

ORIGINAL RESEARCH ARTICLE | DECEMBER 12 2023

Medical Malpractice Payment Reports of Physician Assistants/Associates Related to State Practice Laws and Regulations

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ABSTRACT:

Purpose: Authorizing physician assistants/associates (PAs) to provide care to patients and removing restrictive laws and regulations without sacrificing patient safety is essential to meet the needs of patients and the US healthcare system. The aim of this observational study was to determine if states with permissive compared to restrictive PA scope of practice laws and regulations had higher instances of medical malpractice payment reports (MMPR), a proxy of patient harm.

Design: This observational study examined 10 years (2010-2019) of medical malpractice payment reports data from the National Practitioner Data Bank (NPDB) compared to the laws and regulations of states for the same period.

Results: Negative binomial regressions indicated no statistically significant differences in MMPR rates between states with permissive versus restrictive PA practice laws and regulations. Five of six practice reforms decreased or had no significant effect on PA and physician MMPR occurrences. One reform was associated with a weak but statistically significant increased risk of MMPRs for PAs and a trend toward a decreased risk for physicians.

Conclusion: This study suggests that removing restrictive laws and regulations to PA practice does not increase overall risks to patients or increase rates of malpractice within US healthcare.

"The findings of this study provide evidence that restrictive PA SOP elements can be eliminated from state laws and regulations without adversely affecting MMPRs or patient safety. Removing barriers to optimal practice environments for PAs improves access to high-quality, cost-effective care while maintaining patient safety. Less restrictive state PA laws and regulations will allow PAs to meet the medical needs of patients while increasing benefits for patients and the US healthcare system."

VIEW THE
ARTICLE



PHYSICIAN ASSISTANT (PA) CARE: TESTED, TRUSTED & ESSENTIAL TO SOUTH CAROLINA

RESEARCH ON QUALITY & SAFETY OF PA CARE

- “A large body of research, including both randomized clinical trials and retrospective studies using claims and surveys, suggests that **care provided by NPs and PAs produces health outcomes that are equivalent to physician-provided care.**” – 2019 MedPAC Report[1]
- “PAs delivered the same or better care outcomes as physicians with the **same or less cost of care.**” – Systematic review, PLOS 1[2]
- “Multiple studies comparing providers (physicians, NPs and PAs) have shown **no statistically significant difference in patient safety or quality** when performing similar services.” – Annals of Health Law[3]
- Removing barriers to **optimal practice environments for PAs improves access to high quality, cost-effective care** while maintaining patient safety. – Journal of Medical Regulation[4]

WHO PAS ARE:

PAs are nationally certified and state-licensed advanced care clinicians.

HOW PAS ARE EDUCATED:

PAs are educated in general medicine, which offers a comprehensive view of all aspects of medicine.

Admission to PA programs is highly competitive, requiring a bachelor's degree and completion of course in basic and behavioral sciences as prerequisites. PA programs are approximately three academic years and include classroom instruction and more than 2,000 hours of clinical rotations.

WHAT SOUTH CAROLINA PATIENTS SAY ABOUT PAS:

90%

agree that PAs should be utilized to address healthcare workforce shortages.

89%

of South Carolinians who have seen a PA say PAs improve health outcomes for patients.

88%

agree that PAs should be allowed to provide care to the fullest extent of their education, training, and experience.

[1] https://www.medpac.gov/wp-content/uploads/import_data/scrape_files/docs/default-source/reports/jun19_medpac_reporttocongress_sec.pdf
[2] <https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0259183>
[3] <https://lawcommons.luc.edu/annals/vol33/iss1/3/>
[4] <https://meridian.allenpress.com/jmr/article/109/4/27/498933/Medical-Malpractice-Payment-Reports-of-Physician>
[5] <https://www.aapa.org/download/124639/?tmstv=1705692388>
[6] <https://www.aapa.org/download/113513/?tmstv=1684243672>



PA Practice & Regulation

November 5, 2025

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**Vice President,
Reimbursement &
Professional Practice**
American Academy of
Physician Associates

**Doctor of Health
Science**

Concentrations:
Leadership &
Organizational Behavior;
Fundamentals of Education

Graduate Certificate
Science of Healthcare
Delivery

20+ Years
Licensed &
Certified PA

10+ Years
Regulatory and
professional advocacy

PA Overview

- ~190,000 PAs in the United States
- Practice in every setting and specialty
- Examine, diagnose, prescribe, and treat
- >500 million patient interactions a year
- Nationally certified and state licensed



To Practice as a PA

Graduate from an ARC-PA Accredited Program

- Accreditation Review Commission on Education for the Physician Assistant
- Accrediting body authorized to accredit qualified PA educational programs

Obtain NCCPA Board Certification

- National Commission on Certification of PAs
- Certifying organization authorized to certify PAs
- Administers the PA National Certifying Examination (PANCE) and PA National Recertifying Examination (PANRE)

Obtain State License

<https://www.aapa.org/download/68765/>

PA Education

Pre-PA		PA Program	Certification & Continuing Education
Bachelor's Degree		Master's Degree	NCCPA Certification Examination
		3 Academic Years	
		~ 80 Graduate-Level Academic Credits	100 CME Credits Every 2 Years
~ 2,800 Hours of Direct Patient Care	>3,000 Hours of Education		
	100 Hours Pharmacology	>1,300 Hours Medical, Clinical, Behavioral Sciences	
		~ 2,000 Hours Clinical Practice Experience	NCCPA Recertification Examination Every 10 Years

Data in the table represents national averages and individual experience may vary.

PA Certification



NCCPA-Reported PANCE Medical Content		
Medical Content Category		Percent Allocation
Cardiovascular System		11%
Dermatologic System		4%
Endocrine System		6%
Eyes, Ears, Nose, and Throat		6%
Gastrointestinal System (including nutrition)		8%
Genitourinary System (Male and Female)		4%
Hematologic System		5%
Infectious Diseases		7%
Musculoskeletal System		8%
Neurologic System		7%
Psychiatry/Behavioral Science		7%
Pulmonary System		9%
Renal System		5%
Reproductive System		7%

NCCPA-Reported PANCE Task Categories		
Task Category		Percent Allocation
Diagnosis		18%
History and Exam		16%
Clinical Intervention		16%
Pharmaceutical Therapeutics		15%
Health Maintenance/Pt Education		11%
Diagnostic Studies and Labs		10%
Applying Science		8%
Professional Practice		6%

<https://www.nccpa.net/become-certified/pance-blueprint/>

State Licensing



State PA Practice Laws

- Often written early in the profession, before the evidence for quality and safety
- Few studies assessed the impact of these provisions on patient safety
- Few studies assessed the potential harm (e.g., decreased access to care, increased costs of care, etc.)

J U N E 2 0 1 9

REPORT TO THE CONGRESS
Medicare and the
Health Care
Delivery System

MEC/PAC
Medicare
Policy
Advisory
Committee



**"A large body of research,
including both randomized clinical
trials and retrospective studies . . .
suggests that care provided by
NPs and PAs produces health
outcomes that are equivalent to
physician-provided care
. . . and find no detectable
differences in quality or health
outcomes."**

PA Practice Modernization



States should
"consider eliminating
requirements for rigid
collaborative practice
and supervision
agreements . . . that
are not justified by
legitimate health and
safety concerns."

<https://www.hhs.gov/sites/default/files/Reforming-Americas-Healthcare-System-Through-Choice-and-Competition.pdf>

Reforming America's Healthcare System Through Choice and Competition

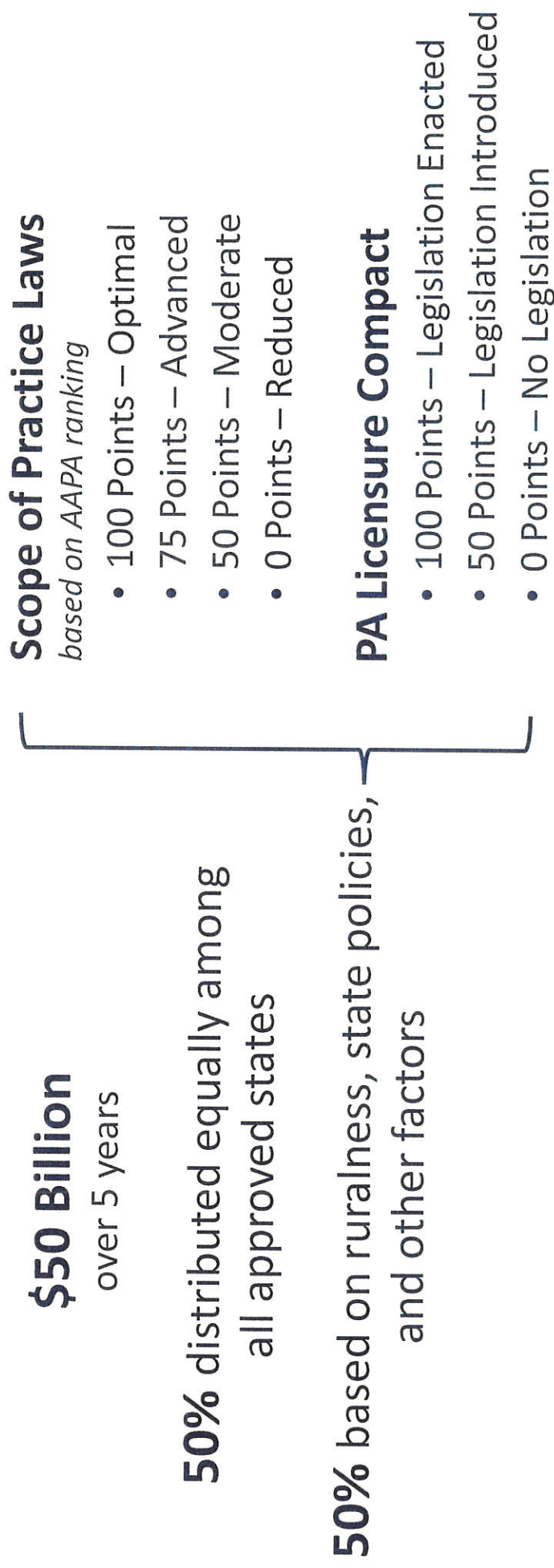


U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES

U.S. DEPARTMENT OF THE TREASURY

U.S. DEPARTMENT OF LABOR

PA Practice Modernization in RHT Program



PA Practice Modernization

WHAT IT IS

- Ensures patients have access to timely, affordable, and high-quality care
- Removes administrative burdens for PAs and physicians

WHAT IT IS NOT

It is not expansion of scope



Received: 15 September 2023 | Accepted: 9 July 2024
DOI: 10.1111/coep.12665

ORIGINAL ARTICLE

CONTEMPORARY ECONOMIC POLICY

Scope-of-practice laws and the practice patterns of nurse practitioners and physician assistants

Benjamin J. McMichael 

Analyzed hundreds of thousands of Medicare claims for services and prescriptions following practice modernization and found no significant changes in practice patterns.

<https://onlinelibrary.wiley.com/doi/abs/10.1111/coep.12665>

“PAs do not change how they care for patients following the relaxation of scope-of-practice laws, undermining patient safety arguments along these lines.”

Several Independent Research Articles found NO EVIDENCE of Patient Harm by Removing Collaboration/Supervision Requirements from State Law

1. Permissive compared to restrictive practice laws for PAs are NOT associated with increased malpractice payments.
2. Relaxing practice laws for PAs decreased “healthcare amenable deaths”
3. Removing a required relationship between a PA and a physician did not increase Board reports or adverse actions.

Original Research Article

Medical Malpractice Payment Reports of Physician Assistants/Associates Related to State Practice Laws and Regulations

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**Analyzed PA State Laws & Regulations and MMPRs
from the National Practitioner Data Bank Public Use
Data File from 2010-2019**

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Results

- **No significant difference in MMPRs for PAs ($p = 0.588$) or physicians ($p = 0.154$) between permissive versus restrictive states**
 - Permissive practice environments = 4 or more permissive SOP elements
 - Restrictive states = 3 or fewer permissive SOP elements
- **More permissive PA practice environment leads to a reduction in MMPRs for PAs and physicians.**

<https://meridian.allenpress.com/jmr/article/109/4/27/498933/Medical-Malpractice-Payment-Reports-of-Physician>

Results

State Elements and Associated Risk of MMPRs for PAs and Physicians
A highly significant decrease in MMPRs for both PAs ($p = 0.000$) and physicians ($p = 0.002$)
Allowing PAs to practice consistent with their training and experience (and not limiting PA SOP to that of collaborating physician)
A significant decrease in MMPRs for physicians ($p = 0.017$) with no effect on MMPRs for PAs ($p = 0.112$)
Allowing PAs to practice in collaboration with physicians or have no formal statutory relationship with a physician
No significant effect on MMPRs for PAs ($p > 0.05$) or physicians ($p > 0.05$)
Allowing PA SOP to be determined at the practice site
Not requiring a physician to be onsite or in proximity to a practicing PA

Conclusions

- Restrictive PA scope of practice elements can be eliminated from state laws and regulations without adversely affecting MMPRs or patient safety
- Allowing PAs and physicians to have flexible collaboration determined at the practice site may result in more meaningful collaboration, optimized practice, and efficiency of care that improves healthcare and reduces risk



Journal of Public Economics

journal homepage: www.elsevier.com/locate/jpube

Supply-side health policy: The impact of scope-of-practice laws on mortality

Analyzed PA and NP State Laws and Healthcare Amenable Deaths Between 2005 and 2019

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Results

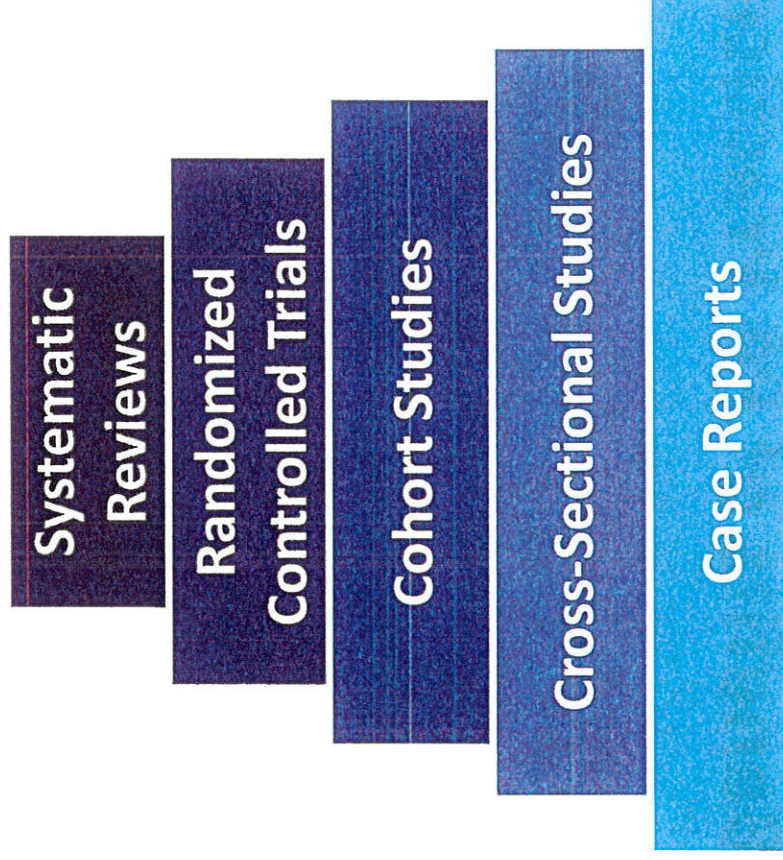
- **Statistically significant decrease** in healthcare amenable deaths with **relaxing** scope of practice laws
- Greater effects found in rural areas, suggesting improved access in these areas.

Benefits of PA Practice Modernization

- Equivalent or increased patient safety
- Increased access, especially in rural and underserved areas
- Decreased costs of care



Levels of Evidence



Higher



Quality of
Evidence

Lower



Risk of
Bias

Higher



Generaliz-
ability



Lower

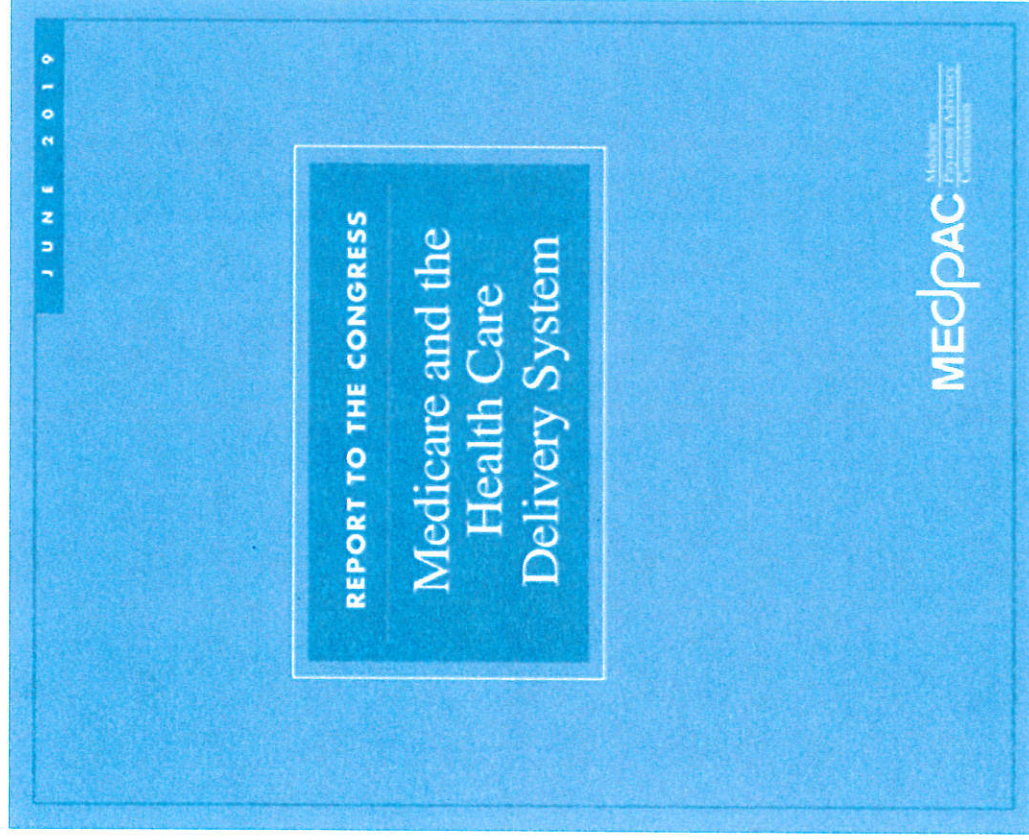


Higher



Lower

“A large body of research, including both randomized clinical trials and retrospective studies . . . suggests that care provided by NPs and PAs produces health outcomes that are equivalent to physician-provided care . . . and find no detectable differences in quality or health outcomes.”



