The Effect of Repealing Prior Authorization for Prescribing Buprenorphine on Buprenorphine Access and Health Care Utilization among Medicaid beneficiaries with Opioid Use Disorders

1. Introduction

Medications for Opioid Use Disorders (MOUD) – Buprenorphine, Naltrexone and Methadone – are food and drug administration (FDA) approved drugs used for treating individuals with opioid use disorders (Clark et al. 2015; Hser et al. 2016; Wakeman et al. 2020; Weiss et al. 2015). MOUD is cost-effective and considered the gold standard in assisting the treatment and recovery of individuals suffering from opioid use (Madras et al. 2020; Committee on Medication-Assisted Treatment for Opioid Use Disorder; 2019; NIDA. Overview. National Institute on Drug Abuse website. 2021). Studies have shown that any of the three medications are effective in treating opioid use disorders. However, given the differing pharmacological profiles of the drugs, opioid using patients and clinicians have preferences towards a certain MOUD. More specifically, since, Buprenorphine induces fewer side effects compared to Naltrexone (Gonzalez and Brogden 1988) and is subject to fewer regulations compared to Methadone (Deck and Carlson 2004; Yarborough et al. 2016), clinicians prefer to prescribe Buprenorphine to opioid using patients (Yarborough et al. 2016). Numerous interventions intending to improve access to MOUD, try to link patients with outpatient treatment programs that treat opioid using individuals with Buprenorphine.

Buprenorphine is a partial opioid agonist and still has the potential for misuse — diversion, trafficking, abuse. Therefore, Buprenorphine and all products containing buprenorphine are categorized as controlled in Schedule III of the Controlled Substances Act of the Drug Enforcement Agency (Drug Enforcement Administration 2025). Despite the relatively lower risk of buprenorphine misuse and overdose, Buprenorphine treatment is more highly regulated than other controlled substances, and many commercial and public insurance plans still require prior authorization before approving buprenorphine prescriptions as a way to both reduce cost and support appropriate use of Buprenorphine (Andrews et al. 2019; Bachhuber 2020; Clark et al. 2015). However, given that Medicaid is the largest payer of substance use services — covering about 40 percent of Americans with opioid use disorders — prior authorization for Buprenorphine in state Medicaid plans is often cited as a barrier to timely and effective prescribing of Buprenorphine to Medicaid beneficiaries with opioid use disorder (Landis et al. 2022; Abraham et al. 2022).

Prior authorization is a health plan cost-control process that requires physicians and other health care professionals to obtain advance approval from a health plan before a specific service or drug is delivered to the patient to qualify for payment coverage (American Medical Association 2022). Prior authorization acts as an ordeal and in the case of Buprenorphine aims to reduce cost and support appropriate use. Utilization management policies like prior authorization are justified and have proven effective to limit the use of low-value services (Colla et al. 2017). However, application of utilization management policies and their induced administrative burdens on high-value services prohibit the take-up of essential health care services among vulnerable populations (Brot-Goldberg et al. 2023). Given the low cost and efficacy of Buprenorphine in aiding treatment and recovery among individuals with opioid use disorders, Buprenorphine is considered a high-value medication and an essential tool for the effective and evidence-based treatment of opioid use disorders among opioid using individuals. However, misguided and overstated concerns of misuse (Pollack 2023) have subjected Buprenorphine to unwarranted scrutiny from law enforcement agencies and health care plans .

Between 2007 and 2013, prior authorization was required for prescribing Buprenorphine in 48 state Medicaid programs (Landis et al. 2022). Studies found that prior authorization requirements for Buprenorphine caused treatment delays (Andraka-Christou and Capone 2018; ASAM 2013), were associated with lowered odds of Buprenorphine provision, putting patients with opioid use disorders at risk of poorer clinical outcomes and overdose deaths (Andrews et al. 2019). Taking evidence into account and to counter the rising number of overdose deaths from the opioid epidemic, states started repealing the use of prior authorization for prescribing Buprenorphine for treating opioid use orders (Christine et al. 2023; Andraka-Christou et al. 2023). Further, the Substance Use Disorder Prevention that Promotes Opioid Recovery and Treatment for Patients and Communities (SUPPORT) Act — a comprehensive, bipartisan legislation to address the opioid epidemic — required that state Medicaid programs cover at least one formulation of Buprenorphine without prior

authorization in its Medicaid plans (H.R.6 Substance Use-Disorder Prevention That Promotes Opioid Recovery and Treatment for Patients and Communities Act or the SUPPORT for Patients and Communities Act 2018).

State Medicaid programs started repealing prior authorization requirements for Buprenorphine in 2015. A number of states required that both the fee-for-service (FFS) and managed care organization (MCO) plans prohibit the use of prior authorization when prescribing Buprenorphine and medications containing Buprenorphine (Andraka-Christou et al. 2023). In some states Buprenorphine products were added to a state's preferred drug list and prior authorization was no longer required for Buprenorphine. In other states the prior authorization for Buprenorphine was only repealed for Buprenorphine-Naloxone products while prior authorization was still required for long-acting injectable Buprenorphine. The literature on the effects of prior authorization on the utilization of medical services is vast but limited in the context of Buprenorphine access for Medicaid beneficiaries. One study analyzing Medicaid Analytic eXtract data from 2006-2013 found that Buprenorphine prior authorization policies were associated with a sizeable and significant reduction in the provision of good quality Buprenorphine care (Landis et al. 2022). Another study analyzing data from the State Drug Utilization Data found that repealing prior authorization requirements for Buprenorphine had no effect on the number of Buprenorphine prescriptions (Christine et al. 2023). This study did not account for number of Medicaid enrollees with opioid use disorders and were not able to distinguish whether a state's Buprenorphine prescriptions rate was a function of care availability or the proportion of the Medicaid population with opioid use disorder. They also did not account for the fact that Buprenorphine prior authorization policies were different for different states and further the dataset they used did not have adequate data on managed care encounters, therefore their analyses was largely based on fee-for-service enrollees. A second study (Keshwani et al. 2022) using the same dataset focused on 2 states (California and Illinois) and found mixed evidence regarding Buprenorphine prior authorization on Buprenorphine access. Therefore, despite the overwhelming support to improve Buprenorphine access, it remains largely unknown as to how repealing prior authorization for prescribing Buprenorphine access has affected Buprenorphine prescribing, and health care utilization among Medicaid beneficiaries with opioid use disorders. This study using Medicaid claims data from the Transformed Medicaid Statistical Information System (T-MSIS) Analytic Files (TAF) aims to fill this gap. As provisions surrounding the coverage of Buprenorphine without prior authorization in the SUPPORT Act of 2018 are set to expire in 2025 and the growing proliferation of managed care in Medicaid, the goal of this study is to estimate the causal effects of repealing prior authorization for prescribing Buprenorphine on Buprenorphine access and opioid use related acute health care utilization — hospitalizations and emergency department — visits among Medicaid beneficiaries with opioid use disorders.

We exploit geographical and temporal variation in the implementation of prior authorization repeal policies for Buprenorphine prescribing and use a staggered difference-in-differences framework to understand the causal impact of repealing prior authorization for prescribing Buprenorphine on Buprenorphine access for and health care utilization among Medicaid beneficiaries with opioid use disorders. Our results show that repealing prior authorization for Buprenorphine prescribing increases both the number of Buprenorphine prescriptions and the likelihood of Medicaid beneficiaries with opioid use disorders receiving Buprenorphine. Using a staggered timing difference-in-differences model, we find that states that repealed prior authorization requirements for Buprenorphine had a higher Buprenorphine access and lower acute health care utilization. We examine whether there are heterogeneous responses to the policy by insurance type and state policy characteristics of their prior authorization repeal for prescribing Buprenorphine. First, we found that access increased significantly for managed care enrollees compared to fee-for-service enrollees. Second, we found that states with less restrictive prior authorization repeals saw significant gains in Buprenorphine access and reduced utilization compared to states with more restrictive prior authorization repeals.

