose ages are from 21 to 40, 41 to 60, and 61 and above.

Table A4: The Impact of Independent Prescriptive Authority on the Number of OTPs

OTPs per 100,000	(1)
Independent prescriptive authority	0.00761
	(0.0347)
Medicaid expansion	-0.0102
	(0.0180)
Opioid death rate in 2006	0.443
	(0.0704)
Observations (state years)	549
Adjusted R-squared	0.967

Notes: The outcome variable is the number of OTPs in each state year. Independent prescriptive authority is a time varying indicator that denotes if a state allows nurse practitioners to prescribe methadone or buprenorphine (Schedule II or III controlled substances). Regression omits state-year in which independent prescriptive authority passed. Regression includes the following time-varying state-level demographic characteristics: unemployment rate, proportions of the population of White, Black, and Hispanic ethnicity, and proportions of the population whose ages are from 21 to 40, 41 to 60, and 61 and above, and an indicator for the presence of OTPs in the state. Standard errors are clustered at state level.

Table A5: The Impact of CARA and Independent Prescriptive Authority Status on Physician Probability of Co-Practicing

Probability of physician co-practicing	(1)
Prescriptive authority*Post CARA	-0.00618
	(0.0109)
Prescriptive authority	0.0434
	(0.0277)
Post CARA	0.0867
	(0.00353)
Medicaid expansion	-0.0271
	(0.0178)
Crude opioid death rate (2006-2016)	0.00548
	(0.00282)
Observations	9,332,839
Adjusted R-squared	0.132

Notes: The outcome is a binary indicator of whether a physician is co-practicing with at least one nurse practitioner. Prescriptive authority is an indicator that denotes if a state allowed nurse practitioners to prescribe buprenorphine (Schedule III controlled substances) in 2016. Data is the SAMHSA waiver data merged onto the NPI/NPPES panel of physician-NP co-practice relationships. All regressions include physician controls for practice size, gender, graduation year from medical school, and specialty, and the sample is restricted to physicians who appear in PECOS and who are in a specialty that sometimes engages in office-based opioid use disorder treatment. Robust standard errors clustered at the state level.

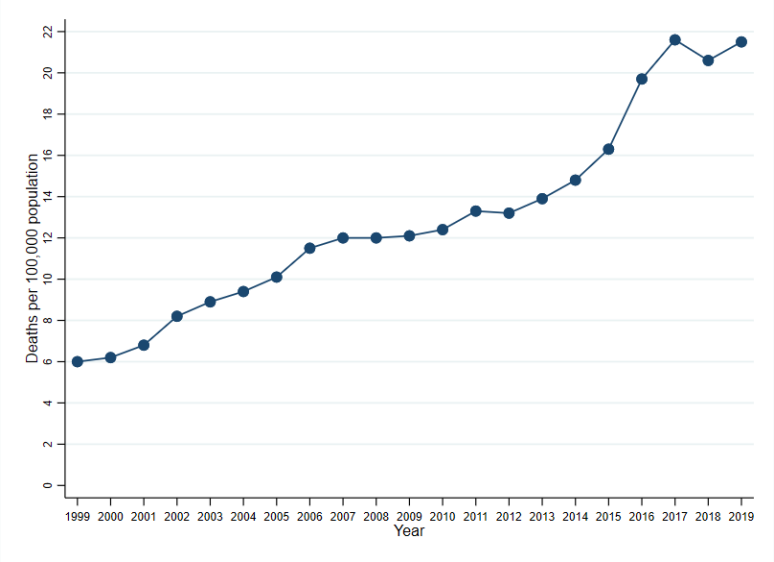

Figure A1: National Opioid Death Rate Over Time

Note: Data was extracted from Centers for Disease Control and Prevention, National Center for Health Statistics, Multiple Cause of Death, 1999-2019 using the CDC WONDER Online Database, released in 2021. The specific underlying causes of death codes used were X40-X44, X60-X64, X85, and Y10-Y14. Codes T40.0-T40.4 and T40.6 were used for the multiple causes of death fields.