Scope-of-practice laws and the practice patterns of nurse practitioners and physician assistants

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Abstract

I evaluate whether nurse practitioners (NPs) and physician assistants (PAs) change how they practice when states relax the scope-of-practice laws governing these professions. I find little evidence that NPs or PAs begin providing specialty services following relaxation. Some evidence suggests that NPs specialize more in rural areas following the relaxation of scope-of-practice laws, but no indication that they do so generally. Overall, the evidence developed here suggests that NPs and PAs do not change how they care for patients following the relaxation of scope-of-practice laws, undermining patient safety arguments along these lines.

KEYWORDS

healthcare workforce, nurse practitioner, physician, physician assistant, scope of practice

JEL CLASSIFICATION

I11, I18, I28

1 | INTRODUCTION

Despite meaningful progress in some areas, the United States continues to struggle with access to healthcare. Many of the policy interventions designed to address this important issue have targeted the demand-side of healthcare services markets. From Medicaid expansion under the Affordable Care Act to Medicare payment reform to modifying billing practices through the No Surprises Act, many of the most salient policy interventions have been designed to stimulate the quantity of healthcare demanded. While Congress has recently taken limited action to increase the supply of physicians in the long term (by increasing the number of residencies available), the supply-side of healthcare markets has been largely ignored on the federal level. Recognizing that stimulating demand for more healthcare does little good when individuals cannot find anyone to care for them, however, states have intervened in the supply-side of healthcare markets. One of the most important policy interventions has been the relaxation of the restrictive scope-of-practice (SOP) laws governing nurse practitioners (NPs) and physician assistants (PAs).

Against a backdrop of a worsening physician shortages—that is particularly acute in rural areas of the country and among primary care specialties like family medicine—NPs and PAs could provide a larger share of healthcare. Like physicians, NPs and PAs provide a range of healthcare services to individuals across the country. They treat a variety of conditions, prescribe medications, and order and interpret tests. Unlike physicians, however, NPs and PAs practice

Abbreviations: APRN, Advanced Practice Registered Nurse; DOJ, Department of Justice; HCPCS, Healthcare Common Procedure Coding System; HHI, Herfindahl-Hirschman Index; MedPAC, Medicare Payment Advisory Commission; NP, nurse practitioner; PA, physician assistant; RUCA, Rural–Urban Commuting Area; SOP, Scope of Practice.

under widely different legal regimes across states. Many states limit the ways in which NPs and PAs are allowed to care for patients and often require that physicians supervise their practices through restrictive SOP laws. Prior work has found that these laws can restrict access to healthcare providers and reduce the amount of care delivered by NPs and PAs (Markowitz & Adams, 2022; McMichael, 2018; Plemmons et al., 2023).

One of the key justifications for maintaining these laws is patient safety. Without physician oversight and legal limits on the care they can provide, the argument goes, NPs and PAs will endanger patient safety because they do not complete the same training as physicians and are not qualified to provide the same range of services as physicians. In other words, NPs and PAs cannot provide high-quality healthcare absent restrictive SOP laws. This argument is multifaceted, and earlier work has examined important questions around the role of SOP law changes in undermining or promoting the delivery of high-quality care (Alexander & Schnell, 2019; Hughes et al., 2015; Hughes et al., 2022; Kurtzman et al., 2017; Markowitz et al., 2017; McMichael, 2023; Traczynski & Udalova, 2018). One key formulation of the patient safety argument that has not been explored in detail is the concern that, without restrictive laws in place, NPs and PAs will shift their practices away from primary care and toward more specialized care that carries bigger risks for patients.

This paper provides new evidence on the question of whether NPs and PAs change how they practice following the expansion of the SOP laws that govern them. To do so, I develop a new, empirical measure of NP and PA practices based on the services and drugs for which they bill Medicare and the specialties of physicians that bill Medicare for the same services and drugs. By “practices” or “practice patterns,” I mean the general range of services and drugs that NPs and PAs provide and prescribe. While NPs and PAs report their specialties to a database maintained by the federal government just as do physicians, the Medicare Payment Advisory Commission (MedPAC) has found that the system for tracking NP and PA specialties is inadequate and often inaccurate (MedPAC, 2019). By using a new, purely empirical method to identify the specialties in which NPs and PAs practice, I am able to provide new and more accurate evidence on the question of whether they change their practice patterns following a change in SOP laws.

Relying on this new measure of NP and PA specialties, I find little evidence that NPs and PAs meaningfully change their practice patterns following changes in the SOP laws governing them. A series of difference-in-differences models focused on changes in NP and PA specialties yield predominantly statistically insignificant results. And among the results that are statistically significant, the magnitudes of the estimated changes in practice patterns are sufficiently small that they are not economically or clinically significant.

The absence of a change in practice patterns among NPs and PAs is relevant to the ongoing policy debate over the content of SOP laws. One of the primary justifications for relaxing SOP laws is that doing so increases the supply of NPs and PAs (particularly in underserved areas) and induces already practicing clinicians to deliver more care (Bhai & Mitchell, 2022; DePriest et al., 2020; Luo et al., 2021; Markowitz & Adams, 2022; McMichael, 2018; Plemmons et al., 2023; Shakya & Plemmons, 2020). One of the primary justifications for maintaining restrictive SOP laws is the fear that NPs and PAs cannot safely deliver care without physicians overseeing their practices (Hughes et al., 2015; Lozada et al., 2020; Mizrahi et al., 2018; Roumie et al., 2005; Sanchez et al., 2016).

Prior work has demonstrated that NPs and PAs can safely and effectively deliver care within their education and training (Kurtzman et al., 2017; Muench et al., 2021; O'Reilly-Jacob et al., 2019; Perloff et al., 2019; Smith, 2022). Thus, if NPs and PAs are going to harm patients when they lack physician supervision, it would most likely occur when NPs and PAs deliver care beyond their education and training. The evidence developed in this paper suggests that this mechanism of potential harm does not materialize. Because NPs and PAs do not shift their practices to more specialized or complex care following a change in SOP laws, there is little concern that they will harm patients for whom they are not qualified to care. Placing this result in the context of the existing literature therefore implies that NPs and PAs can expand access to safe and effective care without risk that the lack of physician supervision will lead to patient harm. Before delving into the details of the data, specialty measure, and empirical models, the next section provides details on NPs, PAs, and the SOP laws that govern them.

2 | BACKGROUND, LEGAL CONTEXT, AND PRIOR WORK

Both the NP and PA professions provide care alongside the medical profession and have done so for over 50 years. Though their backgrounds are different and they complete different educational paths, both NPs and PAs function similarly to physicians. NPs and PAs provide a wide array of healthcare services in many different settings. They examine patients, order and interpret various tests, perform treatment, prescribe medications, and refer patients for

specialty care. To become an NP, most individuals first complete training as a registered nurse and work for several years in various nursing capacities before returning to complete either a masters or doctoral degree in nursing (Adams & Markowitz, 2018; Buerhaus, 2018). Physician assistants, on the other hand, come from more varied healthcare backgrounds, including emergency medical services, athletic training, nursing, and others. Aspiring PAs complete training programs of between 18 months and 3 years before receiving a masters degree. Both NPs and PAs must complete national examinations before being licensed to practice by individual states.¹

Because both the NP and PA professions emerged in the mid-twentieth century, they long post-dated state medical practice acts that were designed to severely restrict the provision of healthcare services (Gevitz, 2019; Mohr, 2013; Starr, 2017). These laws were originally intended to protect the economic interests of those physicians the American Medical Association deemed acceptable and drive other physicians out of practice. Indeed, at the time that NPs and PAs began providing care in the 1960s and 1970s, some states still prohibited osteopathic physicians from caring for patients within their borders, and the American Medical Association was still engaged in an antitrust violation that prohibited physicians from working with some non-allopathic-physician healthcare practitioners (Gevitz, 2019; Mohr, 2013; Starr, 2017).² With these types of laws and institutions in place, NPs and PAs began their existence providing only limited healthcare services and practicing only under physician supervision. The first state SOP laws incorporated these restrictions into the laws that carved exceptions out of state medical practice acts to allow NPs and PAs to provide care.

In the latter part of the twentieth century, some states began relaxing their SOP laws to grant NPs and PAs more authority to provide care and to untether them from physicians. Currently, some states grant NPs and PAs substantially more authority than other states. While researchers and policymakers often refer to SOP laws as single laws, they are actually collections of statutes, regulations, regulatory interpretations, and court decisions that collectively govern both general and nuanced aspects of NP and PA practice. To categorize this large collection of laws, I rely on McMichael and Markowitz (2020) for a classification of NP laws. Using primary legal sources and reviewing state laws since 1998, they created a consistent coding of NP SOP laws based on whether states have granted NPs full practice authority. This categorization isolates the two most important factors in NP SOP laws: whether physicians must oversee NPs when the latter provide care and whether NPs are authorized to prescribe essentially the same medications as physicians in the same state.³

If a state neither requires physician oversight of NP practices (whether this oversight is titled ‘collaboration’ or ‘supervision’) and grants NPs essentially the same prescriptive authority as physicians, then McMichael and Markowitz (2020) categorize that state as granting NPs full practice authority. If either of these two criteria are not satisfied, then a given state is categorized as restricting the practices of NPs. While this classification scheme collapses a body of SOP laws into a binary outcome, it offers benefits that outweigh the losses from using such a system. First, the policy debate over SOP laws—and consequently policymakers’ attention—has focused on full practice authority. By analyzing this outcome, this paper can provide evidence directly relevant to the policy debate. Additionally, because this coding system involves two, clear criteria which must be met, it provides policymakers directions on which laws matter, as opposed to classification schemes that attempt to code many different nuanced laws with multiple variables. Finally, because much of the existing literature focuses on full practice authority, using the coding system of McMichael and Markowitz (2020) allows for the comparison of the results developed here with the many other studies examining full practice authority (McMichael & Markowitz, 2020).

Classifying the SOP laws governing PAs is somewhat more difficult. Unlike NPs, who have enjoyed the ability to practice independently from physicians in many states for many years, states have only recently begun to untether PAs from physicians in the same way. In fact, only three states have done so, and these have only occurred in the last few years. Known as “optimal team practice” among advocates, this is the next big step in relaxing PA SOP laws. Because of the paucity of states that have passed these laws, the recency of these laws, and the fact that many states regulate PAs very differently without granting them full independence from physicians, I do not examine “optimal team practice” here.

Instead, I rely on the categorization scheme for PA laws developed by McMichael (2023). This scheme largely parallels that for NPs described above, but replaces the ability to practice without any form of physician oversight for NPs with the ability to practice at a remote site with onsite visits by supervising physicians required no more than monthly. Thus, states grant PAs “remote practice authority” when PAs can practice at a remote site with visits by supervising physicians required no more than monthly and PAs can prescribe essentially the same range of medications as physicians in the state. If state SOP laws fail either of these criteria, then the relevant state is classified as restricting the practices of PAs (McMichael, 2023).

Because of the importance of NPs and PAs to the healthcare system and, in turn, the importance of SOP laws to the care they deliver, a robust academic literature spanning multiple disciplines has emerged examining these professions and their SOP laws. In general, that literature can be divided into three groups: (1) studies examining NPs and PAs and the care they deliver regardless of the SOP laws in place, (2) studies examining the impact of NP and PA SOP laws on various health and healthcare outcomes without the ability to trace those outcomes to individual NPs and PAs, and (3) studies that examine the impact of SOP laws on health and healthcare outcomes associated with individual NPs and PAs.

The first group of studies contains a large body of work conducted by clinicians, economists, and health services researchers interested in how NPs and PAs care for patients. For example, Buerhaus et al. (2018) analyzed how NPs delivered care using 16 different quality measures and concluded that NPs and physicians were largely indistinguishable on these measures. Kurtzman and Barnow (2017) found similar results in a study of multiple quality indicators. Focused on diabetes patients, Yang et al. (2018) found that NPs delivered comparable care to physicians. Other work has found that, in achieving these comparable outcomes, NPs tend to use similar or fewer resources than physicians (Morgan et al., 2019; O'Reilly-Jacob et al., 2019; Razavi et al., 2021). Relatedly, Muench et al. (2021) found that NPs prescribe fewer opioids to Medicare patients. A review of several studies reached similar conclusions with respect to PAs (Van Den Brink et al., 2021).

While these studies generally suggest that NPs and PAs provide care comparable to that provided by physicians, other studies have reached different conclusions. For example, prior work has found that NPs and PAs may overuse medical resources (such as medical imaging) or overprescribe opioids and antibiotics (Hughes et al., 2015; Lozada et al., 2020; Mizrahi et al., 2018; Roumie et al., 2005; Sanchez et al., 2016). Other work has found some evidence that NPs use more resources and meet quality metrics at lower rates than physicians (Chan & Chen, 2022; Iannuzzi et al., 2015; Kuo et al., 2015). The weight of the evidence, however, suggests that NPs meet quality metrics and use medical resources similar to physicians.

The second group of studies includes work examining the impact of NP and PA SOP laws on various outcomes. One key set of studies has examined the role of SOP laws in the supply of healthcare providers. In general, relaxing NP and PA SOP laws increases the number of these professionals, with medically underserved areas tending to see larger increases (Bhai & Mitchell, 2022; DePriest et al., 2020; McMichael, 2018; Plemmons et al., 2023; Shakya & Plemmons, 2020).

Another key set of studies focused on the care delivered by currently practicing professionals generally finds that, following a relaxation of SOP laws, NPs and PAs increase the amount of care they deliver (Dillender et al., 2022; Luo et al., 2021; Markowitz & Adams, 2022; Park et al., 2020; Stange, 2014). This increase in both the supply of healthcare professionals and the amount of care they deliver seems to benefit patients, as other work has found that patients have better access to a regular source of care and use acute care (such as emergency departments) less frequently when SOP laws are relaxed (McMichael et al., 2019; Traczynski & Udalova, 2018). Patients also benefit in terms of improved outcomes. Traczynski and Udalova (2018) found that patient outcomes improved following a relaxation of SOP laws, and McMichael (2023) found that the rate of healthcare amenable deaths declined following the grant of more authority and autonomy to NPs and PAs. RoyChoudhury and Petrova (2023) similarly found declines in mortality due to heart disease and diabetes when NPs gained greater autonomy.⁴

The third group of studies includes those most specifically focused on the impact of SOP laws on NPs and PAs. These studies include detailed data on both changes in SOP laws and care delivered by individual NPs and PAs. In one early example, Kurtzman et al. (2017) found no statistically significant differences in quality of care across states with different SOP laws governing NPs, though they did find evidence that NPs provided more services when they could practice with greater autonomy. Perloff et al. (2019) similarly found that restrictive SOP laws failed to improve the quality of care delivered to patients. Muench et al. (2021) concluded that relaxing SOP laws improves medication adherence among Medicare patients, and Alexander and Schnell (2019) found that individuals reported fewer days of poor mental health and a reduction of mental-health-related deaths following the relaxation of NP SOP laws. Smith (2022) completed one of the most comprehensive studies of NP SOP laws not limited to Medicare or Veterans Affairs patients. Analyzing detailed data, she found no evidence that granting NPs broader legal authority leads to the provision of more low-value services. And earlier work suggested that broadening NP authority reduces the price of common medical services (Kleiner et al., 2016).

Within the larger context of studies focused on individual providers and the laws governing them, several studies have investigated the role of SOP laws in opioid prescribing. This stems from the fact that physician advocacy groups raised concerns that unsupervised NPs and PAs would inappropriately prescribe opioids, which is a version of the more

general argument examined here that unsupervised NPs and PAs will exceed the limits of their training without restrictive SOP laws. Chan and Chen (2022) concluded that NPs generally prescribe fewer opioids than physicians. McMichael (2020) found evidence that overall opioid prescriptions decline by between 2% and 6% following a grant of full practice authority to NPs, with NPs increasing their opioid prescriptions and physicians decreasing theirs (by a larger amount). McMichael (2021b) examined prescribing patterns across different payers and found similar evidence, and the results of McMichael (2021a) corroborated these findings with evidence that opioid-related deaths decline following a grant of full practice authority.

On the other hand, Grecu and Spector (2019) conclude that these reductions in mortality only occur when mandatory prescription drug monitoring programs are in place. Relatedly, Alexander and Schnell (2019) and Currie et al. (2023) do not find the same evidence of a reduction in opioid prescriptions following a change in NP SOP laws.⁵ To extend the analysis of the arguments physician advocacy groups have made in the context of opioid prescribing to the more general context of overall practice patterns, this paper examines the role of SOP laws in how NPs and PAs deliver care.

3 | DATA

The data I examine here come from publicly available files containing information on the services and drugs delivered by healthcare providers to Medicare fee-for-service beneficiaries.⁶ Specifically, I rely on the Medicare Physician & Other Practitioners - by Provider and Service datasets for information on services. For drugs, I rely on the Medicare Part D Prescribers - by Provider and Drug datasets. For all individual providers billing Medicare, the datasets contain detailed information on the number of services provided and drugs prescribed, the number of times each service or drug was provided or prescribed, and information on the individual provider.⁷ First, the files include all services billed by each provider organized by Healthcare Common Procedure Coding System (HCPCS) codes and year. Healthcare Common Procedure Coding System codes are five digit codes that identify individual healthcare services for which providers can receive reimbursement.⁸ For example, the code 99213 represents an office visit by an established patient lasting between 20 and 29 min, and the code 33945 represents a heart transplant. These codes capture important nuances between a wide array of different healthcare procedures and are the common language of health insurers, which use these codes to both reimburse providers and track their practice patterns over time.