The paper proceeds as follows. Section 2 provides background on the opioid epidemic and prior authorization repeal policies. Section 3 discusses a conceptual model that demonstrates how prior authorization repeal affects outcomes. We describe the data in Section 4 and discuss our empirical strategy in Section 5. We present the results in Section 6 and sensitivity analysis in Section 7. In Section 8 we conclude.

2. Background and Institutional Setting

2.1 Opioid Epidemic in the United States and Buprenorphine

Drug overdose deaths is one of the leading cause of deaths in the United States, claiming the lives of over 100,000 individuals (Abraham et al. 2022; Biondi et al. 2022). Overdose deaths from opioid use have nearly quadrupled in the wake of the opioid epidemic (Humphreys and Shover 2023), especially since the increased supply of fentanyl and fentanyl-laced substances in the market (Powell et al. 2025). Owning its origins to the increased prescriptions of OxyContin since the late 1990s, Medicaid beneficiaries have been disproportionately prescribed pain medications which have led to an increase in opioid addiction (Alpert et al. 2022). In order to regulate the OxyContin and pain medication induced opioid crisis, policymakers regulated the supply of prescription Oxycontin which led to opioid using individuals to substitute OxyContin for more dangerous and illicit opioids such as heroin and synthetic opiates. As a result of the new regulations — prescription drug monitoring programs, Medicaid lock-in programs — use of OxyContin dropped, and intra-venous use of heroin increased exponentially triggering an opioid epidemic in early 2010s. The crisis worsened as the supply of synthetic opiates — fentanyl and fentanyl-laced substances — circulated more increasingly in the market, further triggering a rise in the number of overdose deaths (Alpert et al. 2018).

In response to the opioid crisis, law enforcement agencies and policymakers intending to reduce the supply of illicit opioids in the market and deter individuals from consuming illicit opioids pursued a range of crackdowns on drug users. These policies led to an unprecedented increase in the arrests of black men and women from low-income neighborhoods across the country but did not reduce street prices of drugs or overdose deaths (Pollack and Reuter 2014). As a result of the failure and cruelty of "war-on-drugs" adjacent policies, and strong empirical evidence suggesting that intensifying enforcement has no significant potential for decreasing misuse or raising street prices of illicit or diverted drugs, much of the recent policy response to tackle the opioid epidemic emphasizes harm reduction strategies aimed at reducing fatal overdoses and other problems related to the misuse of both licit and illicit opioids (Maclean et al. 2020). Harm reduction policies include, but are not limited to, naloxone access laws (NALs), Good Samaritan Laws (GSL), and syringe exchange programs (SEP), and the use of MOUD such as Buprenorphine. As noted in Section 1, unlike the its substitutes, Buprenorphine is easier to prescribe. Thus, Buprenorphine has become the gold standard for treating opioid use disorders. A number of interventions aimed to link opioid using individuals to Buprenorphine treatment programs, and clinicians make concerted efforts with their opioid using patients to start them on Buprenorphine. Buprenorphine can be administered in an office-based setting, emergency department or through opioid treatment programs (Yarborough et al. 2016; Landis et al. 2022). The drug is available in sub-lingual, films and injectable forms and can be used by opioid using individuals who are in active use to prevent an overdose and/or wean off opioids if they choose to (Landis et al. 2022).

Despite the many benefits of Buprenorphine, providing access to this medication has been impeded by several factors. First, there is considerable stigma amongst physicians and patients in willing to prescribe and use Buprenorphine to treat opioid addictions (Blendon and Benson 2018). Second, a number of physicians lack the education to adequately treat patients with opioid use disorders (Woo et al. 2017). Third, administrative and regulatory barriers, like requiring X-waivers from physicians to prescribe the drug and prior authorization requirements, have acted as significant barriers to the timely prescription of Buprenorphine to opioid using individuals (Bozinoff et al. 2024). However, recognizing that Buprenorphine has a low risk profile and is safe, effective and easy to prescribe in an office-based settings, state Medicaid programs started repealing prior authorization requirements for Buprenorphine. In 2010 California repealed prior authorization for Buprenorphine and in 2015 two states — Illinois and Rhode Island — repealed prior authorization requirements for Buprenorphine. Following this, 6 more states between 2016 and 2018 repealed prior authorization requirements for Buprenorphine. Following the passage of the SUPPORT Act of 2018, 50 states as of date do not have any prior authorization requirements for at least one formulation of Buprenorphine.

2.2 Prior Authorization Requirements for Prescribing Buprenorphine

Historically prior authorization has been used as a tool for insurers to fight moral hazard problems, where generous insurance coverage may incentivize the use of low-value care (Baicker et al. 2015). If a health care service is subject to prior authorization patients only receive insurance coverage for the said service if they receive explicit authorization from the insurer; otherwise they must pay for the cost of their prescription drugs out of pocket. Acquiring the authorization requires the patients' physician to fill out pre-specified paperwork making the case for why their patient should receive the drug. The goal of these policies is to restrict access to costly drugs to only those patients for whom those drugs provide the highest value (Brot-Goldberg et al. 2023). However, this process comes with administrative costs requiring designated staff to handle prior authorization requests. Evidence from the American Medical Association (2017) suggests that on average 20.4 hours per physician per week are allocated towards handling prior authorization requests (Casalino et al. 2009). This administrative burden from prior authorization has the potential to hinder access to treatment and in the case of Buprenorphine, it has the potential to affect high-value treatment.

Therefore, to effectively manage the opioid epidemic, between July 2015 and December 2018, 11 state Medicaid programs — Illinois, Rhode Island, Hawaii, Delaware, Nebraska, North Carolina, Washington, Indiana and Wisconsin — placed some kind of restrictions on the use of prior authorization for prescribing Buprenorphine and products containing Buprenorphine for both managed care and fee-for-service enrollees. In some states, Buprenorphine products were added to the states' preferred drug list and prior authorization was no longer required. In other states, the prior authorization was repealed for only Buprenorphine-Naloxone products. For policy details see Appendix Table 4.

Illinois' Medicaid program was the first to repeal prior authorization for all FDA approved Buprenorphine and products containing Buprenorphine for both its fee for service and managed care beneficiaries in 2015. Rhode Island's Medicaid program followed suit and repealed prior authorization for all brand name Buprenorphine. Similar policies repealing prior authorization for all Buprenorphine was implemented in Maryland and Pennsylvania in 2017 and 2018 respectively. In Delaware and Nebraska, the Medicaid programs repealed prior authorization for Buprenorphine products that were on the states' preferred drug list. In North Carolina, the program repealed prior authorization for generic films of Buprenorphine that were on the states' preferred drug list, however prior authorization was still required for formulations of Buprenorphine that were not listed on the states' preferred drug list. This policy was implemented in 2018. Lastly, in Indiana, Arizona, Washington and Wisconsin prior authorization was repealed for prescribing Buprenorphine-Naloxone formulations between 2017 and 2018 but prior authorization was still required for prescribing long-acting formulations of Buprenorphine. While there is a clinical case to be made for the use of long-acting Buprenorphine for treating opioid addiction among Medicaid beneficiaries with opioid use disorders, the cost of long-acting formulations sometimes exceeding $600 per beneficiary deems the long-acting Buprenorphine products a financial burden on Medicaid programs which are already struggling to make ends meet for its low-income and socially vulnerable beneficiaries. Thus, in order to manage costs and ensure that effective formulations of Buprenorphine such as a Buprenorphine-Naloxone formulations and other non-injectables products are efficiently allocated, several Medicaid programs refuse to provide coverage for long-acting Buprenorphine or require burdensome prior authorization for prescribing long-acting Buprenorphine to opioid using Medicaid beneficiaries.