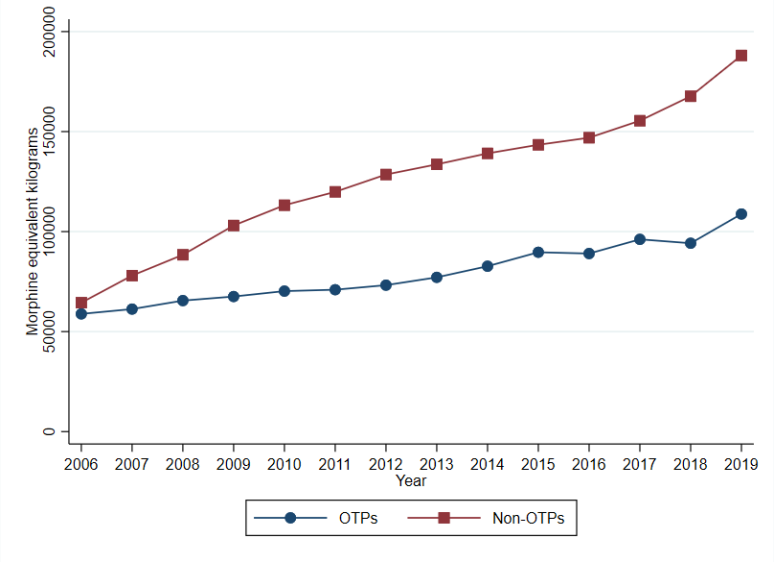

Figure A2: Total Kilograms of Buprenorphine & Methadone Dispensed by Source

Note: Data is extracted from U.S. Department of Drug Enforcement Administration, Automated Reports and Consolidated Ordering System, Retail Drug Summary Reports: Report 5. The sources of dispensing buprenorphine and methadone are classified as Opioid Treatment Programs (OTPs) versus Non-OTPs (pharmacies, hospital, practitioners, and teaching institutions).