Next, the Medicare data include all drugs prescribed by individual providers organized by the brand and generic names of the drugs.⁹ The data do not include the most granular coding system for drugs—national drug codes—but the generic names for the drugs allow for detailed insight into the medications that individual providers prescribe.

Finally, the data include provider identifiers. In addition to the names, addresses, and credentials of individual providers,¹⁰ the data include national provider identifiers (NPIs), which are ten-digit codes assigned to providers when they begin practicing and stay with them throughout their careers. With these individual identifiers, it is possible to track identifiable providers over time. Importantly, the inclusion of NPIs in the data allow me to link the Medicare data to even more granular information on individual providers included in the National Plan and Provider Enumeration System (NPPES) database. Before they may be reimbursed by Medicare or other payers, providers must join this system to be assigned an NPI by the NPPES. As part of this process, providers must identify their type (e.g., physician, NP, dentist, podiatrist), their specialty (e.g., family medicine, psychiatry, internal medicine), and their sub-specialty (e.g., hepatology, nephrology, child and adolescent psychiatry).

Relevant to this study, the specialties identified by physicians are generally accurate and represent the areas in which those physicians actually practice. The same is not true for NPs and PAs, as determined by MedPAC (MedPAC, 2019). While the NPPES database accurately identifies an individual as an NP or PA (as opposed to another type of provider), the database lacks granular specialty categories for NPs and PAs. For example, many NPs trained as “family” NPs actually practice in more specialized areas based on later training and experience. An NP originally trained as a family NP may complete additional training to practice in more specialized areas or work with specialist physicians in areas other than family medicine (e.g., neurology). While these NPs may have a family practice credential, it is not accurate to say that they practice family medicine in the sense that a typical family physician or family NP does. To answer the question of whether NPs and PAs change their practice patterns following the relaxation of SOP laws, I first address the threshold issue of identifying the areas in which they actually practice—simply examining their stated specialty will not necessarily yield an accurate answer.

To address this important problem, I develop a new empirical approach to classifying NPs and PAs that relies only on the accuracy of *physician* specialties. For now, consider only those drugs prescribed by physicians in a particular year. Let $s = 1, \dots, S$ index physician specialties as provided by the NPPES database, and let $g = 1, \dots, G$ index drugs as identified by their generic names. Next, let d_{gs} represent the total number of times physicians in specialty s prescribed drug g in a particular year. With this notation, it is possible to write each drug g as a $1 \times S$ vector of the proportion of prescriptions attributable to each specialty and obtain a specialty profile for each drug:

$$Profile_g = \left(\frac{d_{g1}}{\sum_{s=1}^S d_{gs}}, \dots, \frac{d_{gS}}{\sum_{s=1}^S d_{gs}} \right) \quad (1)$$

Treating this as one of G rows and stacking all drugs profiles together yields a $G \times S$ matrix of all available drugs and specialties. To take a simple example, consider a single drug and assume that only three physician specialties exist. Suppose the above expression could be written as $Profile_g = (0.2, 0.3, 0.5)$. This would imply that of all the times this drug is prescribed, specialty 1 prescribed it 20% of the time, specialty 2 prescribed it 30% of the time, and specialty 3 prescribed it 50% of the time. Another way to view this is, conditional on seeing this drug prescribed, there is a 20%, 30%, and 50% chance it was prescribed by specialty 1, specialty 2, and specialty 3, respectively. In other words, the above expression quantifies each drug based on the percentage of time it is prescribed by each different physician specialty in the Medicare dataset.

Next, it is possible to match each drug's physician specialty profile with the drugs prescribed individual NPs and PAs.¹¹ Let $i = 1, \dots, I$ index NPs, and let r_{ig} represent the total number of times NP i prescribed drug with generic name g in a given year. An individual NP's practice in terms of drugs prescribed can be written as (omitting the individual NP identifier for readability):

$$NP_i^{drugs} = \left(\frac{r_1}{\sum_{g=1}^G r_g}, \dots, \frac{r_G}{\sum_{g=1}^G r_g} \right). \quad (2)$$

In this vector, each element is the proportion of an NP's total prescriptions made up of a given drug. With some straightforward linear algebra (and a small abuse of notation), it is possible to combine the previous two expressions to derive a $1 \times S$ vector that represents an NP's practice in terms of drugs prescribed and physician specialties:

$$\begin{aligned} NP_i^{specialty} &= \left(\frac{r_1}{\sum_{g=1}^G r_g}, \dots, \frac{r_G}{\sum_{g=1}^G r_g} \right) \begin{pmatrix} \frac{d_{11}}{\sum_{s=1}^S d_{1s}} & \dots & \frac{d_{1S}}{\sum_{s=1}^S d_{1s}} \\ \vdots & \ddots & \vdots \\ \frac{d_{G1}}{\sum_{s=1}^S d_{Gs}} & \dots & \frac{d_{GS}}{\sum_{s=1}^S d_{Gs}} \end{pmatrix} \\ &= \left(\frac{r_1}{\sum_{g=1}^G r_g} \frac{d_{11}}{\sum_{s=1}^S d_{1s}} + \dots + \frac{r_G}{\sum_{g=1}^G r_g} \frac{d_{G1}}{\sum_{s=1}^S d_{Gs}}, \dots, \right. \\ &\quad \left. \frac{r_1}{\sum_{g=1}^G r_g} \frac{d_{1S}}{\sum_{s=1}^S d_{1s}} + \dots + \frac{r_G}{\sum_{g=1}^G r_g} \frac{d_{GS}}{\sum_{s=1}^S d_{Gs}} \right) \\ &= (Share_{specialty\ 1}, \dots, Share_{specialty\ S}). \end{aligned} \quad (3)$$

Each element of this vector represents the proportion of an NP's practice attributable to each physician specialty. Essentially, the process described here attaches a profile of physician specialties to each drug an NP prescribes and then calculates a weighted sum (weighted by the number of times an NP prescribes each drug) over all those drug profiles to create a physician specialty profile for each NP in a given year. The same process can be applied to PAs (or any other healthcare profession).

As a simple example, consider a world with three drugs and three physician specialties. Suppose the drug profiles (in terms of physician specialties 1–3) for each of the drugs are: $Profile_1 = (0.2, 0.3, 0.5)$, $Profile_2 = (0.8, 0.1, 0.1)$, $Profile_3 = (0.3, 0.4, 0.3)$. Now take an NP who prescribed the first drug 700 times, the second drug 500 times, and the third drug 800 times. Translating that into the NP drug profile given above yields $NP_1 = (0.35, 0.25, 0.4)$. With this information, the NP's physician specialty profile is:

$$NP_1 = (0.35, 0.25, 0.4) \begin{pmatrix} 0.2 & 0.3 & 0.5 \\ 0.8 & 0.1 & 0.1 \\ 0.3 & 0.4 & 0.3 \end{pmatrix} \quad (4)$$

$$= (0.39, 0.29, 0.32)$$

This implies that this particular NP's practice is comprised of 39% physician specialty 1, 29% physician specialty 2, and 32% physician specialty 3.

A primary advantage of the general process outlined above is that it can be repeated for any series of codes attributable to both physicians and NPs (and PAs). For example, repeating the above process but replacing drugs with HCPCS codes yields a similar physician specialty profile for every NP and PA. I derive a separate series of physician specialty profiles for all NPs and PAs for both drugs and services (HCPCS) in my dataset.¹² Another important advantage of the process outlined above is that it is purely empirical in the sense that no researcher needs to inject external judgment as to which drugs or HCPCS codes are associated with a given physician specialty or a particular type of NP or PA. While prior work has created other processes to identify primary care NPs (O'Reilly-Jacob et al., 2023), they generally require that researchers make specific judgments as to which codes should be associated with which specialties. For researchers who lack clinical experience or who do not have sufficiently granular data to make assumptions about specific instances of care, the purely empirical process of generating physician specialty profiles described here can provide insight into the practice patterns of NPs and PAs.¹³

It is important to note that each of the specialty measures is defined separately for each year in the dataset. Accordingly, specialties can be comprised of different weights on different drugs and HCPCS codes in different years. I define specialties in this way to account for the fact that physicians will organically change their practice patterns over time as new drugs and treatment regimes become available. Because of this year-by-year definition, the results derived from these measures should be interpreted as the practice patterns of NPs and PAs relative to physicians in the same year and not as their practice patterns against a static baseline. This definition provides better insight into what NPs and PAs are actually doing each year in terms of their physician colleagues as opposed to what they are doing relative to a static (and potentially arbitrary) baseline.

To examine the role of SOP laws in changing NP and PA practice patterns, I take three separate approaches at different levels of granularity. At the most granular level, I consider each element of NPs' and PAs' specialty profiles individually. Doing so provides insight into whether they shift between individual specialties following the relaxation of SOP laws.¹⁴ While this specialty-by-specialty analysis can provide evidence of individual shifts, it may not shed light on the general practice patterns of NPs and PAs. To gain insight into these more general practice patterns, I collapse the specialty profiles into four categories: primary care, specialty care, emergency care, and surgery. Primary care includes the following physician specialties: family medicine, general practice, internal medicine, psychiatry, and preventative medicine. Specialty care includes the following physician specialties: allergy and immunology, dermatology, pain medicine, pathology, radiology, urology, electrodiagnostic medicine, medical genetics, neuromuscular medicine (all types), and physical and rehabilitative medicine. Emergency care includes only emergency medicine. Surgery includes the following physician specialties: colon and rectal surgery, neurological surgery, ophthalmology, orthopedic surgery, otolaryngology, plastic surgery, general surgery, thoracic and cardiac surgery, and transplant surgery. Collectively, these four categories of specialties provide more general information than the individual specialties do.

Finally, while examining all physician specialties and the four categories above provide useful information on the practice patterns of NPs and PAs, it does not necessarily capture the degree to which one specialty (or a few specialties) dominates the practice of an individual NP or PA. To capture this aspect of their practice, I apply the Herfindahl-Hirschman Index (HHI) to the specialty shares that comprise an NP's or PA's practice. In general, the HHI is designed to capture the concentration of a market, and applying it to an individual provider can measure the degree to which their practice is concentrated in a few specialties. Obviously, an individual NP or PA is not a market, and specialty proportions are not market shares. However, the HHI fundamentally measures how dominant one component of a larger whole is. In particular, I define the HHI of an individual NP (PA) as: $NP_i^{HHI} = spec_1^2 + \dots + spec_S^2$, where $spec_s = \frac{r_j}{\sum_{g=1}^G r_g} \frac{d_{js}}{\sum_{s=1}^S d_{js}} + \dots + \frac{r_G}{\sum_{g=1}^G r_g} \frac{d_{Gs}}{\sum_{s=1}^S d_{Gs}}$, as described above. Before calculating the HHI, I multiply each specialty proportion by 100 so they are represented as percentages. Thus, the HHI varies from 0 to 10,000 with higher numbers indicating higher concentrations (i.e., practices focused more heavily on one or a few specialties).

Using the HHI allows me to address the potential concern that NPs and PAs begin practicing in widely different specialties following a grant of more autonomy and authority. Along the lines of the argument that NPs and PAs cannot safely provide care absent restrictive SOP laws, the concern here is that NPs and PAs may decide to practice in specialties for which they have not completed significant training. While the HHI does not identify the particular specialty as the previously described metrics do, it measures the spread across those specialties. To return to the simple example provided above, suppose an NP's specialty profile is (0.39, 0.29, 0.32). This NP's HHI is 3386. If the NP shifts completely away from specialty 2 by replacing it with specialty 1, the specialty profile becomes (0.68, 0, 0.32), and the HHI becomes 5648. Analysis of the specialty profile itself will identify the greater specialization within specialty 1, but it will not capture the degree to which the NP practices within other specialties. The HHI, however, will capture this spread across specialties. Accordingly, I examine it to provide evidence on the degree to which one or a few specialties dominate the practices of NPs and PAs.

Prior work has similarly used the HHI to measure the concentration of particular aspects of provider practices. For example, Ryskina et al. (2021) used the HHI when analyzing the degree to which provider practices focused on nursing home patients. As they note, the HHI has been used in various "settings to measure concentration of events or objects in an environment" which is exactly how I use it in my analysis (Ryskina et al., 2021). Because my goal is to measure how focused an NP or PA is in their practice, the HHI is an ideally suited metric. While the HHI is well-suited to my empirical context and question, interpreting it in this context is not necessarily intuitive. The United States Department of Justice (DOJ) has developed guidelines around the HHI in the context of mergers and acquisitions (DOJ, 2024). When the HHI is used to measure market concentration, the DOJ considers markets with an HHI of between 1000 and 1800 to be moderately concentrated. Markets with an HHI of over 1800 are highly concentrated. In these highly concentrated markets, the DOJ considers an increase in the HHI of more than 100 points to presumptively enhance market power. Though individual providers are not markets, these guidelines can prove helpful in interpreting the results below.

Table 1 reports a series of summary statistics for NP and PA specialty practice patterns. Each panel of Table 1 reports the average specialty HHI across the relevant SOP laws as well as the average percentage of NP and PA practices consistent with the four categories of physician specialties defined above: primary care, specialty care, emergency care, and surgery. Full summary statistics for all physician specialties are available in the Appendix. In general, there is some variation in specialty HHIs for NPs and PAs across different SOP-law regimes. In Panel A, for example, the specialty HHI of NPs is about 100 points lower in states with full practice authority relative to those without it. This suggests that the practices of NPs in full-practice-authority states are less dominated by individual physician specialties. The same is true for PAs in Panel B, and this pattern repeats for both NPs and PAs when drugs instead of services are used to estimate physician specialties in Panels C and D. Evaluating these HHI differences using the DOJ's methodology, the average NP and PA is highly concentrated in terms of which physician specialties dominate their practices, and the differences in HHI across legal regimes are close to the cutoff of what the DOJ considers meaningful.

Focusing on the four physician specialty categories, the statistics in Table 1 do not suggest that NPs and PAs practice drastically differently based on the SOP laws in place. To the extent there are any obvious differences in practice patterns, NPs and PAs generally practice more primary care when their SOP laws are relaxed.¹⁵ Overall, however, NPs and PAs do not appear to practice very differently in states with and without restrictive SOP laws based on the raw summary statistics. The next section details an empirical strategy to examine the question of practice changes in more depth.

TABLE 1 Summary statistics.

		Full practice authority				
		No		Yes		Total
Panel A: Nurse practitioner specialty measures based on services						
HHI	3635.88	(1648.17)	3527.75	(1548.81)	3602.33	(1618.76)
Primary care	70.01	(22.21)	71.41	(20.50)	70.45	(21.71)
Specialty care	10.56	(10.48)	10.84	(10.50)	10.65	(10.48)
Emergency care	6.59	(19.40)	4.61	(15.25)	5.98	(18.24)
Surgery	9.01	(10.26)	9.22	(9.83)	9.07	(10.13)
		Remote practice authority				
		No		Yes		Total
Panel B: Physician assistant specialty measures based on services						
HHI	4149.33	(2248.72)	3986.84	(2171.69)	4073.96	(2214.80)
Primary care	50.53	(29.87)	52.70	(28.83)	51.54	(29.41)
Specialty care	13.38	(17.05)	13.12	(15.61)	13.26	(16.40)
Emergency care	15.13	(30.81)	14.38	(29.90)	14.78	(30.39)
Surgery	17.89	(24.54)	16.72	(22.34)	17.35	(23.55)
		Full practice authority				
		No		Yes		Total
Panel C: Nurse practitioner specialty measures based on drugs						
HHI	3807.10	(940.39)	3773.69	(959.12)	3796.47	(946.52)
Primary care	88.41	(11.56)	88.63	(12.08)	88.48	(11.73)
Specialty care	4.40	(6.50)	4.41	(6.88)	4.40	(6.64)
Emergency care	2.05	(1.74)	1.85	(1.70)	1.98	(1.73)
Surgery	2.61	(3.53)	2.33	(3.53)	2.52	(3.53)
		Remote practice authority				
		No		Yes		Total
Panel D: Physician assistant specialty measures based on drugs						
HHI	3473.14	(966.10)	3386.81	(999.84)	3434.27	(982.38)
Primary care	82.39	(14.05)	81.39	(14.08)	81.94	(14.07)
Specialty care	7.93	(10.37)	7.90	(9.54)	7.92	(9.99)
Emergency care	2.86	(2.45)	2.91	(2.43)	2.88	(2.44)
Surgery	4.28	(4.80)	4.54	(4.82)	4.40	(4.81)

Note: Each cell reports the mean of the variable listed to the left (with standard deviations in parentheses) for the legal regime listed at the top of each column. Panels A and C include only NPs, and Panels B and D include only PAs.

4 | EMPIRICAL STRATEGY

Using the specific measures of NP and PA specialty practices described above and focusing on Medicare fee-for-service patients, I estimate the changes in NP and PA practice patterns induced by changes in SOP laws. More specifically, I estimate a series of two-way-fixed-effects regression models to isolate the impact of SOP laws changes on NP and PA practice patterns using the following general specification:

$$\begin{aligned} \text{Specialty Measure}_{ist} = & \beta_1(\text{Full Practice Authority})_{st} \\ & + \beta_2(\text{Remote Practice Authority})_{st} + \sigma_s + \rho_i + \tau_t + \varepsilon_{ist}. \end{aligned} \quad (5)$$

In this model, i indexes individual providers, s indexes states, and t indexes time measured in years. The dependent variable, *Specialty Measure* is either the proportion of an individual NP's (PA's) practice made up by a particular physician specialty, the proportion made up by a particular physician specialty category, or the HHI for an individual NP (PA). The independent variables *Full Practice Authority* and *Remote Practice Authority* are indicator variables that take the value one when and NP or PA practices in a state with the relevant SOP law in place.