3. Conceptual Framework

We view prior authorization for prescribing Buprenorphine to Medicaid beneficiaries with opioid use disorder as a form of ordeal — a non-monetary barrier — that is intended to filter out low-benefit users of Buprenorphine. We use the theoretical framework of ordeal mechanisms (Nichols and Zeckhauser 1982; Finkelstein and Notowidigdo 2019; Brot-Goldberg et al. 2023) to provide insight into how prior authorization for prescribing Buprenorphine can acts as a barrier to access. The ordeal mechanism suggests that when prior

authorization is required for prescribing Buprenorphine, physicians who wish to prescribe Buprenorphine must be willing to overcome the administrative and other logistical barriers imposed by Medicaid's prior authorization process. In theory, this ordeal cost creates a substantial hurdle for individuals with opioid use disorder and prevents them from obtaining necessary treatment in a timely manner.

In this context, the prior authorization process imposes a non-monetary cost on the physician C_P for prescribing Buprenorphine. This would include time, paperwork, or administrative effort and other logistics that physicians must overcome to ensure that patients with opioid using individuals in Medicaid have access to Buprenorphine treatment. If each provider sees a fraction $\theta_j \in [0,1]$ of Medicaid beneficiaries, then their net revenue can be expressed as:

$$\pi_j = \theta_j . R . Q(C_P) - C_P$$

where R is the revenue, Q is the quantity of Buprenorphine dispensed and C_P is the ordeal cost. The provider will offer treatment i.e., engage in the prior authorization only if $\pi_j \geq 0$. If they choose to prescribe Buprenorphine to an opioid using Medicaid beneficiary and engage in the prior authorization process, then the utility of opioid using individual i with opioid use disorder can be expressed as:

$$U_i = B_i - C_P$$

where B_i the private benefit that individual i with opioid use disorder derives from access to Buprenorphine and C_P represents the cost of the ordeal imposed by prior authorization. Thus, only those individuals for whom $B_i > C_P$ will have access to treatment, while others may either forgo treatment, opt for alternative treatments or access Buprenorphine in the underground market. This creates a self-selection process, where the only a fraction of Medicaid beneficiaries with opioid use disorders i.e., higher-benefit individuals are more likely to get access to Buprenorphine treatment from the system, while those with lower private benefits $B_i < C_P$ may not pursue treatment at all. Let $i \in [0,1]$ represent a population of Medicaid beneficiaries, each with a private B_i , drawn from a continuous drawn from a continuous distribution $F(B)$ over $[0, \bar{B}]$. In this model, we assume that Buprenorphine provides a strictly positive benefit to all individuals, such that $B_i > 0 \; \forall \; i$, but that the Medicaid system does not provide automatic coverage. Instead, prior authorization imposes a hurdle, and demand for Buprenorphine is given by:

$$D(C_P) = \{i : B_i \geq C_P\}$$

The total demand for Buprenorphine treatment is therefore given by:

$$Q(C_P) = 1 - F(C_P)$$

When prior authorization is repealed $C_P = 0$, demand for Buprenorphine increases and individuals who previously could not overcome the ordeal of prior authorization to seek Buprenorphine treatment now have access to life-saving treatment. This increased access to Buprenorphine can lead to higher individual welfare (through expanded access to treatment) and greater social welfare (through the reduction of opioid-related harm). The ordeal of prior authorization serves as a filter and restricts Buprenorphine access to only those opioid using individuals who find that the benefit of treatment outweighs the ordeal cost. In the canonical ordeals mechanism this corrects for inefficiencies in the market and corrects for moral hazard. This result – both theoretically and empirically – holds for low-value treatments such as niche branded drugs where the incremental value of the treatment is low relative to its incremental cost (Brot-Goldberg et al. 2023). However, Buprenorphine has high incremental patient value for opioid using individuals and access to Buprenorphine treatment generates substantial social benefits beyond the individual patient. These external benefits include but

are not limited to reductions in mortality from overdoses, decreased crime rates associated with opioid addiction, and reduced transmission of infectious diseases like HIV and hepatitis C.

Let E_i represent the external benefits associated with treating patient i with Buprenorphine. The total social benefit of treating individual i is:

$$SB_i = B_i + E_i$$

where E_i is an externality reduction.

In this framework, the socially optimal rule for prescribing Buprenorphine should consider both private benefits and externalities, and should be based on the criterion:

$$SB_i = (B_i + E_i) \geq C_P$$

However, prior authorization fails to account for these externalities. The current system based on prior authorization screens out individuals whose social benefit from Buprenorphine treatment exceeds the ordeal cost. As a result, the prior authorization process denies treatment to individuals who could derive significant benefits from Buprenorphine treatment, thereby leading to a welfare loss. This misalignment between individual and social benefits occurs because the prior authorization only allows access to those whose private benefit B_i exceeds the cost C_P, disregarding the wider societal impacts of reducing access to Buprenorphine. If we assume that externality reductions E_i are substantial for many opioid using individuals with $B_i < C_P$, we can evaluate the change in total welfare resulting from the repeal of prior authorization. The total welfare change ΔW from repealing prior authorization for prescribing Buprenorphine to Medicaid patients with opioid use disorders can be expressed mathematically as:

$$\Delta \mathrm{W} = \mathrm{W}(\text{without Prior Authorization}) - \mathrm{W}(\text{with Prior Authorization})$$

$$= \int_0^{\bar{B}} (B) dF(B) - \int_0^{\bar{B}} (B - C_P) dF(B)$$

$$= \underbrace{\int_0^{C_P} B \, dF(B)}_{\textbf{Patient Surplus}} + \underbrace{\int_{C_P}^{\bar{B}} C_P \, dF(B)}_{\textbf{Physician Surplus}}$$

This welfare change consists of two components which together suggest that repealing prior authorization for prescribing Buprenorphine will lead to an overall increase in individual welfare and societal welfare. The first term represents increased patient surplus. Repealing prior authorization increases access to Buprenorphine, enabling individuals whose benefit B_i was insufficient to overcome the prior authorization ordeal to now seek and receive treatment. This increases patient welfare because these individuals — who would earlier have been screened out due to prior authorization — are now able to access Buprenorphine treatment in a timely manner. The second term represents provider or physician surplus, which are the increased cost savings as a result of reduced administrative costs due to elimination of the ordeal. Repealing prior authorization requirements for prescribing Buprenorphine reduces burdens for health care providers and patients alike. By removing the need for time-consuming paperwork and approval processes, health care providers can focus more on treatment delivery and patients can get access to essential treatments on time. The empirical analysis in this paper focuses on estimating the effect of the policy on the first component – increased patient surplus.

The theoretical model motivates our empirical analysis, which seeks to quantify the effects of repealing prior authorization for prescribing Buprenorphine on patient access to Buprenorphine and effects of the policy change on opioid use related health care utilization among Medicaid beneficiaries with opioid use disorders. Specifically, we hypothesize that the likelihood of being prescribed Buprenorphine will increase as the ordeal of

prior authorization for prescribing Buprenorphine is repealed. Further if access to Buprenorphine improves as a result of repealing prior authorization, then opioid using individuals are less likely to receive opioid use related care at hospitals or at emergency departments. Therefore, we predict that the policy change of repealing prior authorization for prescribing Buprenorphine will decrease the number of opioid use related hospitalizations and the number of opioid use related emergency department visits.