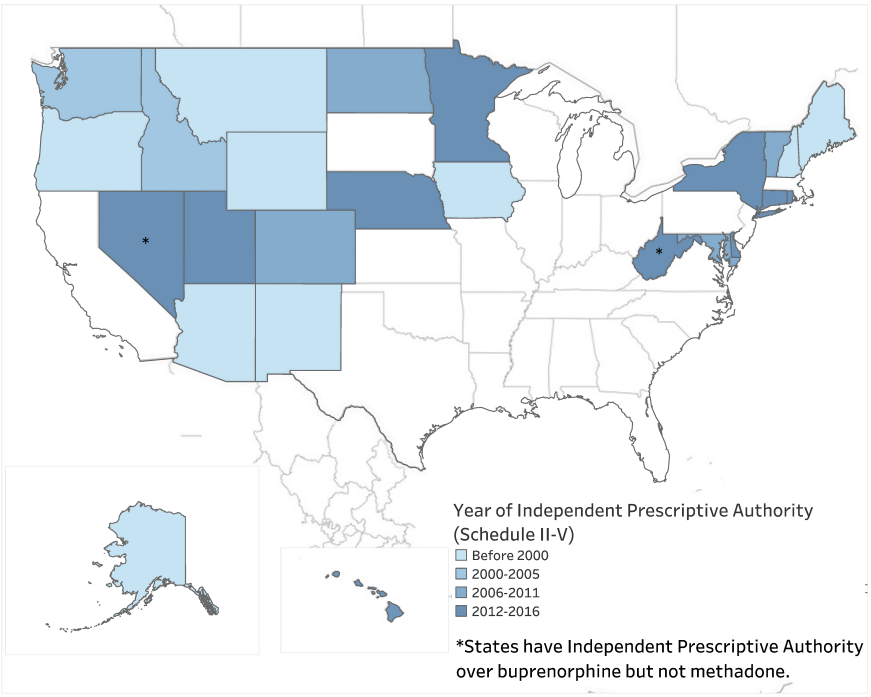

Figure A3: Map of Independent Prescriptive Authority

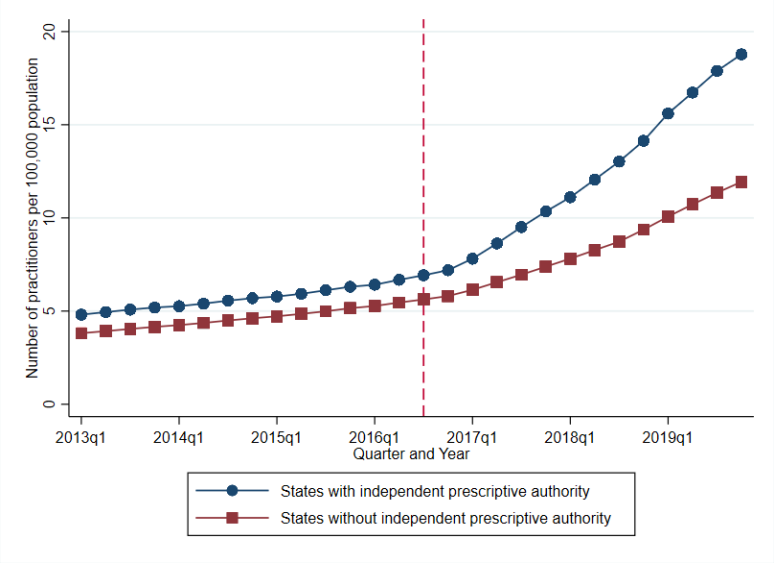

Figure A4: Buprenorphine-Waivered Practitioners by Prescriptive Authority Status Over Time

Note: The data on office-based buprenorphine practitioners comes from the U.S. Department of Health & Human services, Substance Abuse and Mental Health Services Administration. Prescriptive authority status denotes if a state allowed nurse practitioners to prescribe buprenorphine (Schedule III controlled substances) when CARA passed. The dash line represents the passage of CARA.

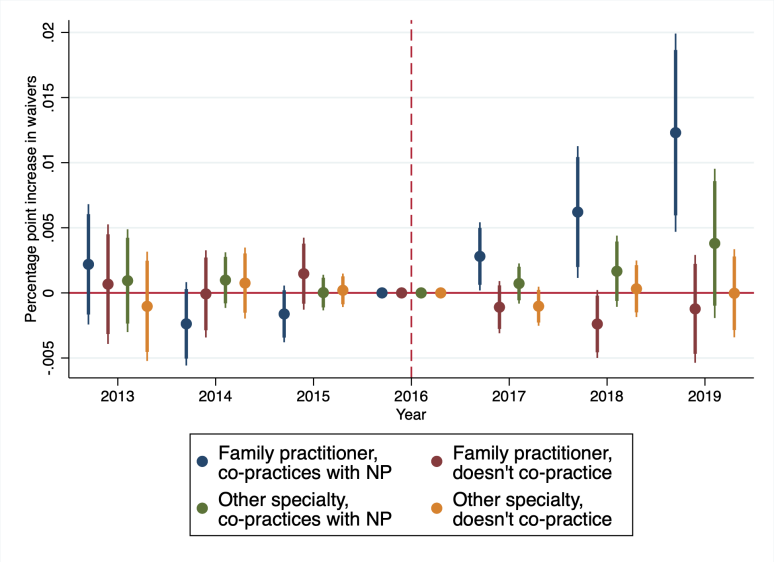

Figure A5: The Effect OF CARA AND NP Independent Prescriptive Authority on Physician Probability of Obtaining a Waiver, by Co-practice State, for Family Practice Practitioners versus Other Specialities

Note: The figure plots coefficients from an event study analysis. Event time is defined relative to the year that CARA passed (2016) and nurse practitioners were granted the ability to prescribe buprenorphine subject to state law. Data is the SAMHSA waiver data merged onto the NPI/NPPES panel of physician-NP co-practice relationships. The models are estimated for four different samples of waivered physicians: family practice physicians co-practicing with a nurse practitioner, family practice physicians who do not co-practice with nurse practitioners, other specialities co-practicing with a nurse practitioner, and other specialities who do not co-practice with nurse practitioners. See the text for a description of the data and model. Thin bars represent 95% confidence intervals and thick bars represent 90% confidence intervals.

Data Appendix

In Section 6, we examine the relationship between nurse practitioners and physicians, looking for evidence of physician crowd-out in opioid use disorder treatment. In order to conduct this analysis, we construct a unique and detailed address-level panel dataset of practitioners, extracting and merging data from several sources. This multi-year panel dataset contains physician covariates including practice location, specialty, medical school attended and date, buprenorphine waiver status, as well as information on other providers they practice alongside (co-practice status). We are making this resource available at https://github.com/akilby/npi as a Python package that provides an API to this data.