The vectors σ_s , ρ_i , and τ_t include a full set of state, individual provider, and year fixed effects, respectively. Provider fixed effects control for observed and unobserved characteristics of providers and their patient mix. State fixed effects control for time invariant characteristics of individual states, such as their legal systems beyond SOP laws. I include state fixed effects in addition to provider fixed effects because some providers change states during the study period. Year fixed effects control for any linear or nonlinear trends in practice patterns over time. The provider fixed effects absorb much of the heterogeneity present in practice patterns and allow the models to isolate the role of SOP laws from any idiosyncratic factors present at the provider level. The inclusion of these fixed effects obviates the need for many control variables, as provider fixed effects better control for confounding factors than traditional state- or county-level variables. Throughout the analysis, standard errors are clustered at state level to address potential intra-cluster correlation associated with SOP Laws.

When examining changes in NP practice patterns, I limit the models to only NPs. When examining PA practice patterns, I limit the models to only PAs. However, all models include indicators for both NP and PA SOP laws. In theory, the laws governing one type of provider may indirectly impact the other type as the affected provider type changes its practice patterns. In general, states do not contemporaneously change the SOP laws governing NPs and PAs. As prior work has found, political spending and maneuvering drives changes in SOP laws—not concerns for patient welfare or safety (McMichael, 2017; Traczynski & Udalova, 2018). Because of this, SOP laws for different professions change at different times, meaning that one group of laws is not generally picking up the effects of the other group of laws (McMichael, 2023). I do not separately estimate models limited to only physicians. Because the specialty profiles are defined based on physicians themselves, these results will likely suffer from an endogeneity problem.

In addition to limiting models to different types of providers, I separately estimate models for all providers and models that include only providers practicing in rural areas. Prior work has found consistent evidence that NPs and PAs play relatively larger roles in rural areas, so I examine those areas separately. To define “rural,” I rely on the rural-urban commuting area (RUCA) codes included in the Medicare services dataset. Any provider designated as practicing in area with a RUCA code of 5 or higher is classified as practicing in a rural area.¹⁶ While identifying rural providers is straightforward for the services dataset, the drugs dataset does not include such granular location information. I match the services dataset to the drugs data to identify rural providers in the latter dataset. However, not all providers appear in both datasets, so the drugs dataset rural subsample is not a complete subsample.

Recent research into two-way-fixed-effects models has found that they may yield biased estimates when the treatment is implemented at different points in time for different treated units (Borusyak et al., 2024; Callaway & Sant’Anna, 2021; Goodman-Bacon, 2021). And all two-way-fixed-effects models rely on a parallel trends assumption. To address these issues, I perform a series of Goodman-Bacon decompositions and estimate a series of event-study models. Both are discussed in more detail in the Robustness section following the Results section.

5 | RESULTS

Because the HHI measures of practice patterns are the most general, I begin with those. Table 2 reports the results from a eight separate two-way-fixed-effects models with HHI as the dependent variable. Focusing first on Panel A, columns (1) and (2) report results limited to NPs, and columns (3) and (4) report results limited to PAs. Across all NPs, a grant of full practice authority does little to impact the HHI of NPs. The point estimate of less than 1 is more than two orders of magnitude below what the DOJ considers meaningful in analyzing markets, and it

TABLE 2 Results for the relationship between scope of practice laws and practice categories.

	(1) NPs	(2) NPs (rural)	(3) PAs	(4) PAs (rural)
Panel A: HHI based on services				
Full practice authority	0.128 (12.607)	84.799* (41.331)	-14.140 (17.132)	122.008 (72.576)
Remote practice authority	13.710 (16.512)	56.192 (38.938)	-54.040 (36.912)	-65.693 (99.401)
Observations	777,026	53,920	530,000	25,464
Panel B: HHI based on drugs				
Full practice authority	-3.534 (14.073)	1.533 (15.296)	-17.747 (15.244)	-11.163 (19.586)
Remote practice authority	4.121 (16.821)	5.735 (32.105)	-27.223 (16.929)	6.546 (31.811)
Observations	929,544	49,517	610,792	23,053

Note: The dependent variable in each specification is the HHI of all NPs or PAs. Each model includes a full set of individual provider, state, and year fixed effects. Standard errors clustered at the state level are reported in parentheses.

* $p < 0.05$. ** $p < 0.01$.

implies that NPs do not substantially change their practice patterns when they can practice with full practice authority. The same is not true when considering only NPs in rural areas. In column (2), these NPs increase their HHI by 85 points, which is close to what the DOJ would consider meaningful in the context of market concentration. This increase suggests that these NPs become more specialized once they can provide the full range of care they are trained to provide. Later models explore the specialties among which this increase is concentrated.

Turning to PAs, the results in Panel A of Table 2 suggest they become slightly less specialized following a grant of remote practice authority. Their specialty HHIs decrease by about 54 points for all PAs and about 66 points among PAs practicing in rural areas. These estimates, however, are not statistically significant. They also are less than the 100-point cutoff the DOJ uses when evaluating markets.

With respect to the estimates of specialization derived from the Medicare drug data in Panel B of Table 2, the evidence of practice changes is even weaker. For NPs, the estimated change in specialty HHI is close to zero across all NPs and NPs practicing in rural areas. For PAs, there is similarly little evidence of a change in specialization as measured by specialty HHI.

While the HHI results are informative as to the overall practices of individual NPs and PAs, they do not elucidate shifts between individual physician specialties. To examine potential shifts following changes in SOP laws, I next estimate changes in the percentage of an NP's or PA's practice attributable to four categories of physician specialties: primary care, specialty care, emergency care, and surgery. Table 3 reports the change in physician specialty categories practiced by NPs and PAs following a change in SOP laws. Panel A reports changes in NP practice patterns as measured by services. The results are uniformly statistically insignificant. Even if they were statistically significant, they imply changes of less than half a percentage point in NP practices across all four specialty categories. In Panel B, the point estimates are similarly small for PAs, though the estimate in column (2) implies that the small increase in specialty care is statistically significant.

When the specialty categories are based on drugs instead of services, the estimates are similarly small and almost uniformly statistically insignificant in Panels C and D of Table 3. The point estimate in column (1) of Panel D implies that PAs reduce their focus on primary care by half a percentage point. However, despite its statistical significance, this point estimate is quite small given that PAs generally devote 84% of their practices to primary care (as reported in Table 1 above).

TABLE 3 Results for the relationship between scope of practice laws and practice categories.

	(1) Primary care	(2) Specialty care	(3) Emergency care	(4) Surgery
Panel A: Nurse practitioner categories based on services				
Full practice authority	-0.201 (0.222)	-0.061 (0.097)	0.254 (0.127)	0.025 (0.067)
Observations	777,026	777,026	777,026	777,026
Panel B: Physician assistant categories based on services				
Remote practice authority	0.771 (0.503)	0.382* (0.163)	-0.875 (0.582)	-0.363 (0.242)
Observations	530,000	530,000	530,000	530,000
Panel C: Nurse practitioner categories based on drugs				
Full practice authority	-0.011 (0.150)	0.013 (0.050)	-0.017 (0.015)	0.068 (0.037)
Observations	929,544	598,638	929,544	929,544
Panel D: Physician assistant categories based on drugs				
Remote practice authority	-0.504** (0.170)	0.250 (0.213)	-0.067 (0.053)	-0.053 (0.078)
Observations	610,792	371,322	610,792	610,792

Note: The dependent variable in each model is the percent of an NP's or PA's time spent practicing within the primary care or specialty category listed at the top of each column. Each model includes a full set of provider, state, and year fixed effects. Standard errors clustered at the state level are reported in parentheses.

* $p < 0.05$. ** $p < 0.01$.

Next, Table 4 repeats the models reported in Table 3 but limits the samples to include only NPs and PAs practicing in rural areas. As with the above results, the point estimates are all less than one percentage point, suggesting that the grant of full practice authority to NPs and remote practice authority to PAs does little to change how they practice. The only statistically significant point estimate (which is still small) indicates that NPs increase their provision of emergency care in rural areas when emergency care is defined based on services (column (3) of Panel A). In general, the results for physician specialty categories do not suggest NPs and PAs change their practice patterns following changes in SOP laws. This is not to say they do not change the volume of care they provide, which patients they treat, or other aspects of their practices (as prior work has found). But the results do suggest that they do not begin to practice in ways beyond their training and knowledge.

To examine potential shifts following changes in SOP laws at a more granular level, I next estimate changes in the percentage of an NP's or PA's practice attributable to individual physician specialties. Figure 1 reports the change in physician specialties practiced by NPs following a grant of full practice authority. The error bars represent 95% confidence intervals. In general, there is no statistically significant evidence of a shift in NP practice patterns following the grant of full practice authority. NPs increase their provision of services associated with emergency medicine as well as psychiatry and neurology. And they decrease their provision of services associated with family medicine, internal medicine, and urology. While these shifts are not statistically significant, they are the only ones of even marginal economic significance, as the shifts in other specialties are quite small.

Figure 2 reports the change in physician specialties practiced by PAs following a grant of remote practice authority. As with the evidence for NPs, there is little indication of meaningful shifts in PAs' practice patterns when they gain more authority and autonomy. They provide fewer services associated with emergency medicine, orthopedic surgery, pathology, and thoracic surgery, but only the changes in pathology and thoracic surgery are statistically significant. They provide more services associated with family medicine, internal medicine, otolaryngology, and radiology, but only the changes in the last two specialties are statistically significant. And even with this significance, the magnitude of the

TABLE 4 Results for the relationship between scope of practice laws and practice categories in rural areas.

	(1) Primary care	(2) Specialty care	(3) Emergency care	(4) Surgery
Panel A: Nurse practitioner categories based on services				
Full practice authority	-0.004 (0.389)	-0.370 (0.300)	0.702* (0.337)	-0.053 (0.233)
Observations	53,920	53,920	53,920	53,920
Panel B: Physician assistant categories based on services				
Remote practice authority	1.714 (1.371)	-0.184 (0.377)	-1.128 (1.066)	-0.528 (0.646)
Observations	25,464	25,464	25,464	25,464
Panel C: Nurse practitioner categories based on drugs				
Full practice authority	0.036 (0.181)	-0.021 (0.067)	0.015 (0.031)	0.072 (0.063)
Observations	49,517	31,026	49,517	49,517
Panel D: Physician assistant categories based on drugs				
Remote practice authority	0.021 (0.367)	-0.012 (0.516)	-0.066 (0.080)	-0.247 (0.246)
Observations	23,053	12,966	23,053	23,053

Note: The dependent variable in each model is the percent of an NP's or PA's time spent practicing within the primary care or specialty category listed at the top of each column. Each model includes a full set of provider, state, and year fixed effects. Standard errors clustered at the state level are reported in parentheses.

* $p < 0.05$. ** $p < 0.01$.

changes are generally less than one percentage point. In other words, the evidence may be statistically significant, but it is unlikely significant to policymakers, given the small magnitudes.

To create a more comprehensive picture of any changes in practice patterns, Figures 3 and 4 report results from a series of models that use prescription drugs to measure the practice patterns of NPs and PAs in terms of physician specialties. For NPs, there is little indication of any meaningful changes in practice patterns in Figure 3. Only the small increase in drugs associated with ophthalmology is statistically significant, and this change is small in magnitude—less than half a percentage point.

The evidence for PAs in Figure 4 suggests some changes in practice patterns. Physician assistants prescribe more drugs associated with anesthesiology, dermatology, and pain medicine, and these changes are statistically significant. They prescribe fewer drugs associated with emergency medicine, family medicine, and internal medicine, but only the decline in family medicine is statistically significant. While the evidence of changes in practice patterns for PAs is more consistently statistically significant than for NPs, it is equally consistently insignificant in magnitude. Across models for all physician specialties, there is no indication of more than 0.5% point change in PA practice patterns. In general, the evidence developed here suggests that NPs and PAs do not meaningfully change how they practice following the relaxation of SOP laws.

So far, the models reported here have focused on all NPs and PAs. However, prior work has demonstrated that changing NP and PA SOP laws tends to have the most salient effects in underserved areas. To examine the potential of SOP laws to have a larger impact in these areas, I re-estimate the primary models but include only providers in rural areas. In the interest of succinctness, the results of these models are reported in Appendix A. Turning first to NPs in rural areas, these professionals increase their provision of services associated with emergency medicine and internal medicine following a grant of full practice authority, though only the change in emergency medicine is statistically significant. Conversely, they decrease the provision of services associated with anesthesiology, family medicine, and urology, but only the first of these changes is statistically significant.

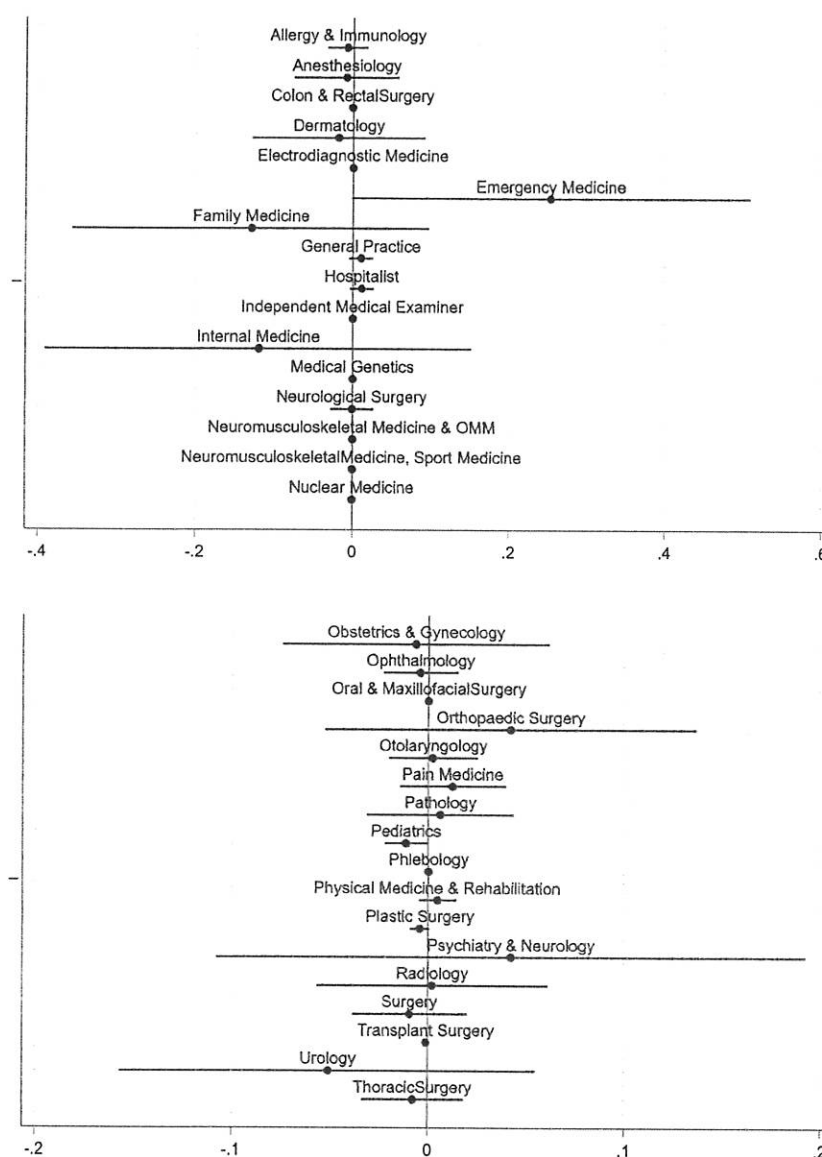


FIGURE 1 Nurse practitioner specialties based on services. Each point and error bars report the result from an individual regression that includes only NPs. The dependent variable in each specification is the share of an NP's practice made up of the physician specialty listed above the point estimate. The independent variable of interest is an indicator for full practice authority. Each model includes a full set of individual provider, state, and year fixed effects. 95% confidence intervals based on standard errors clustered at the state level are reported for each point estimate.

With respect to PAs, they similarly exhibit little change in practice patterns. Physician assistants provide fewer services associated with emergency medicine, radiology, and surgery following a grant of remote practice authority. But only the change in radiology is statistically significant. On the other hand, PAs provide more services associated with family medicine and internal medicine, but these changes are not statistically significant. Models using drugs instead of services to measure practice patterns offer even less evidence of shifts in practice patterns among rural NPs and PAs. Across both types of professionals, the only statistically significant change is a decrease in PAs prescribing drugs associated with surgery when PAs gain remote practice authority. Overall, the results from the models focused on rural providers yield substantially similar results as those focused on all providers.