We anticipate heterogeneity in the policy's impact based on individual-level characteristics and state-specific policy contexts. First, the removal of prior authorization requirements for buprenorphine prescribing is likely to have a more pronounced effect among Medicaid beneficiaries enrolled in managed care plans. Managed care organizations (MCOs) employ utilization management strategies, including prior authorization, more extensively than fee-for-service (FFS) programs (Baicker and Robbins 2015). This places greater administrative burdens on providers, who must comply with varying prior authorization protocols across multiple MCOs. Eliminating prior authorization requirements, therefore, may reduce provider burden, lower the incidence of denied buprenorphine claims, and mitigate barriers to initiating or continuing treatment. As a result, the policy change may facilitate greater provider participation and better improve buprenorphine access for individuals with opioid use disorder enrolled in managed care plans. We anticipate increase in Buprenorphine access among individuals in in fee-for-service plans as well, however, if prior authorization requirements in fee-for-service plans were less cumbersome than the requirements in managed care plans, then repealing prior authorization for prescribing Buprenorphine might not have had a big effect on Buprenorphine access for enrollees in fee-for-service plans. Second, as stated in Section 2.2, when prior authorization was repealed across states, different states pursued different policies. In some states, the repeal applied to any and all products containing Buprenorphine, whereas in other states, the repeal only applied to specific formulations of Buprenorphine like Buprenorphine-Naloxone. We hypothesize that states with a more generous or less restrictive repeal of prior authorization requirements for prescribing buprenorphine will impose a lesser burden on physicians compared to states with more rigid prior authorization policies. Specifically, we predict that states where prior authorization is limited to a restricted list of buprenorphine formulations will see a lower likelihood of opioid-using Medicaid beneficiaries receiving buprenorphine compared to states where the repeal of prior authorization for Buprenorphine applies to a broader range of Buprenorphine products. Therefore, we anticipate that the policy change of repealing prior authorization to have a dose-response effect on Buprenorphine access and opioid-use related health care utilization.

4. Methods

4.1 Data Sources

The data for this study come from Transformed Medicaid Statistical Information System (T-MSIS) Analytic Files (TAF) data from 21 U.S. Medicaid programs from 2015-2019, through an agreement with the Centers for Medicare and Medicaid Services. Demographic and enrollment information come from the demographic and eligibility files, beneficiaries with opioid using disorders are identified using International Classification of Disease Codes (ICD)-9 and ICD-10 diagnoses codes from the inpatient and other services claims files. Data on Buprenorphine use come from the pharmaceutical and other services claims files. Data on hospitalizations and emergency department visits come from the inpatient claims files and other services claims files respectively.

4.2 Study Sample

The study sample includes a repeated cross-section of non-elderly — aged 18 to 64 years — Medicaid beneficiaries who have a claims-based diagnostic record of opioid use disorder. In 2015 for all 21 states and for Maryland between 2015 and 2017, we used ICD-9 codes to identify beneficiaries with opioid use disorders, for other states after 2016, we use ICD-10 codes to identify to identify beneficiaries with opioid use disorders.

Since drug prescription coverage for dual eligible beneficiaries is largely covered by Medicare and Medicaid only provides partial coverage for Buprenorphine, we aim to exclude beneficiaries who are dual eligible. In one

state (Alabama) we fail to exclude duals due to data quality issues. We exclude Alabama from the main sample in a sensitivity analysis to ensure robustness of our findings to the potential inclusion of duals in the analysis. We build on the minimal data quality checks from DQ Atlas for the years 2015-2019 and further exclude states from the analysis in which we cannot reliably ascertain encounters for Buprenorphine prescriptions, inpatient hospitalizations or emergency department visits (Centers for Medicare & Medicaid Services 2025). A more detailed note on the inclusion criteria for states is noted in Appendix Tables 1 and 2. The final study sample includes 21 states and 737,379 unique Medicaid enrollees with a diagnostic record of opioid use disorder.

4.3 Study Variables

4.3.1 Treatment Variable: Indicator for Repeal of Prior Authorization for prescribing Buprenorphine

The explanatory variable of interest is whether an individual with opioid use disorder was in a state that prohibited its Medicaid program — for both fee for service and managed care beneficiaries — from using prior authorization for prescribing Buprenorphine. We use a dichotomous indicator that equals 1 if an individual is in a state that repealed the use of prior authorization for prescribing Buprenorphine during the study period (treatment group) and 0 if an individual is in a state that did not repeal the use of prior authorization for prescribing Buprenorphine during the study period (control group). This dichotomization results in 11 states — Arizona, Delaware, Hawaii, Indiana, Illinois, Maryland, Nebraska, North Carolina, Rhode Island, Washinton, Wisconsin — in the treatment group and 10 states in control group. See Figure 1.

Implementing the inclusion restrictions and accounting for data quality checks, the final study sample consists of 417,216 unique opioid using Medicaid beneficiaries in states where prior authorization is not required for prescribing Buprenorphine and 580,705 individuals opioid using Medicaid beneficiaries in states that where prior authorization is required for prescribing Buprenorphine. These 737,379 opioids using Medicaid beneficiaries contribute to 6,281,448 individual-quarter level observations in the dataset.

4.3.2 Dependent Variables

The study examines the impact of repealing prior authorization for prescribing Buprenorphine on four outcomes: likelihood of receiving Buprenorphine, number of Buprenorphine claims, number of inpatient hospitalizations and number of emergency department visits among Medicaid beneficiaries with opioid use disorders. Buprenorphine claims in the claims data are identified through National Drug Classification (NDC) codes and are dichotomized accordingly to explore the effects of the policy change on the likelihood of receiving Buprenorphine, number of hospitalizations are identified through an algorithm of federally assigned service category (FASC) noted by TAF (Hula et al. 2021), and emergency department visits are identified through procedure codes and revenue center codes (NCQA HEDIS 2022). The ICD codes, NDC codes and procedure codes used to identify opioid using individuals, Buprenorphine prescriptions and health care utilization are detailed in Appendix Tables 5 and 6.

4.3.3 Other Variables

We estimated all models in the analysis controlling for a beneficiary's age, sex and whether or not they were enrolled in a managed care plan. We also control for prevalence of opioid use – measured via number of overdose deaths per 1000 – in the state, during the study period. In addition, we include state fixed effects and period (measured as quarters) fixed effects in all estimations to account for unobserved heterogeneity across states and over time periods. The covariates are summarized in Table 1.

Medicaid beneficiaries with opioid use disorders across both states with (control group) and without prior authorization (treatment group) for prescribing Buprenorphine were on average 38 years old. In the treatment group Medicaid beneficiaries with opioid use disorders were more likely to be female and beneficiaries in this group were also more likely – 77% versus 58% – to be enrolled in Medicaid managed care plans compared to

fee-for-service Medicaid during the study period. In the treatment group, states on average had a higher overdose death per 1000.

5. Empirical Strategy

The analysis uses a difference-in-differences regression framework to examine the impact of repealing prior authorization for prescribing Buprenorphine on Buprenorphine access and health care utilization among Medicaid beneficiaries employing multiple estimators for transparency and comparison. The main source of identifying variation is whether a state Medicaid program repeals prior authorization for prescribing Buprenorphine. The identifying assumption in this research design is the parallel-trends assumption. In the context of this study, the assumption warrants that, trends in outcomes across states that prohibited the use of prior authorization for prescribing Buprenorphine and states that allowed the use of prior authorization for prescribing Buprenorphine should be similar before states prohibited the use of prior authorization, indicating that any changes after restrictions on prior authorization can be attributed to the policy change rather than pre-existing differences. Although untestable, a standard way to assess the credibility of this assumption is to examine whether trends are parallel prior to implementation. First, we examine trends in unadjusted likelihood of receiving Buprenorphine, Buprenorphine prescriptions, hospitalizations and emergency department visits to visually assess the parallel-trends assumption. The trends in unadjusted likelihood of receiving Buprenorphine, Buprenorphine prescriptions, hospitalizations and emergency department visits satisfy the parallel-trends assumption reasonably well. See Figure 2. We also test the parallel-trends assumption for the outcomes more rigorously by plotting the pre-trends in covariates-adjusted outcomes in our preferred event study design using the Chaisemartin and D'Haultfœuille (2020), described later.

To analyze the impact of repealing prior authorization for prescribing Buprenorphine, we start by estimating the following canonical two-way fixed effects model:

$$\boldsymbol{Y_{ist} = \alpha + \beta_1 \, (PA\ Repeal)_{ist} + X'_{ist}\gamma + \theta_s + \delta_t + u_{ist}}$$

where i indexes the individual, s indexes the states and t indexes the time period.