To construct data for analysis, first, we extract practitioner information from the National Provider Identifier / National Plan and Provider Enumeration System (NPI/NPPES). The NPI was mandated as a national identifier for health care providers in 2007.[26] An NPI number is permanent for each provider, with registration details including address, credentials, and specialty publicly available at https://npiregistry.cms.hhs.gov. We have constructed a panel of provider information starting in 2007 using the full download files archived on https://download.cms.gov/nppes/NPI_Files.html, as well as files archived at https://data.nber.org/npi/.[27]

Second, we extract data from the Medicare Provider Enrollment, Chain, and Ownership System (PECOS), using CMS's Physician Compare data. Practitioners appear in PECOS and Physician Compare when they bill Medicare, and this data contains additional information on practitioners, including up-to-date billing address information, group practice information, and training data, starting in 2013. Combined, these data cover the universe of all physicians and nurse practitioners currently practicing in the United States — 1,256,483 physicians and 357,285 NPs.

For years 2013-2019, we use address, phone number, and billing information in these two data sources to construct a dataset that links nurse practitioners and physicians together. Specifically, we define a *co-practicing relationship* with an NP in a few ways. First, we assume all practitioners using the same PECOS Group Practice PAC ID, which is derived from billed locations in Medicare claims, at the same time, have a co-practicing relationship. For practitioners who are not in PECOS and/or have Group Practice ID missing, we infer a co-practicing relationship if a physician and nurse practitioners are listed at the same time period at the same physical address (requiring the same zip code and telephone number) in either PECOS or the NPI system. This procedure may miss some co-practice relationships, as some co-practicing providers do not share a telephone number even though they practice at the same location. Code for this linkage is provided in the NPI package, linked above.

Next, we identify the NPIs of SAMHSA-waivered providers using our FOIAed buprenorphine waiver data, merging name, address, and telephone number to the NPI data to assign an NPI number to all waivered providers (which include MD/DOs, NPs, and PAs). Our procedure yields a match rate of 95%. As far as

[26] All HIPAA Covered Entities were required to be in compliance by May 23, 2007 with a rule requiring use of the NPI for all standard transactions.

[27] A new NPI download file is released monthly by CMS. For historical data files, some months are missing from both CMS and the NBER archive; available data sources have months missing in the 2007-2013 period. To account for missing months in earlier years, we aggregate the raw monthly data to an NPI-quarter panel dataset. After aggregating at the NPI-quarter level, there is complete coverage from 2012-present, and partial coverage prior to that.

we know, a match from SAMHSA substance abuse practitioner data to unique practitioner NPI has not been constructed before. The NPI-SAMHSA linkage allows merging SAMHSA waiver status onto many other physician datasets, and is provided in the NPI package linked above.

We restrict our sample in a few ways. First, we restrict our sample to physicians who appear in PECOS, because physicians are usually only deactivated from the NPI database when they die or the NPI has been used for fraud; this means that it contains a number of retirees; also, PECOS contains many of the physician level-controls we use in our analysis.

Second, many physicians practice in specialties where it is never necessary to obtain a SAMHSA waiver. Across our panel dataset, 2-3% of physicians nationally obtain SAMHSA waivers, and the decision is heavily influenced by specialty, ranging from less than 0.3 percent of physicians such as medical oncologists, cardiovascular disease specialists, and pediatric pulmonologists, to around 4% of emergency medicine and maternal and fetal medicine specialists, and over 5% for General Practitioners, Family Practitioners and Primary Care. (Pain care specialists, psychiatrists, and substance use disorder specialists all have very high rates of waiver adoption.) We set a cutoff of a waiver adoption rate of 2.5% for a specialty to be included in our sample; about 65% of the physician sample is dropped due to this cutoff. Our results are robust to alternative cutoffs, and also to approaches that examine only family practitioners, general practitioners, and primary care physicians, a key target for expanding access to buprenorphine.

The final analysis dataset is a panel dataset of 324,979 physicians and 28 quarters from 2013 to 2019 that contains physician waiver status over time, co-practice status over time, practice size, and a rich panel of physician covariates.