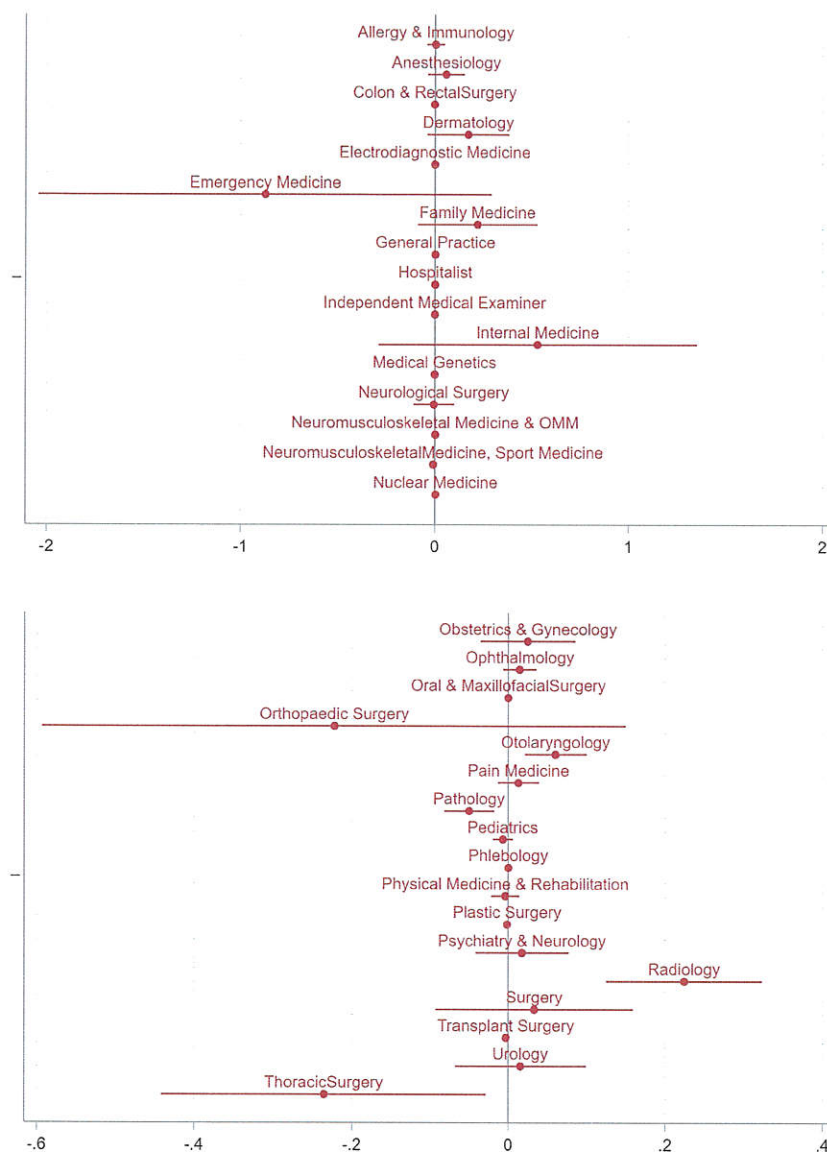


FIGURE 2 Physician assistant specialties based on services. Each point and error bars report the result from an individual regression that includes only PAs. The dependent variable in each specification is the share of a PA's practice made up of the physician specialty listed above the point estimate. The independent variable of interest is an indicator for remote practice authority. Each model includes a full set of individual provider, state, and year fixed effects. 95% confidence intervals based on standard errors clustered at the state level are reported for each point estimate.

6 | ROBUSTNESS

The primary threat to the validity of the models comprising the main analysis is the violation of the parallel pre-trends assumption. To examine this assumption, I estimate a series of event-study models in which the primary SOP-law indicator variable is replaced by a series of lead and lag indicator variables. Specifically, I include an indicator variable for the year a new SOP law became effective, and indicator variables for the first, second, third, and fourth years after the law is effective. I also include an indicator for the law having been in place for five or more years. These lag variables allow me to examine how the effect of a given SOP law phases in over time.

More importantly for the parallel pre-trends assumption, I include indicator variables for 2 years, 3 years, 4 years, and 5 years before the relevant SOP law became effective. I also include an indicator for six or more years before the law became effective, with 1 year before the law became effective serving as the baseline year. This set-up allows me to

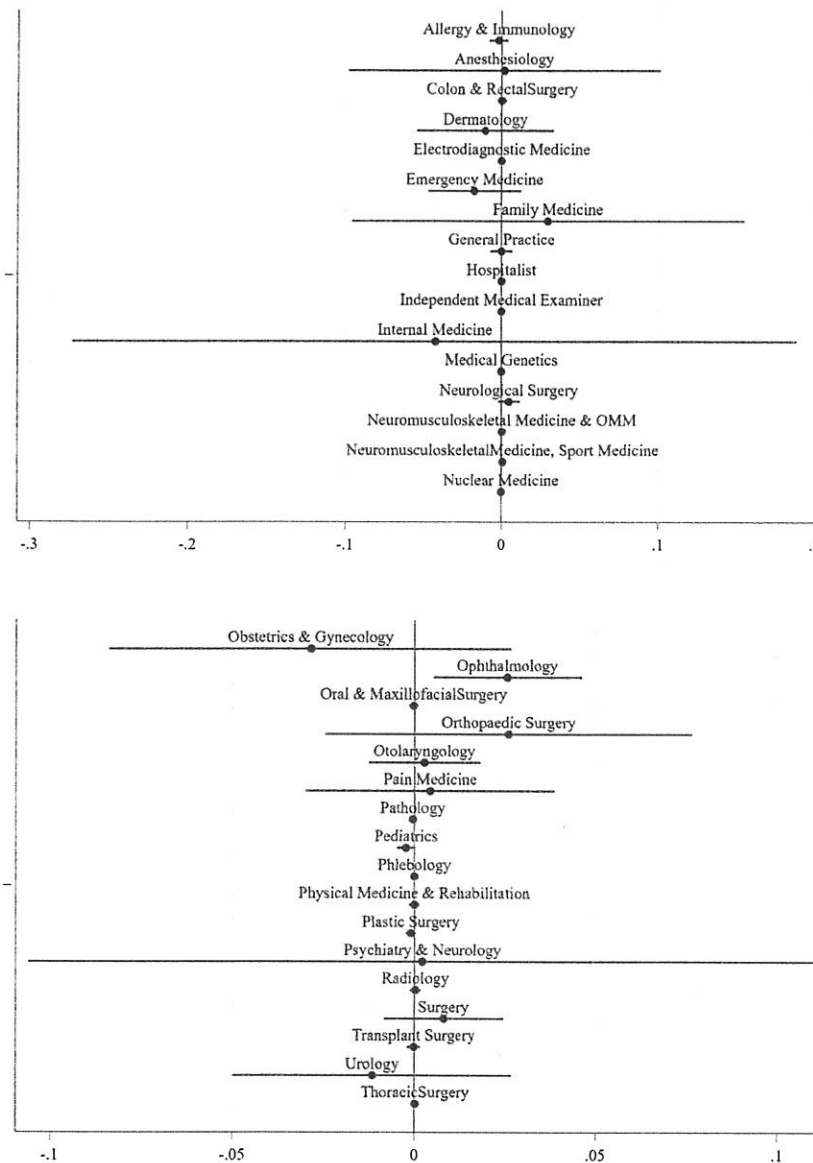


FIGURE 3 Nurse practitioner specialties based on drugs. Each point and error bars report the result from an individual regression that includes only NPs. The dependent variable in each specification is the share of an NP's practice made up of the physician specialty listed above the point estimate. The independent variable of interest is an indicator for full practice authority. Each model includes a full set of individual provider, state, and year fixed effects. 95% confidence intervals based on standard errors clustered at the state level are reported for each point estimate.

examine the coefficients on the lead variables for violations of the parallel pre-trends assumption. I also estimate the joint significance of all these lead variables to evaluate the overall risk that the assumption does not hold. Because of the volume of results, appendices report all event study model results. Appendix B reports results for full practice authority for NPs with physician specialties based on services. Appendix C does the same for PAs. Appendices D and E repeat Appendices B and C but rely on prescriptions to assign physician specialties to NPs and PAs, respectively. All results are reported graphically, and each graph includes the p value for the joint test of statistical significance for the lead variables.¹⁷

Some graphs indicate that the parallel pre-trends assumption may not hold for certain models, but this is not unexpected given the volume of results. And in general, the results reported in the appendices do not indicate any consistent or systematic violation of the assumption that the pre-trends are generally parallel. Additionally, most graphs indicate that the coefficients oscillate around zero both before and after the implementation of the relevant SOP law. In other words,

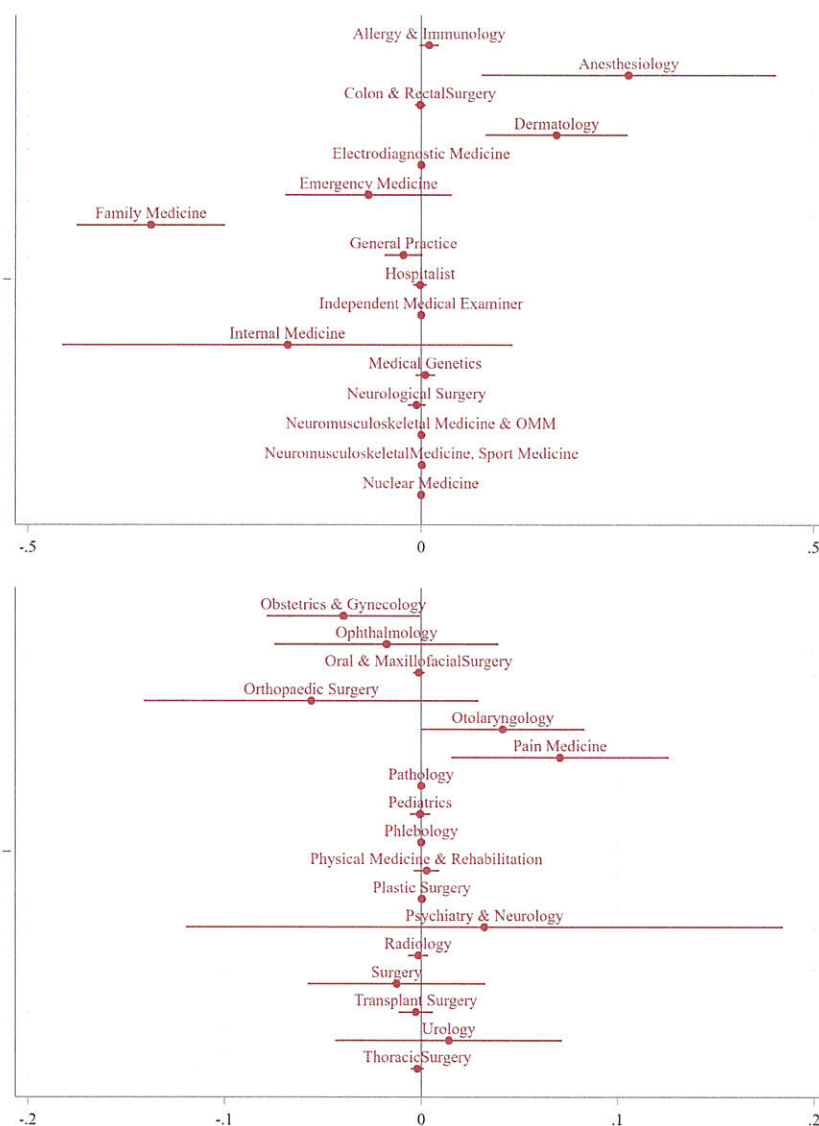


FIGURE 4 Physician assistant specialties based on drugs. Each point and error bars report the result from an individual regression that includes only PAs. The dependent variable in each specification is the share of an PA's practice made up of the physician specialty listed above the point estimate. The independent variable of interest is an indicator for remote practice authority. Each model includes a full set of individual provider, state, and year fixed effects. 95% confidence intervals based on standard errors clustered at the state level are reported for each point estimate.

most models indicate essentially no change relative to the baseline year. This supports the conclusions from the primary models that NPs and PAs do not meaningfully change the care they deliver following a change in SOP laws.

Next, the two-way-fixed-effects models reported above may suffer from the type of bias identified in recent work by Goodman-Bacon (2021), Callaway and Sant'Anna (2021), and Borusyak et al. (2024). Those models differ in their econometric approaches but attempt to address potential concerns with heterogeneous treatment effects of laws passed at different times. All are computationally intensive and are therefore not computationally feasible with individual-level data and individual provider fixed effects. While I cannot estimate these models for computational reasons, I report Goodman-Bacon decompositions in the appendix for the primary HHI and physician specialty category models.¹⁸ These decompositions demonstrate that the 2×2 comparisons of treated and untreated units receive the majority of the weight in the two-way fixed effects models. This suggests that the potential bias identified in recent research is not a substantial concern for the models reported below (Hollingsworth et al., 2024). I also perform Goodman-Bacon decompositions for all other models reported below. These decompositions are omitted in the interest of succinctness but do not indicate that the results above are biased.

7 | DISCUSSION AND CONCLUSION

In general, I find little evidence that either NPs or PAs meaningfully change how they deliver care following a change in SOP laws. While the evidence does not indicate that these professionals remain entirely static in their practices after a change in laws, it does not suggest they suddenly shift to entirely new specialties. Some evidence suggests that NPs may provide more care associated with emergency medicine following a grant of full practice authority, and some evidence based on the drugs PAs prescribe suggests they move away from family medicine and toward certain specialties like dermatology. However, the magnitude of the changes are quite small. Focusing on NP and PA practice patterns more generally, the evidence does not suggest that NPs and PAs begin focusing their practices more on a single specialty following a change in SOP laws. Thus, the results reported above do not support the concern that, following a relaxation of SOP laws, NPs and PAs will begin providing different types of care or care beyond their training and education. In other words, policymakers need not be concerned that relaxing SOP laws will lead to NPs and PAs suddenly providing new types of care.

Importantly, the evidence developed in this paper should not be interpreted in a vacuum. Multiple studies have found that relaxing SOP laws for NPs and PAs increases the supply of these clinicians and the amount of care they deliver (Bhai & Mitchell, 2022; DePriest et al., 2020; Luo et al., 2021; Markowitz & Adams, 2022; McMichael, 2018; Plemmons et al., 2023; Shakya & Plemmons, 2020). Combined with the evidence developed here, this suggests that, following a change in SOP laws, NPs and PAs provide more care to patients but do not change the type of care they provide. Thus, more patients have access to the types of care that NPs and PAs have provided for years.

Relatedly, a key justification for maintaining restrictive SOP laws is the concern that, without physician supervision, NPs and PAs may harm patients because they lack the education completed by physicians. Multiple studies have confirmed that NPs and PAs can competently deliver many of the services traditionally reserved to physicians (Kurtzman et al., 2017; Muench et al., 2021; O'Reilly-Jacob et al., 2019; Perloff et al., 2019; Smith, 2022). These studies generally focus on the types of care that fall squarely within the education of NPs and PAs, such as diabetes management, prescribing drugs in an outpatient setting, etc. And many of these studies have evaluated the care provided by NPs and PAs without physician oversight.

Given the strong evidence that NPs and PAs can competently care for patients within their education and training without physician supervision, the primary way in which NPs and PAs could harm patients is by delivering care for which they are not trained. The analysis detailed above suggests that this concern is minimal. The evidence that NPs and PAs do not begin providing new types of care following changes in SOP laws demonstrates that the primary means by which they could harm patients does not typically occur.¹⁹ Thus, the fear that NPs and PAs will harm patients by providing overly complex or novel types of care should not stand in the way of relaxing SOP laws.

In general, the analysis and evidence presented in this paper offers new insight into the practice patterns of NPs and PAs. In addition to elucidating the types of care they generally provide in terms of physician specialties associated with the same types of care, it demonstrates that NPs and PAs continue to provide the same types of care once they are able to practice under more relaxed SOP law regimes with less physician oversight. Combined with evidence that these SOP law changes increase access to care and that NPs and PAs can safely provide care within their training and expertise without physician oversight, the results developed in this paper suggest that relaxing SOPs can effectively increase access to safe and effective care.

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DATA AVAILABILITY STATEMENT

The data that support the findings of this study are publicly available Data.CMS.gov. The services files are available at <https://data.cms.gov/provider-summary-by-type-of-service/medicare-physician-other-practitioners/medicare-physician-other-practitioners-by-provider-and-service>. The prescription files are available at <https://data.cms.gov/provider-summary-by-type-of-service/medicare-part-d-prescribers/medicare-part-d-prescribers-by-provider-and-drug>.

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ENDNOTES

- ¹ It is worth noting that while the PA profession encompasses all PAs, NPs are the largest contingent of the more general profession of advanced practice registered nurses (APRNs). Other types of APRNs include certified nurse midwives, clinical nurse specialists, and certified registered nurse anesthetists. While these professions are certainly important, they provide more specialized care and are (often) governed by different sets of SOP laws. Because of this, this paper focuses on NPs and reserves examination of these other types of APRNs to work specifically focused on them (Chen et al., 2023; Markowitz et al., 2017).
- ² The term “allopathic” physician refers to physicians who possess “MD” degrees. Historically, these physicians were members of the “regular” medical sect. The most prominent examples of non-allopathic physicians today are osteopathic physicians, who possess “DO” degrees. While osteopathic physicians did not gain full rights to practice in all 50 states until the 1970s because of opposition from allopathic physicians, osteopathic and allopathic physicians are regulated nearly identically today (Gevitz, 2019; Mohr, 2013; Starr, 2017).
- ³ Pegging NP prescriptive authority to physician prescriptive authority is necessary because some states have laws that apply to both groups of providers and place more restrictions on some medications than do other states. In these instances, it is unlikely states are acting to restrict NPs specifically since they similarly restrict physicians.
- ⁴ Markowitz et al. (2017) found positive quality effects on labor and delivery outcomes when studying certified nurse midwives and relaxations of their SOP laws. On the other hand, Chen et al. (2023) found only modest changes in anesthesia-related care following changes in the rules governing certified registered nurse anesthetists. While my analysis does not focus on either of these types of providers, results for these other types of APRNs are nonetheless relevant to the more general debate over SOP laws.
- ⁵ As Currie et al. (2023) explain, the differences in the findings between these two groups of opioid-focused papers may be explained by different data sources and slightly different econometric models. It is also important to note that Alexander and Schnell (2019) and Currie et al. (2023) use a substantially different coding of NP SOP laws than that recommended by McMichael and Markowitz (2020). Additionally, Currie et al. (2023) state that McMichael (2020) commits an error in calculating MMEs per day supplied instead of aggregating total MMEs. However, MMEs per day supplied is the standard measure of opioid prescriptions used by the Prescription Drug Monitoring Program Training and Technical Assistance Center and recommended in its documents demonstrating how to calculate MMEs. Currie et al. (2023) further suggest that the number of prescriptions examined by McMichael (2020) is not possible based on an erroneous comparison between McMichael’s *outpatient* opioid data and ARCOS data which include *all* opioids. This is not a meaningful comparison, as it does not compare datasets containing the same information, and therefore does not explain the differences in the results of the two groups of papers.
- ⁶ Data on services and drugs provided to those enrolled in Medicare Advantage plans is not included.
- ⁷ Because these data are publicly available, they do not include patient level information, such as demographic data or diagnosis codes. All the data analyzed here are organized at the provider, not the patient, level.
- ⁸ HCPCS codes can be more complicated than this, with different modifiers attached to different codes. This level of detail, however, does not matter for the purposes of this study, and I simply rely on the HCPCS codes listed in the Medicare dataset throughout the analysis.
- ⁹ Technically, the data only includes drugs that were both prescribed by the provider and filled by the patient. If a drug is prescribed but not filled by the patient, it will not appear in the data because Medicare will never be called upon to reimburse the prescription. While this detail is important to keep in mind, I will refer to prescribed drugs with the understanding that they must also be filled in the interest of succinctness and clarity.
- ¹⁰ Only the Medicare data on services include the addresses of providers. The drug data do not include addresses or ZIP codes, only the state in which the provider practices.
- ¹¹ For ease of exposition, I only discuss NPs, but the process is easily extended to PAs.
- ¹² While the data analyzed here lack diagnosis codes, the same process could be repeated for diagnosis codes if those were available. The process could also be used with a combination of different codes (e.g., drug and diagnosis codes).
- ¹³ This is *not* to suggest that prior work is incorrect. Indeed, in certain settings, specific clinical knowledge can improve the delineation of different medical specialties. The approach described here, however, can be applied without that knowledge or other clinical assumptions and is appropriate for classifying a large number of specialties. Future work may choose to rely on the vector approach here (as I do for the remainder of my analysis) or categorize individual NPs or PAs as specialty X if that specialty represents the majority or plurality of a given provider’s practice or use an altogether different cutoff. The primary contribution of the approach described here is the derivation of the specialty profile.
- ¹⁴ To improve the readability of the results, I multiply each element by 100 so that the results can be interpreted in terms of percentages.
- ¹⁵ It is worth noting that emergency medicine has specific HCPCS codes that identify services provided in emergency departments. Because of this, the specialty measure based on services more clearly identifies emergency medicine as a specialty. This explains the discrepancy in the emergency medicine percentages across the services and drugs tables.
- ¹⁶ The United States Department of Agriculture defines RUCA codes, with higher codes indicating more rural areas. The code of 5 is the first code that does not involve commuting within an urbanized area or an urban cluster.
- ¹⁷ The appendices note when models cannot be estimated because of insufficient data, which occurs when too few NPs or PAs provide care consistent with a particular physician specialty.