In the above equation $\boldsymbol{Y_{ist}}$ are patient-level outcomes of interest, $\boldsymbol{X'_{ist}}$ is a vector of time varying controls,$\boldsymbol{PA\ Repeal_{st}}$ equals 1 if individual i is in state s with prohibition on prior authorization for prescribing Buprenorphine in time period t. $\boldsymbol{\theta_s}$ and $\boldsymbol{\delta_t}$ are state fixed effects and quarter fixed effects, respectively. $\boldsymbol{u_{ist}}$ is a mean zero error term clustered at the state level. The coefficient of interest is $\boldsymbol{\beta_1}$, which provides the estimate of how change in outcomes differ across states that did and did not repeal prior authorization for prescribing Buprenorphine. The equation is estimated separately for each outcome.

Recent advances in econometric theory suggest that standard two-way fixed effects model can provide biased estimates when there is variation in treatment timing, as the estimate may capture heterogeneity and variation in the effect rather than the average treatment effect on the treated. More specifically, the use of earlier-treated units as controls for later-treated units – often referred to as a forbidden comparison – will bias the treatment effect if the impact of earlier implementation grows or wanes over time (De Chaisemartin and D'Haultfœuille 2020; Sun and Abraham 2021; Callaway and Sant'Anna 2021; Roth et al. 2023). Since, prior authorization for Buprenorphine prescribing was implemented across different states in different quarters, using a two-way fixed effects model without accounting for variation in treatment timing might violate the parallel trends assumption and provide incorrect estimates. Estimates from the canonical two-way fixed effects in the context of the study will likely be biased due to variation in treatment timing. To check for this, we use a Goodman-Bacon decomposition (Goodman-Bacon 2021) to decompose the two-way fixed effect estimator into three component parts (earlier treated *versus* late treated, later treated *versus* earlier treated and never-treated *versus* timing groups) based on their treatment status to analyze how each component part contributes to the overall estimate.

In order to account for any bias arising from variation in treatment timing across the study period, the models are estimated using methods described in Chaisemartin and D'Haultfœuille (2020). The staggered difference-in-

differences model specified using Chaisemartin and D'Haultfœuille (2020) accounts for heterogeneous treatment effects and ensure that the parallel trends assumption holds when there is variation in treatment timing across units. To formally test the parallel-trends assumption, a dynamic event study of the form is estimated for of all periods using the above-mentioned estimators for each outcome.

We consider the Chaisemartian and D'Haultfœuille (2020) estimator as the preferred model, since it avoids problematic 2 × 2 difference-in-differences comparisons that violate the parallel-trends assumption and derives estimates under more general conditions. More specifically, the Chaisemartian and D'Haultfœuille (2020) estimator compares changes in outcomes for units whose treatment status changed to other units whose treatment status remained constant over the same periods. In doing so, the estimator avoids the forbidden comparison between early and later-treated unit and yields an interpretable average treatment effect on the treated estimate under generalizations of the parallel trends assumption (Roth et al. 2023; Wang et al. 2024). However, for the sake of transparency, results from two estimators — two-way fixed effects estimates and Chaisemartin and D'Haultfœuille (2020) — are presented

6. Results

6.1 Main Results

Estimated effects of repealing prior authorization for prescribing Buprenorphine on the likelihood of receiving Buprenorphine, number of Buprenorphine claims, opioid-use related hospitalizations and opioid-use related emergency department visits are presented in Table 3. Column 1 contains estimated coefficients from the two-way fixed effects models. The estimated coefficients in Column 1 suggest that repealing prior authorization for prescribing Buprenorphine increased the likelihood of receiving Buprenorphine and the number of the Buprenorphine claims. Thus, the estimated coefficients in Column 1 show that repealing prior authorization for prescribing Buprenorphine increased Buprenorphine access and decreased the number of opioid-related hospitalizations and emergency department visits. However, the estimated effects are not significantly different from zero. The estimates from the canonical two-way fixed effects models are meaningful but may be subject to problems with two-way fixed-effects models when there is variation in treatment timing.

The Goodman-Bacon (2021) decomposition of coefficients estimated using the canonical two-way fixed effects model is used to (a) explore potential biases in the two-way fixed effects model and (b) identify the source of variation in the difference-in-differences model with staggered treated timing. Table 2 shows that the estimated coefficients from the two-way fixed effects estimator are mainly driven by the estimated effects derived from 2 × 2 comparisons of the never-treated group versus timing groups. The 2 × 2 comparisons of early versus late treated units, late versus early treated late treated units, never-treated units versus timing groups (early versus late treated units, late versus early treated) produce estimated coefficients in both directions, indicating potential violation of the parallel trends assumption. If variation in treatment timing induced no biases due to likely “forbidden comparisons”, the 2 x 2 comparisons across the different component parts in Table 2 would yield similar estimates. The Goodman-Bacon (2021) decomposition in the context of this study suggests clear evidence of bias associated with the estimated effects from the two-way fixed effects model.

Table 3, Column 2 shows estimated coefficients from the Chaisemartin and D'Haultfœuille (2020) estimator. Estimated coefficients the model suggests that repealing prior authorization for prescribing Buprenorphine is associated with a 3% increase in the likelihood of receiving Buprenorphine, a 25% increase in the number of Buprenorphine prescriptions, a 20% decrease in the number of OUD related hospitalizations and a 2% decrease in the number of OUD related emergency department visits per quarter. However, the estimate for opioid use related emergency department visits is not statistically significant from zero.

The dynamic event study effects repealing prior authorization estimated from the Chaisemartian and D'Haultfœuille (2020) are graphically represented in Figure 3. The estimated effects in most of the pre-treatment periods are not significantly different from zero for all four outcomes, suggesting no obvious violation

of the parallel-trends assumption. In the post treatment periods, we see that repealing prior authorization for prescribing Buprenorphine slightly increases the the likelihood of receiving Buprenorphine and the same is observed for the number of Buprenorphine claims suggesting that repealing prior authorization for prescribing Buprenorphine has a modest increase on the likelihood of receiving Buprenorphine and the number of Buprenorphine prescriptions over time. The results also suggest that in the post treatment period the number of opioid-use related hospitalizations reduces significantly over time, especially in the latter half of the post treatment period. However, opioid related emergency department visits the post treatment period for suggests that the prior authorization repeal for prescribing Buprenorphine had no statistically significant impact on the number of emergency department visits for Medicaid beneficiaries with opioid use disorders. We report estimated event study effects of the policy change in all pre- and post-treatment periods in Appendix Tables 7 and 8. The tables show that the estimated dynamic effects are generally consistent across two estimators, however, tend to be slightly higher and statistically significant for the Chaisemartian and D'Haultfœuille (2020) estimators most likely as the models using the latter account for variation in timing of policy change.

6.1 Heterogeneity

To test for heterogeneous effects of repealing prior authorization for prescribing Buprenorphine, we stratify our main regression equation using the Chaisemartin and D'Haultfœuille (2020) model, by several variables described in the conceptual framework. First, we stratify by whether or not an individual was enrolled in a managed care plan. Second, we stratify by restrictiveness of the prior authorization repeal for prescribing Buprenorphine. States that repealed prior authorization for all Buprenorphine products — Maryland, Delaware, Nebraska, Hawaii, Rhode Island —were categorized as non-restrictive and states that repealed prior authorization for only Buprenorphine-Naloxone formulations — Arizona, Illinois, North Carolina, Washington, Indiana, Wisconsin—were categorized as states with restrictive prior authorization repeals. We define states with restrictive and non-restrictive prior authorization repeals separate treatment groups in this analysis.

When stratifying by whether or not an individual was enrolled in a managed care plan, we find that for enrollees in a managed care plan, repealing prior authorization for prescribing Buprenorphine significantly increases the likelihood of receiving Buprenorphine, significantly increases the number of Buprenorphine claims, and significantly decreases the number of opioid-use related hospitalizations. We do not find statistically significant effects on these outcomes for enrollees in a fee-for-service plan. For both categories of enrollees, we do not find statistically significant effects of the policy change on opioid-use related emergency department visits. We present these estimates in Columns 1 and 2 of Table 4.