- ¹⁸ Because Goodman-Bacon decompositions require strongly balanced panels and only one treatment period (i.e., units cannot become untreated once treated), I modify the sample to perform these decompositions. First, I drop all providers who do not appear in all years of the relevant dataset. Next, I drop all providers who moved from one state to another at some point during the sample period. This yields a strongly balanced panel dataset as required for Goodman-Bacon decompositions.
- ¹⁹ To be clear, the evidence developed here suggests that NPs and PAs simply do not provide this type of care. It does not suggest that they could or could not competently provide more specialized care. Future work with different data should evaluate the competency of NPs and PAs to provide specific types of care.

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SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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Medical Malpractice Payment Reports of Physician Assistants/Associates Related to State Practice Laws and Regulations

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ABSTRACT:

Purpose: Authorizing physician assistants/associates (PAs) to provide care to patients and removing restrictive laws and regulations without sacrificing patient safety is essential to meet the needs of patients and the US healthcare system. The aim of this observational study was to determine if states with permissive compared to restrictive PA scope of practice laws and regulations had higher instances of medical malpractice payment reports (MMPR), a proxy of patient harm.

Design: This observational study examined 10 years (2010-2019) of medical malpractice payment reports data from the National Practitioner Data Bank (NPDB) compared to the laws and regulations of states for the same period.

Results: Negative binomial regressions indicated no statistically significant differences in MMPR rates between states with permissive versus restrictive PA practice laws and regulations. Five of six practice reforms decreased or had no significant effect on PA and physician MMPR occurrences. One reform was associated with a weak but statistically significant increased risk of MMPRs for PAs and a trend toward a decreased risk for physicians.

Conclusion: This study suggests that removing restrictive laws and regulations to PA practice does not increase overall risks to patients or increase rates of malpractice within US healthcare.

Introduction

The US healthcare system is one of the most complex and high-cost health systems globally. Despite spending nearly twice on healthcare as a share of the economy as other countries, the US has the highest rate of avoidable deaths, one of the lowest life expectancies, higher chronic disease burdens, and other health disadvantages in comparison with comparable nations.¹ In addition, physician and provider shortages, a rising number of natural and health emergencies, increasing numbers and ages of healthcare beneficiaries, greater complexity of conditions and comorbidities, ongoing disparities in health outcomes, and other factors threaten US healthcare.²⁻⁶

The high per capita cost of care, low value per cost, and other factors have caused policy experts (eg, The National Academies of Sciences, Engineering, and Medicine and The Hamilton Project), regulatory agencies (eg, US Department of Health and Human Services, US Department of Treasury, and US

Department of Labor), and other stakeholders to recommend changes to the US health system. The recommended changes include authorizing qualified healthcare practitioners, such as physician assistants/associates (PAs), to practice to the full extent of their training and qualifications without restrictive state laws and regulations that limit their scope of practice (SOP) or impose requirements on physician collaboration.⁷⁻¹¹

State laws and regulations have been imposed on the PA profession in part to address health and safety concerns, yet there is a lack of evidence that these laws and regulations affect patient safety. Some PA practice laws and regulations and physician collaboration requirements have been noted to be unnecessary, unjustified, costly, and potentially detrimental.⁸⁻¹¹ Proponents of permissive PA practice laws and regulations note the demonstrated quality, cost-effective care provided by PAs, care that has been shown in many ways to be comparable to that of physicians.⁸⁻¹⁵ The available evidence demonstrates favorable PA practice laws

and regulations increase patient access, lower healthcare costs, positively affect quality of care, and reduce preventable healthcare amenable deaths.^{8-10, 16-18} Past research has noted that PAs have lower rates of malpractice and lower malpractice payments when compared to physicians.¹⁹⁻²⁰ In addition, the comparable and sometimes complementary services PAs provide compared to physicians are associated with high levels of patient satisfaction, and patients report that PAs are trusted, valued practitioners who provide safe and effective healthcare and improve health outcomes.^{11, 21-23}

Despite the evidence supporting the benefits of PAs and the removal of restrictive SOP laws and regulations, there is opposition from some physicians, physician groups, and regulators primarily based on an unfounded assertion that permissive PA practice laws and regulations threaten patient safety and should be opposed.²⁴⁻²⁵ Other opponents are concerned permissive laws and regulations will result in increased malpractice payments and premiums.²⁶⁻²⁷

If, as suggested by opponents, permissive PA practice laws represent a threat to patient safety and an increased risk of malpractice, there should be a greater number of malpractice payments against PAs in states with permissive compared to restrictive PA practice laws and regulations. Reported malpractice payments serve as an approximation of the acts or omissions constituting medical errors or negligence, are highly correlated with adverse patient outcomes, and have been used as a surrogate measure of serious adverse medical events.²⁸⁻³⁰ It is also important in an assessment of risk, and consistent with other research, to analyze potential transference of risk from one group of practitioners (ie, PAs) to another (ie, physicians) with changes in collaborative practices.³¹ Therefore, this study evaluated if PA practice laws and regulations affect the number of medical malpractice payment reports (MMPR) for PAs and physicians within the US, including Washington, DC.

Methods

Data for the number of MMPRs against PAs and physicians (allopathic and osteopathic physicians combined) between 2010 and 2019 were obtained from the National Practitioner Data Bank (NPDB) Public Use Data File³² as of March 31, 2023. Data from the NPDB were used because the database is the most comprehensive national source of information about practitioners' malpractice and medical discipline records.³³

This 10-year span of data was selected for analysis as it was the most recent period prior to temporary regulatory waivers enacted due to COVID-19 and to allow for expected delays in reporting of aggregated judgements,¹⁹ both of which would have confounded the analysis. The number of MMPRs for PAs and allopathic and osteopathic physicians that occurred in each state and year of the 10-year data period were extracted and used to develop a variable reflecting the number of MMPRs for each practitioner type used in subsequent data analysis.

Additional control variables from the Agency for Healthcare Research and Quality's (AHRQ) Social Determinants of Health dataset were included in the analyses.³⁴ From this dataset, the number of employed PAs and physicians per state and Washington, DC, population of each state and Washington, DC, county-level unemployment rate,

IF, AS SUGGESTED BY OPPONENTS, PERMISSIVE PA PRACTICE LAWS REPRESENT A THREAT TO PATIENT SAFETY AND AN INCREASED RISK OF MALPRACTICE, THERE SHOULD BE A GREATER NUMBER OF MALPRACTICE PAYMENTS AGAINST PAs IN STATES WITH PERMISSIVE COMPARED TO RESTRICTIVE PA PRACTICE LAWS AND REGULATIONS.

and county-level income per capita were derived for each data year. Consistent with prior research on SOP reform and MMPR events, data relating to the presence of joint and several liability reforms, limits on punitive and non-economic damages, and apology laws were included.³¹

Six elements of an ideal PA SOP that allow for optimal practice were identified based on recognized standards, industry experts, and regulatory agencies (Table 1).^{8-9,35} These ideal factors eliminate physician supervisory requirements and allow collaborative practices, if needed, to be determined at the practice level based on institutional policies and the training, experience, and competency of the individual PAs. The state laws and regulations for all 50 states and Washington, DC, as published in the annual *PA State Laws and Regulations* from 2010 through 2019 and confirmed with legislative and regulatory tracking software,³⁶⁻⁴⁵ were independently reviewed by 2 researchers to ensure data accuracy. Any discrepancies in analysis, for which there were

few, were reviewed by a policy expert and consensus was obtained.

Each of the SOP elements were assigned a code to perform statistical analysis for each year in which they were in effect (Table 1). A restrictive component identified in either a state's laws or regulations for an element was assigned a "0". The express exclusion of a restrictive component or the absence

of restrictive language in laws or regulations for an element was assigned a "1". State laws were used to determine the nominal assignment in instances where there was a discrepancy between the laws and regulations due to a delay in regulatory updates. A change in an SOP element was then assigned to the year following a legislative amendment or a revision of a regulation. This was done to

Table 1
PA scope of practice elements analyzed

Elements, definitions in state laws and regulations, and assignments	
PAs practice in collaboration or have no formal statutory relationship with a physician.	
• Permissive: The working relationship between a physician and a PA is described as collaboration and/or there is the absence of the term "supervision" or "supervising physician."	• Restrictive: The working relationship a physician has with a PA is defined as supervision or there are terms like "supervising physician" or "physician supervision."
Physicians may collaborate with an unlimited number of PAs.	
• Permissive: There is an absence of a limit or a specific number of PAs with whom a physician may collaborate or supervise.	• Restrictive: There is a maximum number of PAs, either total or at one time, with whom a physician may collaborate or supervise.
No physician co-signature or specific mandated review is required on medical record documentation or orders.	
<i>*Did not review or include any requirements, if present, for co-signature of prescriptions.</i>	
• Permissive: There is no requirement (explicit or implied) for physician co-signature of medical record documentation or orders made by a PA. Any review of medical records or orders, if required, can be performed on a sample of records, periodically, or 'in accordance with accepted standards.'	• Restrictive: There is a requirement for physician co-signature on all or some portion of medical record documentation and/or orders made by a PA or for some duration of time (eg, co-signature required for new PAs or PAs new to a practice or specialty).
Scope of practice determined at the practice site.	
• Permissive: There is no requirement that a regulatory body approve a PA's scope of practice or the services they may perform.	• Restrictive: Some or all PAs must have their scope of practice or a list of services they perform approved by a regulatory body.
PAs practice without the need for the physical presence or proximity of a physician.	
• Permissive: There are no requirements for a physician to be within proximity of a PA (either by time or distance), have an in-person meeting with a PA, or ever be present at the practice site. Any quality review, if required, does not specify it must be done in-person or face-to-face.	• Restrictive: There are requirements that a physician have a periodic on-site presence at a facility in which a PA practices, proximity requirements (defined by time or distance) to a PA during the PA's practice, or in-person meeting requirements.
Scope of practice is determined by the training and competency of the PA; not limited to the scope of a collaborating physician.	
• Permissive: There is no language limiting a PA's scope of practice to a component of a collaborating/supervising physician's scope of practice or specialty.	• Restrictive: There is language limiting a PA's scope of practice to a component of a collaborating/supervising physician's scope of practice or specialty.

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control for interstate variations in legislative and regulatory schedules and is consistent with the methodology of citations in the *PA State Laws and Regulations* books. It also accounts for some inevitable delay for regulatory or legislative changes to be incorporated into practice. Summary statistics

for the variables used in this study can be viewed in Table 2.

Negative Binomial Regression Analysis

A series of multilevel regression analyses were calculated to explore the predictive relationship

Table 2
Summary statistics

Variable	Mean	Std Dev	Min	Max
Physician Associate (PA) Counts				
Medical Malpractice Payment Records (MMPRs)	3.75	5.63	0	36
MMPR severity: Temporary injury	0.85	1.52	0	11
MMPR severity: Permanent injury	2.07	3.68	0	28
MMPR severity: Death	1.23	2.09	0	16
Physician (MD & DO) Counts				
Medical Malpractice Payment Records (MMPRs)	130.77	194.97	0	1398
MMPR severity: Temporary injury	29.57	51.65	0	500
MMPR severity: Permanent injury	74.12	112.40	0	726
MMPR severity: Death	40.23	58.21	0	327
Scope of Practice (SOP) Factors				
Relationship with physician not defined as supervisory	0.05	0.22	0	1
No physician collaboration/supervision ratio restrictions	0.22	0.41	0	1
No physician co-signature requirements	0.59	0.49	0	1
No physician on-site/proximity or in-person/meeting requirements	0.34	0.47	0	1
SOP determined at practice site	0.63	0.48	0	1
PA SOP not limited by collaborating/supervising physician SOP	0.10	0.31	0	1
Permissiveness of SOP regulations in Practice State	0.13	0.34	0	1
Control Factors				
State population (millions)	6.17	6.95	0.55	39.28
Total PAs	2089	2420	103	14943
Total MDs	13015	23887	1193	140148
Total DOs	1466	1727	64	6909
Joint and several liability reform	0.82	0.38	0	1
Punitive damages cap	0.62	0.49	0	1
Non-economic damages cap	0.46	0.50	0	1
Apology law	0.76	0.43	0	1
Average county percentage in poverty	15.11	3.85	8.32	25.72
Averaged county unemployment rate	6.31	2.41	2.48	13.97
Averaged county real income per capita (thousand \$)	26.82	5.77	17.62	56.15

Note: The number of observations for all variables is 510. For scope of practice factors and tort reforms, mean values reflect the proportion of state-years within the sample frame where the regulatory changes were in effect. Practitioner counts reflect PAs, MDs, and DOs who were not employed by the federal government.

between SOP elements and MMPR occurrences for PAs and allopathic and osteopathic physicians (combined) within each state across the data years. After examining the data, negative binomial regressions were selected due to the presence of overdispersion. A significant empty negative binomial model was found, indicating MMPRs varied between states(s) across the years(t) included in the analysis ($\sigma^2_{\mu st} = 0.365$ $p < 0.001$).

Subsequent log-linked negative binomial regression analyses were calculated to identify how the overall regulatory environment in a state during the data period impacted the occurrences of MMPRs. The basic estimating equation took the following form: $MMPR_{st} = \exp(\beta_0 + \beta_1 SOP_{st} + \beta_2 Torts_{st} + \beta_3 X_{st} + Y_s + \tau_t + \ln(pop_{st}) + \epsilon_{st})$ where MMPR represents the number of malpractice counts, or the severity of an incident of malpractice, against practitioners in state s in year t . Due to insufficient counts to analyze more granular cases of MMPRs, MMPRs coded in the NPDB as minor temporary injury and major temporary injury were categorized in this study as *temporary injury* and four categories of permanent injuries were classified as *permanent injury*. MMPRs coded as death were also included in the analysis, but insignificant injuries and emotional injuries were not due to insufficient PA data.

The presence of the SOP elements in state s at time t are represented in the equation by *SOP* indicator variables. An additional indicator code was created to classify states with 4 or more permissive SOP elements as *permissive states*

A SERIES OF MULTILEVEL REGRESSION ANALYSES WERE CALCULATED TO EXPLORE THE PREDICTIVE RELATIONSHIP BETWEEN SOP ELEMENTS AND MMPR OCCURRENCES FOR PAs AND ALLOPATHIC AND OSTEOPATHIC PHYSICIANS (COMBINED) WITHIN EACH STATE ACROSS THE DATA YEARS.

and those with three or fewer permissive SOP elements as *restrictive states*. *Torts* represents the litigiousness of states based on their passage of the previously mentioned tort reforms; *X* represents the state level control factors of unemployment, percent of the population in poverty, and income per capita. To account for variance across years, variables used within the model were within-state cluster centered. Indicator variables for each state

(Y) and year (τ) were included. The natural log of the annual state population was used as an offset variable, as opposed to the number of PAs or physicians, due to the conflating influence of the regulatory environment on the population of practitioners within a state. Regressions were analyzed using IBS SPSS version 29.

Results

There were no significant interactions between states having permissive practice environments (with 4 or more permissive SOP elements) compared to restrictive states (with 3 or fewer SOP elements) and the number of MMPR occurrences (Table 3).

There were also no statistically significant interactions between instances of overall PA MMPRs and a state having joint and several liability reforms, limits on punitive and non-economic damages, or apology laws (Table 4). However, certain SOP elements had a significant effect on the number and severity of MMPRs for PAs and physicians (Table 5). The results for each series of models are detailed in the following sections.