Stratifying by restrictiveness of the prior authorization repeal for prescribing Buprenorphine, we find that states that repealed prior authorization for all Buprenorphine products saw a significant 3.5 percent increase in the likelihood of receiving Buprenorphine. These states also saw significant increase in the number of Buprenorphine claims and a significant decrease in both opioid use related hospitalizations and emergency department visits. For states that repealed prior authorization for only select formulations of Buprenorphine, we found that the policy change significantly increased the likelihood of receiving Buprenorphine. However, the effect size of the policy change was smaller compared to states that repealed prior authorization for all Buprenorphine products. We also found that for these states, the number of Buprenorphine claims increased, the number of hospitalizations decreased but the number of emergency department visits increased. These estimates are presented in columns 3 and 4 of Table 4.

7. Robustness Checks

We conducted several robustness checks. First, a common issue with analyses of state policies is unobserved confounding, in particular implementation of prior authorization repeal policies access occurred at the same time as other policies that could affect Buprenorphine access and health care utilization. Our estimated results would be biased if there are unobserved state policies that are associated with trends in Buprenorphine access and health care utilization. Although inherently untestable, to mitigate this concern, we collect information on

other Medicaid policies potentially related to Buprenorphine access. One such policy of Delivery System Reform Incentive Program (DSRIP) — a pay-for-performance program aimed at improving medication assisted treatment coverage of Medicaid beneficiaries — was implemented during the study period in Arizona and Washington (Hinton et al. 2022). We individually and collectively exclude Arizona and Washington from our main analyses to test the robustness of our results to the inclusion of these states in our data. The results are presented in Appendix Table 9. We find that our results are robust to the exclusion of Arizona and Washington from the main sample frame which suggests that our results are not biased by the implementation of the respective policies in Arizona and Washington during the same time period.

Second given that we are not able to exclude duals due to poor data quality of the dual eligibility status variable for Alabama, we conducted a sensitivity analysis by excluding Alabama from the main sample. The results are presented in Column 1 of Appendix Table 10. We find that our results are robust to the exclusion of Alabama from the main sample frame which suggests either that there are only a handful of opioids using dual eligible beneficiaries in the state of Alabama or that the potential inclusion of duals in a single state does not significantly influence the study outcomes. In addition, three other states in the dataset — North Carolina, Maine and Rhode Island — are included with caution in the sample due to potential issues with their claims volumes and/or enrollment data. Therefore, we conduct a sensitivity check by excluding these states from our main analysis. The results are presented in Columns 2-4 of Appendix Table 10. We find that the exclusion of these states slightly change the magnitude of the coefficient estimates but the direction of the estimates are consistent with the results of our main analysis.

Finally, we conduct two sensitivity checks on the use of ordinary least squares (OLS) regressions. First in our main specification for the outcome of likelihood of receiving Buprenorphine, we use a linear probability model to estimate the effect of the policy change on the likelihood of receiving Buprenorphine. We do so because the alternative estimator that correct for mismeasurement in a difference-in-differences framework with staggered treatment timing is built upon OLS regressions, with unclear validity in other models. Addressing potential bias caused by staggered treatment timing was critical in this analysis (Qi et al. 2024). However, it may be more appropriate to estimate this model using a logistic regression. We thus test the sensitivity of our results to this choice using two-way fixed effects logistic regression model, which better accommodates the binary nature of our outcome variable. Second, in our main specification for the outcomes of Buprenorphine claims, hospitalizations and emergency department visits we treat the dependent variables as continuous variables. However, it may be more appropriate to treat these outcomes as count data since they are nonnegative integers with a skewed distribution. We thus test the sensitivity of our results to this choice using two-way fixed effects negative binomial regressions, which better accommodate count data with a large fraction of zeros. These estimates, shown in Appendix Table 11, have the same direction as the estimates from the two-way fixed effects OLS regression models. Similar to the two-way fixed effects linear models, the estimates from both the logistic regression model and the negative binomial regression models — controlling for state and time period effects, demographic characteristics and overdose deaths — are not statistically significant from zero. The size of the estimated effects are smaller for the likelihood of receiving Buprenorphine and number of Buprenorphine claims, and similar for the number of hospitalizations and emergency department visits. The similarity of these estimates suggests that using linear models to estimate the effect of policy change for our outcomes does not result in substantial bias, although it may bias our magnitudes somewhat.

8. Discussion and Conclusion

In this pooled cross-sectional analysis of Medicaid claims data from 21 states, we present empirical estimates of the effects of repealing prior authorization for prescribing Buprenorphine on the likelihood of receiving Buprenorphine, the number of Buprenorphine claims, number of opioid-use related hospitalizations and number of opioid-use emergency visits. Our analysis using staggered difference-in differences estimators — which account for variation in timing of policy change — found that repealing prior authorization for prescribing Buprenorphine increases the likelihood of receiving Buprenorphine, the number of Buprenorphine claims, reduces opioid-use related hospitalizations and has no effect on the number of ED visits.

In our study sample, individuals on average report a 13% probability of receiving Buprenorphine, 0.60 number of Buprenorphine claims and 0.12 number of hospitalizations per quarter. The results from our preferred staggered difference-in-differences model suggest that repealing prior authorization for prescribing Buprenorphine on average, increases the likelihood of receiving Buprenorphine by 3%, the number of Buprenorphine claims by 25% and reduces the number of opioid-use related hospitalizations by 20% per quarter. A back of the envelope calculation — based on estimates in Table 3 — suggests that on average, the prior authorization repeal for prescribing Buprenorphine in Medicaid resulted in approximately 90,000 more Medicaid enrollees with opioid use disorder getting access to some formulation of Buprenorphine in a year.

In tests of heterogeneity, we found that the estimated effect of repealing prior authorization increased Buprenorphine access and reduced hospitalizations for both managed care and fee-for-service enrollees. We also found that the policy change reduced ED visits for managed care enrollees. Importantly, we also found greater estimated effects for individuals in states where the policy change was implemented without restrictions compared to states where the policy change was implemented with restrictions. This suggests a dose-response relationship between repealing prior authorization for prescribing Buprenorphine and Buprenorphine access, and health care utilization among Medicaid beneficiaries with opioid use disorders. Taken together, our findings suggest that repealing prior authorization for prescribing Buprenorphine access led to a moderate increase in Buprenorphine access, and a decrease in acute health care utilization among Medicaid beneficiaries with opioid use disorders. These findings also underscore two important things. First removing ordeals like prior authorization — for high-value drugs like Buprenorphine — improves access to Buprenorphine. Second, access to Buprenorphine, and more broadly shift a towards outpatient opioid use treatments, leads to a decrease in expensive health care utilization, which potentially could lead to decreased downstream costs accrued to Medicaid. However, the modest effect size of the policy change on Buprenorphine access suggests that removing ordeals like prior authorization are necessary but not sufficient in improving access to Buprenorphine among Medicaid beneficiaries with opioid use.

The findings from this study should be viewed with respect to several limitations. First, state TAF records varied in data quality, which may have influenced the results. To address this concern, we excluded some states on the basis of our review of TAF data quality assessments using Medicaid's Data Quality Atlas and outcomes trends for each state (see Appendix Table 2). However, we could not rule out that some data quality issues remained. Second, compared to Medicaid data from state agencies, TAF underreports opioid use disorder diagnoses by about 11% (Chughtai et al. 2025). Thus, the number of individuals with opioid user disorder in the study sample might be undercounted. However, the estimated prevalence of opioid use disorder (3.3%) is consistent with similar estimates of opioid use disorder prevalence in other studies of Medicaid beneficiaries using TAF data (Lindner et al. 2023; 2024). Third, this was an observational study design, and states may have repealed prior authorization for prescribing Buprenorphine on the basis trends in Buprenorphine treatment or prevalence of opioid-use in the state. Although we assessed and adjusted for changes occurring before the prior authorization repeal, associations might not identify causal estimates if changes in outcomes that were unrelated to the prior authorization repeal occurred concurrent with the prior authorization repeal. We examined outcome trends before the prior authorization repeal and adjusted for differential outcome trends of treatment and control states to account for such potential confounding. We also accounted for one other policy change in two of our treatment states related to Buprenorphine access and broader medications for opioid user disorder coverage (Hinton et al. 2022) and found that our main results are robust to the said sensitivity check (see Appendix Table 9). Fourth, we only examined outcomes related to patient welfare: Buprenorphine access and health care utilization. Due to lack of data on claims denials and poor-quality data on overdoses, we were not able to examine the impact of prior authorization on provider behavior and social welfare, both of which are likely to be affected by repealing prior authorization for prescribing Buprenorphine. Future research with better quality data and/or mixed-methods research should shed some light on how prior authorization or the lack thereof for high-value care influences provider behavior and health outcomes.

Our study sheds light on two important things. First, our study highlights that removing barriers on health care services — which introduce positive externalities and confer social benefits — can also improve access to essential health care services for vulnerable populations. Our findings confirm that administrative barriers have first-order effects on access to health care (Dunn et al. 2024) and they also confirm that expansion of authorization restrictions on high-value drugs (like Buprenorphine) which have low prices, could easily be inefficient, generating substantial administrative burden for little value (Brot-Goldberg et al. 2023). Second, our study findings emphasize that repealing prior authorization for prescribing Buprenorphine is a necessary step but not a sufficient one to improve access to Buprenorphine for Medicaid beneficiaries. The modest effects we find on the estimates for Buprenorphine access (see Table 3, Column 2) are consistent with other studies on the prior authorization repeal for Buprenorphine (Keshwani et al. 2022) and also consistent with other studies of reduced administrative burden — like removing X-waivers for prescribing Buprenorphine — which found no increases or modest increase on Buprenorphine treatment after policy implementation (Christine et al. 2024). However, the positive effect sizes we observe, suggests that from both an economic and a clinical perspective, repealing prior authorization for prescribing Buprenorphine is beneficial for both patients with opioid use disorders and the health care system. However, given the ongoing burden of opioid overdoses that are driving overdose deaths, and systemic barriers and social determinants of health that hinder access to treatment for the most vulnerable and marginalized populations there is an urgent need for more comprehensive policy changes within Medicaid to improve access to care for Medicaid beneficiaries with opioid use disorders.

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Table 1: Characteristics of Medicaid Beneficiaries with Opioid Use Disorders

	Full Sample	States with Prior Authorization for Buprenorphine	States without Prior Authorization for Buprenorphine
	N=737,379	**N=417,216**	**N=580,705**
Age, Mean (SD), Years	38.01 (11.75)	38.01 (11.74)	38.02 (11.75)
Sex, (%)			
Male	56.79	52.10	64.19
Female	43.21	47.90	35.81
Insurance Status, N (%)			
Managed Care	350,243	314,512 (77.23)	339,788 (58.51)
Fee-for-Service	465,768	129,535 (31.81)	279,218 (48.08)
Overdose Deaths per 1000	1417.37(833.20)	1681.94 (1220.13)	1249.46 (342.87)

Figure 1: States implementing Repeal of Prior Authorization for prescribing Buprenorphine