MMPR Occurrences. A significant regression equation was found predicting the relationship between the number of MMPRs in a state and the regulatory environment within a state ($p < 0.001$, $\beta = -14.41$), indicating the passage of PA SOP elements may influence the occurrence of MMPRs within a state. Two SOP elements were found to have a significant impact on the number of PA MMPRs. States enacting legislation allowing PAs to practice outside the scope of practice of their collaborating/supervising physician had a statistically significant 58.3% reduction in PA MMPRs ($IRR = 0.417$, 95% CI 0.309-0.592 [$\beta = -0.875$, $p < 0.001$]). Conversely, removing physician co-signature requirements lead to a 16.2% increase in PA MMPRs ($IRR = 1.162$, 95% CI 1.001 – 1.349 [$\beta = 0.150$ $p < 0.05$]; Table 3). Physician MMPRs were also significantly affected by changes to PA SOP ($p < 0.001$, $\beta = -10.76$). When relationships with physicians were not defined as supervisory ($p < 0.05$, $\beta = -0.29$ [$IRR = 0.745$, 95% CI 0.586 – 0.948]), there were no physician supervision/collaboration ratio restrictions ($p < 0.05$, $\beta = -0.16$ [$IRR = 0.853$, 95% CI 0.735 – 0.990]), and PAs could practice outside the scope of practice of their supervising/collaborating physician ($p < 0.01$, $\beta = -0.25$ [$IRR = 0.782$, 95% CI 0.671 – 0.910]; Table 3) physician MMPRs decreased.

MMPR Severity. Permissive states were no more likely than restrictive states to have PAs committing MMPRs resulting in temporary injury, permanent injury, or death. However, some SOP elements were related to MMPR severity. PA MMPRs resulting in temporary injury occurred less frequently when relationships were not defined as supervisory ($p < 0.05$, $\beta = -2.02$) and when PA SOP was not limited by the SOP of their supervising or collaborating physician ($p < 0.001$, $\beta = -0.90$). However, PA MMPRs resulting in temporary injury increased in instances when there were no physician on-site/proximity or in-person/meeting requirements ($p < 0.05$, $\beta = 0.24$). PA SOP not being limited

by the SOP of their supervising or collaborating physician related to a reduction in the number of PA MMPRs whose outcome was permanent injury ($p < 0.001$, $\beta = -1.13$). Additionally, PA SOP not being limited by the SOP of their supervising or collaborating physician also predicted fewer death related PA MMPRs ($p < 0.01$, $\beta = -0.69$; Table 5).

Discussion

While there were statistically significant interactions between some elements of PA practice reforms and PA and physician MMPRs, having a more permissive regulatory environment for PAs was not associated

Table 3
Interaction between MMPRs (PAs/Physicians) and Scope of Practice (SOP) regulatory factors

SOP Factor	IRR(SE)	95% Confidence Interval		p
		Lower Bound	Upper Bound	
Physician Assistant/Associates (PAs)				
Relationship with physician not defined as supervisory	0.663 (0.259)	0.399	1.101	0.112
No physician collaboration/supervision ratio restrictions	0.946 (0.126)	0.738	1.211	0.659
No physician co-signature requirements	1.162 (0.076)	1.001	1.349	0.048*
No physician on-site/proximity or in-person/meeting requirements	1.006 (0.087)	0.847	1.194	0.949
SOP determined at practice site	1.062 (0.082)	0.904	1.247	0.463
PA SOP not limited by collaborating/supervising physician SOP	0.417 (0.152)	0.309	0.592	0.000***
Permissive State	1.100 (0.175)	0.780	1.551	0.588
Physicians (MDs & DOs)				
Relationship with physician not defined as supervisory	0.745 (0.122)	0.586	0.948	0.017*
No physician collaboration/supervision ratio restrictions	0.853 (0.076)	0.735	0.990	0.036*
No physician co-signature requirements	0.910 (0.050)	0.826	1.003	0.058
No physician on-site/proximity or in-person/meeting requirements	1.016 (0.058)	0.907	1.138	0.783
SOP determined at practice site	0.967 (0.052)	0.873	1.071	0.520
PA SOP not limited by collaborating/supervising physician SOP	0.782 (0.078)	0.671	0.910	0.002**
Permissive State	1.160 (0.104)	0.945	1.424	0.154

N=510. Values reflect incident rate ratios. Standard errors in parentheses. State population used as offset variable. Models also include tort-related laws, averaged county unemployment rates, averaged county-level real income per capita, and the averaged percent of the county living in poverty.

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

with an increase in PA MMPRs between 2010 and 2019. Therefore, this study finds no evidence that creating a permissive practice environment will lead to an increase in MMPRs. In fact, almost all the PA SOP elements included within these statistical models illustrate that creating a more permissive PA practice environment leads to a reduction in MMPRs for PAs and physicians. The exact cause of the decreased overall MMPRs is unknown, but allowing PAs and physicians to have flexible collaboration determined at the practice site may result in more meaningful collaboration, optimized practice, and efficiency of care that improves healthcare and reduces risk.

Allowing PAs to practice consistent with their training and experience, and not limiting their SOP to that of a collaborating/supervising physician, was associated with a highly significant decrease in MMPRs for both PAs and physicians. Allowing PAs to practice in collaboration with physicians or have no formal statutory relationship with a physician and authorizing physicians to collaborate with an unlimited number of PAs significantly decreased the risk of MMPRs for physicians without affecting the occurrence of MMPRs for PAs. Allowing PA SOP to be determined at the practice site and not requiring a physician to be onsite or in proximity to a practicing PA had no significant effect on PA or physician MMPR occurrences.

Not requiring physician co-signature was associated with a relatively weak ($\beta = 0.150$), but statistically

significant ($p = 0.048$) increased risk of MMPRs for PAs while a trend toward a decreased risk for physicians was approaching significance ($p = 0.058$). These findings may represent a more accurate attribution of care and accountability rather than an overall increased risk to patients.

ALLOWING PAs TO PRACTICE CONSISTENT WITH THEIR TRAINING AND EXPERIENCE, AND NOT LIMITING THEIR SOP TO THAT OF A COLLABORATING/SUPERVISING PHYSICIAN, WAS ASSOCIATED WITH A HIGHLY SIGNIFICANT DECREASE IN MMPRS FOR BOTH PAs AND PHYSICIANS.

Furthermore, an interpretation of these findings is limited by the fact that there was considerable interstate variability in laws and regulations related to co-signature, with some states mandating co-signature of all medical records of a PA and other states only requiring a physician signature for a limited number of PAs, certain percentage of medical records, or specified time. Conversely, physicians may have been required to co-sign medical records in the absence of state laws or regulations requiring it due to billing mechanisms like “incident to” or split (or shared) billing. Therefore, this element may be influenced by confounding factors to a greater

Table 4
Malpractice events and severity by state permissiveness and tort reforms

Measure	Malpractice	Temporary Injury	Permanent Injury	Death
Physician Associates (PAs)				
Permissive state	-0.078 (0.176)	-0.440 (0.299)	-0.077 (0.279)	0.226 (0.264)
Joint and several liability reform	0.218 (0.119)	0.332 (0.207)	0.173 (0.180)	0.271 (0.190)
Punitive damages cap	-0.047 (0.090)	-0.177 (0.148)	0.019 (0.137)	0.139 (0.146)
Noneconomic damages cap	0.072 (0.078)	0.178 (0.127)	-0.011 (0.118)	0.164 (0.123)
Apology law	0.055 (0.091)	-0.013 (0.148)	0.025 (0.137)	0.070 (0.146)

N=510. Values reflect incident rate ratios. Standard errors in parentheses. State population used as offset variable. Models also include individual scope of practice regulations, averaged county unemployment rates, averaged county-level real income per capita, and the averaged percent of the county living in poverty.

Note: Due to limited instances of PA MMPRs, categories in the NPDB dataset were combined based on categorization as “temporary” or “permanent” injury. Emotional and insignificant injuries were not included in the analysis. States with 4 or more SOP reforms were classified as permissive states.

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$ (no values in this table were statistically significant).

extent than other SOP elements. Given that and the relatively weak association between the independent (physician co-signature) and dependent (PA MMPRs) variables, further research is needed prior to assuming the correlation implies causation.

This research, supporting similar findings that relaxing state laws and regulations does not result in harmful or low-quality care¹¹⁻¹⁸, should assuage fears that eliminating restrictive PA practice elements will lead to an increase in PAs' patients having serious adverse medical events. It should also alleviate concerns that rates of malpractice would increase.

Limitations

There were several limitations to the study. Although the NPDB is the largest national database of MMPRs, there may be some, although limited, non-compliance in reporting by entities and claims against corporations or hospitals may not identify individual practitioners.⁴⁶ There is also variability in elapsed time between a negligent act or omission and a malpractice report to the NPDB; however, there are fewer elapsed years for aggregated judgements for PAs than physicians and the timeframe of the data analyzed should allow for delayed reporting.¹⁹ In addition, data in the

Table 5
SOP factors and reported severity of malpractice events

SOP Factor	Malpractice	Temporary Injury	Permanent Injury	Death
Physician Associates (PAs)				
Relationship with physician not defined as supervisory	-0.412 (0.259)	-2.021* (0.964)	-0.198 (0.360)	-0.596 (0.444)
No physician collaboration/supervision ratio restrictions	-0.056 (0.126)	0.129 (0.193)	-0.167 (0.197)	0.004 (0.192)
No physician co-signature requirements	0.150* (0.076)	0.161 (0.112)	0.121 (0.115)	0.229 (0.118)
No physician on-site/proximity or in-person/meeting requirements	0.006 (0.087)	0.241* (0.122)	-0.075 (0.134)	-0.026 (0.135)
SOP determined at practice site	0.060 (0.082)	0.050 (0.130)	0.164 (0.124)	-0.048 (0.126)
PA SOP not limited by collaborating/supervising physician SOP	-0.875*** (0.152)	-0.896*** (0.269)	-1.133*** (0.247)	-0.689** (0.223)
Permissive state	0.095 (0.175)	-0.470 (0.299)	-0.046 (0.276)	0.324 (0.261)
Physicians (MDs & DOs)				
Relationship with physician not defined as supervisory	-0.294* (0.122)	-0.285 (0.162)	-0.208 (0.135)	-0.455** (0.170)
No physician collaboration/supervision ratio restrictions	-0.159* (0.076)	-0.035 (0.086)	-0.257** (0.086)	-0.277** (0.095)
No physician co-signature requirements	-0.094 (0.050)	-0.042 (0.055)	-0.124* (0.054)	-0.096 (0.061)
No physician on-site/proximity or in-person/meeting requirements	0.016 (0.058)	0.168** (0.064)	0.002 (0.064)	0.035 (0.071)
SOP determined at practice site	-0.033 (0.052)	-0.011 (0.059)	0.019 (0.057)	-0.149* (0.064)
PA SOP not limited by collaborating/supervising physician SOP	-0.246*** (0.078)	-0.246** (0.090)	-0.264** (0.086)	-0.313*** (0.098)
Permissive state	0.149 (0.104)	-0.021 (0.120)	0.244* (0.176)	0.300* (0.131)

N=510. Values reflect incident rate ratios. Standard errors in parentheses. State population used as offset variable. Models also include tort-related laws, averaged county unemployment rates, averaged county-level real income per capita, and the averaged percent of the county living in poverty.

Note: Due to limited instances of PA MMPRs, categories in the NPDB dataset were combined based on categorization as "temporary" or "permanent" injury. Emotional and insignificant injuries were not included in the analysis.

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

NPDB may not comprehensively and definitively correspond with unsafe practice or patient harm.

Another limitation unrelated to the NPDB is that some acts or omissions of PAs may have been attributed to a physician or employer under the doctrine of respondent superior and not reported as an MMPR of a PA; however, a review of case law

THIS RESEARCH, SUPPORTING SIMILAR FINDINGS THAT RELAXING STATE LAWS AND REGULATIONS DOES NOT RESULT IN HARMFUL OR LOW-QUALITY CARE, SHOULD ASSUAGE FEARS THAT ELIMINATING RESTRICTIVE PA PRACTICE ELEMENTS WILL LEAD TO AN INCREASE IN PAs' PATIENTS HAVING SERIOUS ADVERSE MEDICAL EVENTS.

demonstrated that liability for the acts or omissions of a PA are generally assigned to a PA, even when a physician has explicit or implied liability as a collaborating physician.⁴⁷

This study could not account for some state, practice, and PA factors that may affect MMPRs. While the statistical model controlled for some economic factors like unemployment and income per capita, other economic characteristics of a state and individual attitudes toward litigation could affect the findings. Additionally, practice characteristics were unable to be assessed but may be relevant. These characteristics include but are not limited to PA utilization, patient complexity, workplace culture, the extent to which laws and regulations were followed, and how quickly changes in laws and regulations were adapted into practice. The individual characteristics of PAs (eg, experience, specialty, etc.) that may affect clinical outcomes are not available within the NPDB or AHRQ data and therefore could not be included in this model.

Another limitation is in the interpretation of state laws and regulations and the categorization of the SOP elements. A restrictive designation was given regardless of whether an element applied in all or only limited circumstances. Additionally, although most elements could be easily delineated as permissive or restrictive, some state laws and regulations used vague language that had to be interpreted, and Board directives related to laws and regulations at the time could not be

ascertained. However, any random error in interpretation, with over- and under-interpretation equally probable, was likely minimized by the large number of data points. Additionally, by assessing the risk of malpractice against the overall leniency or restrictiveness of a state, the effects of variations in individual components were minimized.

The findings of physician MMPRs have limited extrapolation beyond their intent to ensure there was no overall increase in the rates of MMPRs among PAs and physicians or a transference of risk from one group of practitioners to another with changes to collaboration requirements. The various PA practice laws and regulations may affect physician practice differently, and changes in PA laws and regulations are not likely to influence the rates of MMPRs among physicians who do not collaborate with PAs.

Despite the limitations, the NPDB represents the most comprehensive source of practitioners' malpractice and medical discipline records. This is the first study to examine PA practice laws and regulations and their relationship to PA and physician MMPRs, and it demonstrates no evidence that states with permissive compared to restrictive PA practice laws and regulations had higher instances of MMPRs or patient harm.

Conclusion

The findings of this study provide evidence that restrictive PA SOP elements can be eliminated from state laws and regulations without adversely affecting MMPRs or patient safety. Removing barriers to optimal practice environments for PAs improves access to high-quality, cost-effective care while maintaining patient safety. Less restrictive state PA laws and regulations will allow PAs to meet the medical needs of patients while increasing benefits for patients and the US healthcare system.

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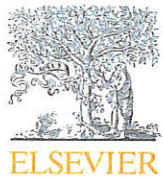
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Supply-side health policy: The impact of scope-of-practice laws on mortality

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ABSTRACT

The increased use of nurse practitioners (NPs) and physician assistants/associates (PAs) to provide healthcare represents an important supply-side policy option to expand access to care. However, restrictive scope-of-practice laws limit their ability to deliver care. I examine the effect of relaxing these scope-of-practice laws on healthcare amenable deaths, which are sensitive to access to care. Analyzing deaths in the United States between 2005 and 2019, I find that relaxing NP scope-of-practice laws reduces healthcare amenable deaths by 12 per 100,000 individuals and that relaxing PA scope-of-practice laws reduces these deaths by 10 per 100,000, with larger reductions in rural areas.

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1. Introduction

Over a decade after the passage of the Affordable Care Act (ACA) and nearly a decade after the first round of ACA Medicaid expansion, the United States continues to struggle with access to healthcare. Through the ACA and other acts like the Medicare Access and CHIP Reauthorization Act, the federal government has directed billions of dollars to improve access to care across the country (Antos and Capretta, 2020). However, these efforts come with an important caveat: They are predominantly demand-side policy interventions designed to increase the demand for healthcare and facilitate access to the means to pay for care. While certainly important, access to health insurance does not equate to access to healthcare. Indeed, without access to healthcare professionals, the ability to pay for healthcare through insurance or government programs may not be relevant. This paper examines an important supply-side policy intervention that has gained popularity over the last twenty years: the increased use of nurse practitioners (NPs) and physician assistants (PAs) to deliver care alongside physicians.¹

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¹ The PA profession is currently undergoing a change in name. Historically and in many states currently, PAs are known as "physician assistants," but a national PA organization recently voted to change the profession's name to "physician associate." In the interest of succinctness and to avoid confusion, I will refer to them primarily as "PAs."

The American Association of Medical Colleges (2021) estimates that "[b]y 2034, demand for physicians will exceed supply by a range of between 37,800 and 124,000... physicians." This demand–supply gap will include "[a] shortfall of between 17,800 and 48,000 primary care physicians" (American Association of Medical Colleges, 2021). These shortfalls will not affect the entire country equally, however, with "people living in rural communities" facing more substantial gaps in access to healthcare providers (American Association of Medical Colleges, 2021).

Over 230,000 nurse practitioners (NPs) and 125,000 physician assistants (PAs) were practicing in 2021, and they can provide many of the healthcare services offered by physicians (Bureau of Labor Statistics, 2021; Bureau of Labor Statistics, 2021). Many states, however, maintain scope-of-practice (SOP) laws that restrict the ability of NPs and PAs to deliver care. For example, states often require that physicians supervise the practices of NPs and PAs, and many states restrict the types of medications these clinicians may prescribe. States have historically justified restrictive SOP laws as necessary to promote and protect patient safety (Kleiner, 2011). Well-designed SOP laws can achieve this goal, but unnecessarily restrictive SOP laws risk inhibiting access to care. Over the last twenty years, many states have abandoned their restrictive laws in favor of broader laws that grant NPs and PAs more autonomy and authority. As these changes have occurred, two aspects of SOP laws—increasing access to and ensuring the

quality of healthcare—have become important in the debate over the best way to regulate NPs and PAs.

Recognizing the importance of NPs and PAs, robust economic and health policy literatures have emerged evaluating the care delivered by these professionals (Buerhaus, 2018; van den Brink et al., 2021; Morgan et al., 2019; Chan and Chen, 2022). Within these literatures, a separate line of research has explored the effects of different SOP laws on access to care and the delivery of care by NPs and PAs (McMichael, 2018; Kurtzman et al., 2017; Alexander and Schnell, 2019; Markowitz et al., 2017; Traczynski and Udalova, 2018). Studies focusing on SOP laws provide important evidence on the role of these laws, but they share one important shortcoming in that each focuses on a relatively narrow aspect of the healthcare system. The narrow focus of these studies allows them to provide relatively deep insight into specific aspects of access to care and care delivery, but their evidence may not be generalizable to the rest of the healthcare system.² And this potential lack of generalizability represents an important gap in the literature. This paper fills that gap by analyzing a broad outcome that is clearly connected to the healthcare system generally: death.