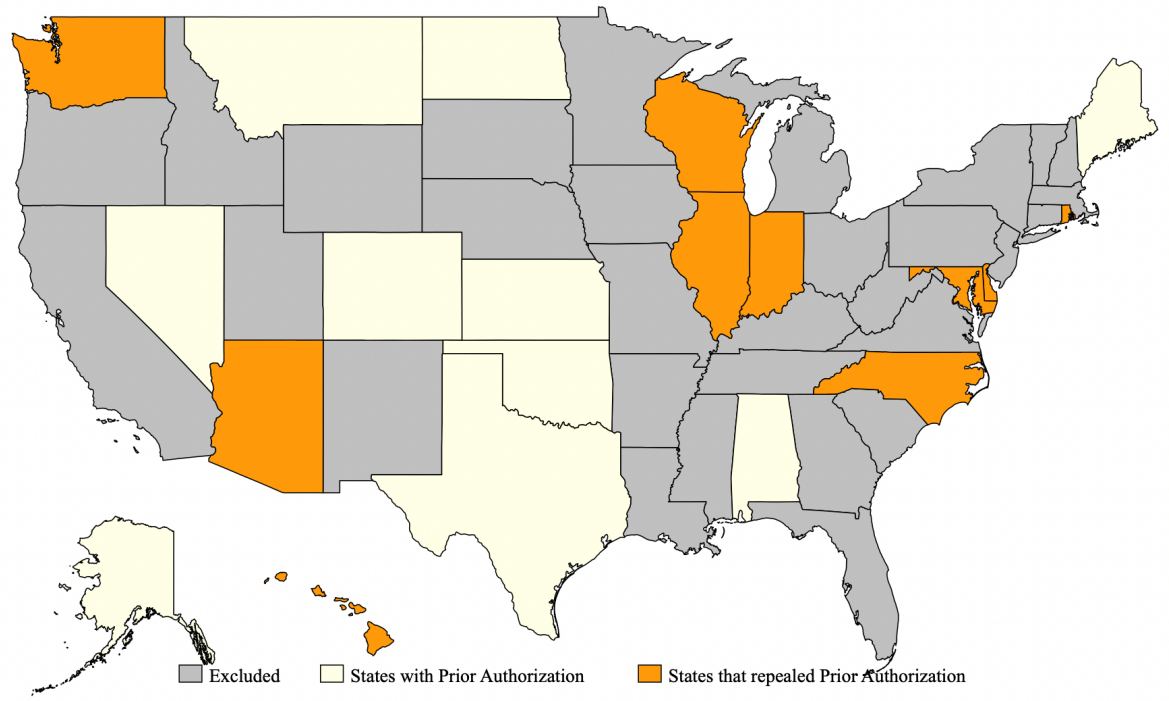

Figure 2: Unadjusted Trends in Outcomes

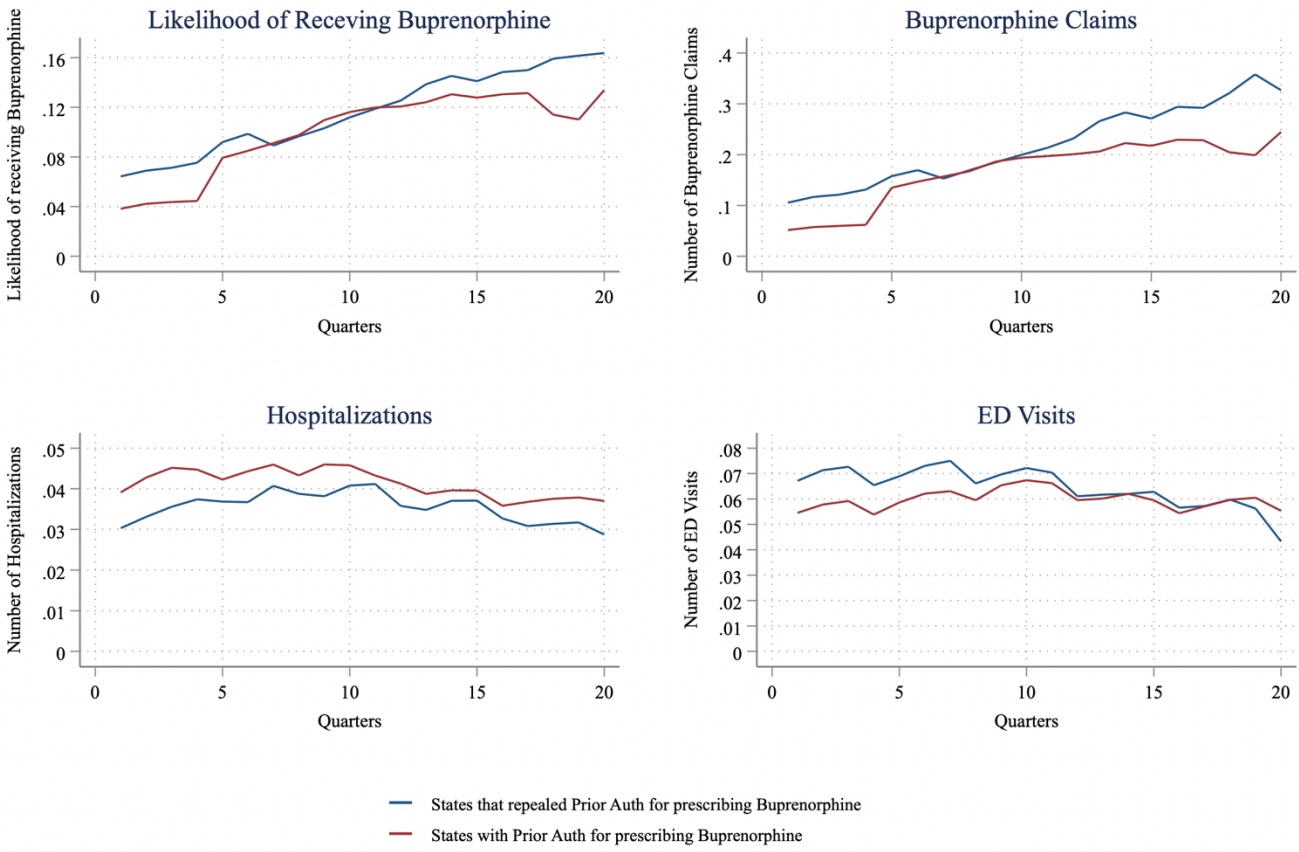

Table 2: Goodman-Bacon Decomposition of Outcomes in the two-way fixed effects estimator

	Estimate on Likelihood of Buprenorphine	Estimate on Number of Buprenorphine	Estimate on Likelihood of Hospitalizations	Estimate on Number of ED Visits	Weight
Early vs. Late	0.593	2.916	-0.051	0.014	0.198
Late vs. Early	-0.284	-0.957	0.093	-0.012	0.383
Never vs. Timing Groups	0.029	-0.089	-0.012	-0.027	0.419

Note:

(1) The Goodman-Bacon decomposition requires a balanced panel, we thus exclude observations of individuals who do not appear in the data in a given quarter during the study period.

(2) This table presents 2 × 2 difference-in-differences comparisons for three components parts based on the implementation status of repealing prior authorization for prescribing Buprenorphine. The three component parts are: earlier-treated units vs. later-treated units, later-treated units vs. earlier-treated units and never-treated group versus timing groups (earlier-treated units vs. later-treated units, later-treated units vs. earlier-treated units).

Table 3: Estimates from Difference-in Differences Models

	Two-Way Fixed Effects	**Chaisemartin and D'Haultfoeuille (2020)**
	Effect of Policy Change (95% CI)	**Effect of Policy Change (95% CI)**
Likelihood of Receiving Buprenorphine	0.017 (-0.021 to 0.055)	**0.029 (0.001 to 0.047)**
Number of Buprenorphine Claims	0.126 (-0.071 to 0.321)	**0.153 (0.042 to 0.264)**
Number of OUD-related Hospitalizations	-0.006 (-0.039 to -0.028)	**-0.025 (-0.046 to -.006)**
Number of OUD-related ED Visits	-0.015 (-0.034 to 0.004)	-0.003 (-0.015 to 0.008)
Fixed Effects		
States	Yes	Yes
Time (Quarter)	Yes	Yes
N	737,379	737,379
N-T	6,281,448	6,281,448

Figure 3: Event Study Plots from Staggered Differences in Differences Model using Chaisemartin and D'Haultfoeuille (2020)

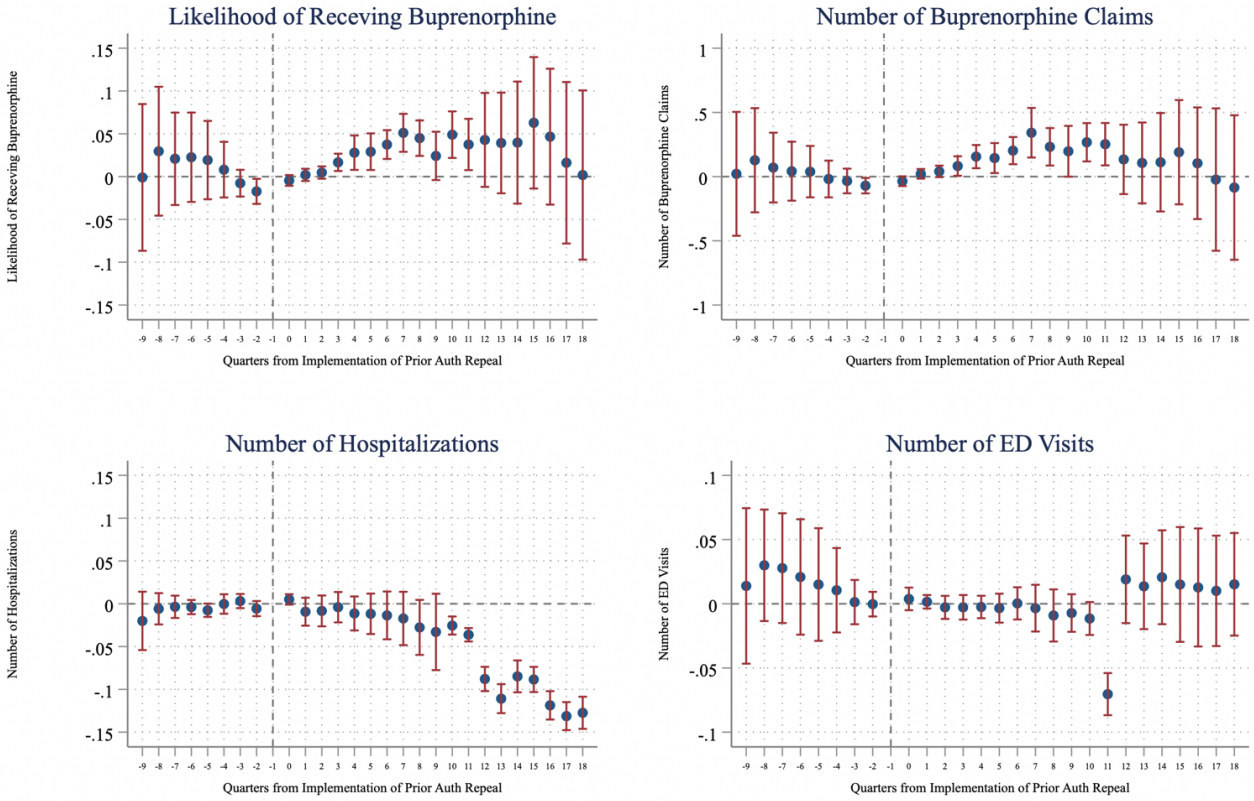

Table 4: Heterogeneous Effects of Policy using Chaisemartin and D'Haultfoeuille (2020)

	Managed Care	Fee-for-Service	States repeal PA without restrictions	States repeal PA with restrictions
Likelihood of Receiving Buprenorphine	**0.046*** **	0.015	**0.039*** **	**0.023*** **
Number of Buprenorphine Claims	**0.256** **	0.062	**0.206*** **	**0.115*** **
Number of OUD-related Hospitalizations	**-0.022*** **	**-0.027*** **	**-0.028*** **	**-0.0527** **
Number of OUD-related ED Visits	-0.004	-0.004	**-0.022** **	0.007
Fixed Effects				
States	Yes	Yes	Yes	Yes
Time (Quarter)	Yes	Yes	Yes	Yes
N	465,768	349,902	337,868	579,860
N-T	3,721,881	2,252,389	2,719,876	4,423,101

Note: P<0.01 ***; P<0.05 **; P<0.1*