Specifically, I analyze a comprehensive dataset of healthcare amenable deaths to estimate the effect of relaxing SOP laws to grant NPs and PAs more autonomy and authority across the healthcare system generally. A healthcare amenable death is “defined as [a] premature death from causes that should not occur in the presence of timely and effective health care” (Nolte and McKee, 2011). Recent research has used this definition of healthcare quality when examining the impact of Medicaid expansion and other health reforms (Sommers et al., 2014; Miller et al., 2021). Unlike the narrow quality measures examined in previous work on SOP laws, healthcare amenable deaths are relevant to the entire healthcare system. Additionally, examining healthcare amenable deaths avoids important problems that may undermine the conclusions drawn from analyzing specific quality-of-care metrics. First, institutions and healthcare providers may “game” more narrowly defined quality measures, meaning measures relying on healthcare-specific data may not accurately represent the care delivered (Portuondo et al., 2022). Second, while Medicare, Medicaid, or other healthcare claims data provide a granular picture of healthcare delivery, recent research has demonstrated that this type of data may not be a reliable way to track NPs or PAs. “Incident to” billing procedures allow providers to substitute a physician for an NP or PA in the claims data under certain conditions, leaving over 30 million visits to NPs and PAs per year misclassified as physician visits (Patel et al., 2022). Because healthcare amenable deaths are broadly defined based on death certificates, examining this measure avoids some of the issues encountered in the existing literature.

In general, if restrictive SOP laws are necessary to ensure the delivery of only high-quality care as physician groups urge and some state legislatures believe, then relaxing these laws should either result in no change in healthcare amenable deaths or increase these deaths.³ If, however, restrictive SOP laws inhibit access to NPs and PAs and are not necessary to ensure that these professionals deliver high-quality care, then relaxing these laws should decrease healthcare amenable deaths.

Overall, the results support the latter hypothesis: relaxing NP and PA SOP laws leads to a statistically significant decrease in healthcare amenable deaths. Relaxing NP SOP laws reduces health-

care amenable deaths by 12 per 100,000 individuals, and relaxing PA SOP laws reduces these deaths by 10 per 100,000. These reductions suggest that relaxing SOP laws does not generally lower the quality of healthcare. With respect to healthcare access, liberalizing SOP laws for NPs and PAs has larger effects in rural areas, implying that amending these laws can improve access to high-quality care in underserved areas. Interestingly, the effects of relaxing NP and PA SOP laws on healthcare amenable deaths are larger than the effect of expanding Medicaid. Thus, to the extent policymakers consider Medicaid expansion a worthwhile policy to improve access to quality care, they may wish to consider relaxing SOP laws as well. In general, the results of the analysis provide important new evidence on the role of SOP laws in the healthcare system.

This paper contributes to several distinct bodies of literature. First, it contributes to the growing economic literature on the role of SOP laws within the healthcare system. By analyzing a broader measure of impact—deaths—than has previously been examined, this paper extends the results of prior, narrower work to the entire healthcare system (Traczynski and Udalova, 2018; Markowitz et al., 2017; Kleiner et al., 2016; Smith, 2022; Stange, 2014; Chan and Chen, 2022; Alexander and Schnell, 2019; Grecu and Spector, 2019). The evidence developed in this paper answers important questions around the generalizability of prior work within more specific healthcare contexts (Morgan et al., 2019; Razavi et al., 2021; Kuo et al., 2015; Hughes et al., 2015; Perloff et al., 2019; McMichael, 2021b). A review of the existing body of evidence in the next section demonstrates the continued relevance of the generalizability question in the context of SOP laws and individual healthcare providers, and this paper represents one of the first broad investigations of the healthcare system overall.

Second, beyond contributing to the literature on healthcare providers and SOP laws, the results developed here contribute to the broader literature on occupational licensing. Traditionally (and currently in many states), restrictive occupational licensing laws have been justified as necessary to protect unknowing consumers from “quacks” offering ineffective or harmful treatments or products (Arrow, 1963). By restricting entry into professions in the name of promoting quality, however, occupational licensing laws restrict access to services and raise the price of those services. A large body of research has examined the role of occupational licensing in the healthcare context and found evidence consistent with decreased access and higher prices (Kleiner et al., 2016; Kleiner and Krueger, 2013; Farronato et al., 2020; McMichael, 2018; Shakya and Plemmons, 2020; Markowitz and Kathleen Adams, 2022; Dillender et al., 2022). This study speaks to the question of access to services and the equally important question of whether occupational licensing improves or undermines the quality of services provided. The existing evidence is conflicted on the quality question, with many papers finding that licensing laws undermine quality and other papers finding that quality improves with occupational licensing and with dividing services among different professions (Lazuka, 2018; Anderson et al., 2020; Law and Kim, 2005; Kleiner and Kudrle, 2000; Markowitz et al., 2017; Kurtzman et al., 2017; McMichael, 2021b; Chan and Chen, 2022). The evidence developed here offers a broader view than past work has been able to provide on the impact of restrictive occupational licensing laws on both the quality of services provided and access to those services.

Finally, the results developed in this paper extend the existing literature on the role of healthcare system reform in mortality. Ostensibly, a primary goal of the healthcare system is to avoid death when possible. Multiple studies have investigated the impact of demand-side reforms on mortality, including work focused on reforms of Medicaid coverage (Miller et al., 2021; Goldin et al., 2020), Medicare coverage (Card et al., 2009), and private insurance coverage (Abaluck et al., 2021; Chandra et al., 2021). Related work has examined specific coverage mandates. For example, Son (2022)

² I do not mean to criticize these studies for their narrow focus. Each of the studies mentioned here was well executed and addressed an important topic. And future work should continue to address narrow topics in detail. I only mean to highlight the inability of these studies to provide insight into the healthcare system as a whole.

³ If these laws do not increase access to care, then healthcare amenable deaths should remain unchanged since individuals would not have more access to care. If these laws increase access to care and are necessary to ensure quality care, then healthcare amenable deaths should increase as more people receive low quality care.

finds that diabetes coverage mandates reduce diabetes-related deaths. A few studies have investigated the impact of reforms targeting healthcare providers on mortality as secondary outcomes, but none has examined the impact of SOP laws (Klick and Stratmann, 2007; Avraham and Schanzenbach, 2015). By filling this gap in the healthcare system reform literature, this paper provides important new evidence that facilitates the comparison of different healthcare system reforms on equal terms, i.e., in terms of deaths avoided.

2. Background and institutional context

2.1. Nurse practitioners, physician Assistants, and the laws that govern them

Both the NP and PA professions emerged in the mid-twentieth century (Brennan, 2020; Cawley, 2022).⁴ To become an NP, an individual must first complete training as a registered nurse. Most registered nurses practice for several years in various healthcare settings before furthering their training as NPs. NP training programs award either a master's or doctoral degree and require between 18 months and 5 years to complete (Buerhaus, 2018; Adams and Markowitz, 2018). To become a PA, an individual must complete a program that lasts three academic years on average and culminates in the award of a master's degree. Both NP and PA training programs include classroom courses as well as clinical training. Every state requires that NPs and PAs possess a license to practice, and obtaining this license involves passing different national certification exams.

Once trained and licensed, NPs and PAs practice in a variety of healthcare settings. They tend to enter primary care fields at higher rates than physicians (Dalen et al., 2017; Barnes et al., 2018; Buerhaus et al., 2015), and they also tend to care for rural, Medicaid, and underserved populations to a greater extent than physicians (Xue et al., 2018; Xue et al., 2019; McMichael, 2018). NPs tend to focus on primary care to a greater extent than PAs. Approximately 70% of NPs provide primary care (American Association of Nurse Practitioners, 2020). In contrast, approximately 25% of PAs practiced in a primary care specialty, with almost 19% and 13% practicing in surgical subspecialties and emergency medicine, respectively (National Commission on Certification of Physician Assistants, 2019).

Though NPs and PAs deliver a wide range of healthcare, the services that NPs and PAs can provide and the conditions under which they can provide those services varies from state to state. Each state has established the legal SOP for NPs and PAs through various statutes and regulations. A subset of the more familiar occupational licensing laws, SOP laws effectively determine how NPs and PAs may care for patients in each state (Anderson et al., 2020). Prior work has taken different approaches to categorizing the SOP laws governing NPs and PAs, but throughout my analysis, I adopt the coding scheme for NP laws developed by McMichael and Marowitz (2022). They reviewed individual statutes and regulations to avoid errors arising from the use of different secondary sources and inconsistent interpretations across sources (McMichael and Markowitz 2022). No similar coding system exists for PA laws, so I use a system based on McMichael (2018). The appendix reports the coding of both sets of laws and the legal citations supporting that coding.

Beginning with NP SOP laws, states fall into one of two categories: full practice authority or restricted practice. A state is coded as granting full practice authority if it: (1) requires no physician oversight of NPs by physicians and (2) grants NPs the same authority to prescribe medications as physicians. A state fails the first requirement if it imposes any sort of physician oversight on NPs, regardless of whether that oversight is denominated "supervision" or "collaboration." A state fails the second requirement if it imposes more restrictions on the prescriptive authority of NPs than on the prescriptive authority of physicians. A state that fails either of these two requirements is categorized as allowing "restricted practice." With full practice authority, NPs can practice anywhere they choose without the need to locate near a physician or refer patients to physicians for certain medications.

Unlike NPs, who have practiced independently of physicians in some states for years, PAs have only recently gained authority equivalent to full practice authority. Generally referred to as "optimal team practice," this level of independence is rare for PAs (Mittman, 2022). Only three states have changed their SOP laws to be consistent with optimal team practice, and all three did so within the last three years. However, many states have changed their laws to untether PAs from physicians without granting them the authority to practice fully independently. And that untethering is the focus of my coding system. Specifically, a state grants PAs "remote practice authority" if it: (1) requires onsite physician supervision no more than monthly and (2) grants PAs the same authority to prescribe medications as physicians. Failing either of these criteria results in a state being classified as "onsite practice." Although some states have begun moving to optimal team practice, remote practice authority still best captures the next step of liberalizing PA SOP laws in many states. With remote practice authority, PAs can practice long distances from their supervising physicians and offer a wider range of healthcare services.

Tables A1 and A2 in the appendix provide a complete list of NP and PA SOP laws, respectively, for all fifty states and the District of Columbia.⁵ One issue with using a binary coding scheme for NP and PA SOP laws is that this type of scheme may not capture incremental changes in SOP laws. For example, a law allowing NPs to sign death certificates broadens their SOP but would not, by itself, lead to a change in the SOP law classification used here. Because of this, the control group throughout the analysis—states that do not grant full practice authority to NPs and states that do not grant remote practice authority to PAs—may see small changes in their SOP laws that are not captured by my coding system. To the extent that this causes problems in the empirical estimates below, it should bias any estimates of the effect of relaxing SOP laws toward zero. If SOP laws change incrementally to broaden the SOP of NPs and PAs without crossing the boundaries established in my coding system, then NPs and PAs in control states will be able to serve patients slightly better. This should reduce the difference in healthcare amenable deaths in control and treated states, biasing the coefficients on the NP and PA SOP law variables toward zero.

Despite these limitations on the binary coding system for SOP laws, McMichael and Markowitz (2022) nevertheless recommend its use for several reasons. First, they explain that, for most health outcomes, focusing on full practice authority for NPs (and, by implication, remote practice authority for PAs) is most appropriate. Moving from restricted practice to full practice authority (remote practice authority) represents a fundamental shift in the ability of NPs (PAs) to care for patients. They are no longer tethered to physicians and can provide care in more isolated locations. These legal regimes also allow NPs and PAs to provide a wider array of

⁴ NPs are one type of advanced practice registered nurse (APRN), the other three types of APRNs include "clinical nurse specialists (CNS), certified nurse midwives (CNM), and certified registered nurse anesthetists (CRNA)" (Adams and Markowitz, 2018). All types of APRNs play important roles in the healthcare system. I focus on NPs because they are the most numerous type of APRN and provide the widest range of healthcare services. CNMs focus obstetrical and gynecological care, CRNAs provide anesthesia-related care, and CNSs focus primarily on managing patients and not necessarily on delivering healthcare services directly (Adams and Markowitz 2018).

⁵ For the remainder of the analysis, I treat the District of Columbia as a state. McMichael and Markowitz (2022) provide similar information on NP SOP laws extending back to 1998.

care to a wider array of patients because they do not require the same level of physician involvement. Accordingly, McMichael and Markowitz (2022) recommend using the coding scheme adopted here in situations where broad health outcomes are the outcomes of interest—and healthcare amenable deaths are, by design, a broad health outcome. Second, attempting to include multiple variables for multiple aspects of SOP laws (even two variables for the two components—practice authority and prescriptive authority—of full practice authority and remote practice authority described above) may induce multi-collinearity problems. States regularly enact changes to multiple aspects of SOP laws simultaneously, making estimating the separate effects of different incremental SOP-law changes exceedingly difficult. Third, focusing on the legal definitions of SOP laws outlined above allows for a comparison of the results developed in this study with a wide array of other work that has used similar definitions. These definitions also facilitate the development of the most policy-relevant evidence, as policymakers are focused on similar legal changes as those discussed above.⁶

Turning to changes in NP and PA SOP laws over time, the trend has been toward greater liberalization of SOP laws for both NPs and PAs. Fig. 1 provides more context for this trend, reporting the percentage of the US population living in a jurisdiction that granted NPs full practice authority and, separately, in a jurisdiction that granted PAs remote practice authority. In 2005—the beginning of the period considered here—<10% of the population lived in a state that had granted NPs full practice authority. By 2019—the end of the period considered here—more than a quarter of the US population lived in a state that had granted NPs full practice authority. In 2005, <30% of the population lived in a state that had granted PAs remote practice authority. This number grew to over 40% by the end of 2019.

Two aspects of this trend toward liberalization are worth noting. First, prior work has demonstrated that political spending (as opposed to healthcare-related concerns) drives changes in NP and PA SOP laws (McMichael, 2017; Traczynski and Udalova, 2018). Based on this evidence, the risk that a rise in healthcare amenable deaths causes states to change their SOP laws is minimal. Second, states do not generally relax NP and PA SOP laws simultaneously. This is not surprising, given that different political interests drive changes in the two sets of laws. It is nevertheless important for the analysis because it implies that changes in one set of SOP laws will not pick up the effects from changes in the other set of SOP laws. The analysis reported below demonstrates this empirically.

2.2 The existing evidence

Research on NPs and PAs falls into two general categories. The first category includes studies that evaluate the care delivered by NPs and PAs themselves without regard for the SOP laws in place. The second category includes studies that focus on the SOP laws governing NPs and PAs to evaluate the role those laws play in the delivery of care and healthcare outcomes.

Within the first category, multiple studies have examined the care delivered by NPs and PAs, often comparing it to the care delivered by physicians. Much of this work relies on data from Medicare beneficiaries, Veterans Affairs (VA) patients, and other public insurance programs. Buerhaus et al. (2018) examined Medicare beneficiaries and focused on 16 different quality measures grouped into four domains of primary care: chronic disease management, pre-

ventable hospitalizations, adverse outcomes, and cancer screening. They concluded that neither NPs nor physicians outperform the other group on all relevant quality measures. Perloff et al. (2019) took a similar approach to examining Medicare beneficiaries and found that restrictive SOP laws do not improve the quality of care delivered by NPs. More recently, Razavi et al. (2021) stratified Medicare beneficiaries into different risk categories and found that NPs tended to use fewer and less expensive services than physicians, particularly in lower risk strata. In another study, Muench et al. (2019) examined opioid prescriptions among the Medicare population, finding that beneficiaries managed by NPs were less likely to receive an opioid prescription but were more likely to receive a high daily dose than those managed by physicians.

Beyond Medicare beneficiaries, multiple studies have focused on the VA patient population. Morgan et al. (2019), for example, found that the use of NPs and PAs as primary care providers for complex patients with diabetes resulted in less use of acute care and lower costs overall. And Yang et al. (2018) found that diabetes management by NPs and PAs was comparable to that provided by physicians within the VA system. Other studies of a variety of populations have yielded similar evidence. For example, prior research has found that NPs do not meaningfully differ from physicians when caring for HIV patients, providing primary care, prescribing medications, or providing critical care (Wilson et al., 2005; Mundinger et al., 2000; Jiao et al., 2018; Kreeftenberg et al., 2019). And a 2021 systematic review of 39 separate studies of PAs found that “PAs delivered the same or better care outcomes as physicians with the same or less cost of care” (van den Brink et al., 2021).

In general, these studies suggest that NPs and PAs can provide care comparable to that provided by physicians in specific medical settings (Kurtzman and Barnow, 2017). On the other hand, however, some studies have found evidence that NPs and PAs overuse medical resources by ordering more diagnostic imaging than physicians, referring patients for specialty care inappropriately, overprescribing opioids, and overprescribing antibiotics (Mizrahi et al., 2018; Hughes et al., 2015; Lozada et al., 2020; Sanchez et al., 2016; Roumie et al., 2005). Other work has found that teams of resident physicians outperform NPs and PAs in hospital settings and that NPs may not meet quality metrics for diabetes as well as physicians (Iannuzzi et al., 2015; Kuo et al., 2015). And recent work found that, in the context of emergency care in the VA system, NPs used more resources but achieved worse patient outcomes than physicians (Chan and Chen, 2022).

Collectively, studies focusing on NPs and PAs provide important insight into the ability of different healthcare professionals to care for patients. Because they do not account for differences in SOP laws, however, these studies cannot elucidate the role of these laws in inhibiting access to care or promoting the delivery of high-quality care. Though fewer in number, several studies have explored the effects of different SOP laws on access to care and the delivery of care by NPs and PAs.

One set of studies has found that relaxing the SOP laws governing NPs and PAs increases the supply of these professionals in the relevant jurisdictions (McMichael, 2018; DePriest et al., 2020; Shakya and Plemmons, 2020). And other work has found that these laws also increase the amount of care delivered by individual NPs and PAs (Markowitz and Adams, 2022; Luo et al., 2021; Dillender et al., 2022).⁷ Focusing on the implications for patients, Traczynski and Udalova (2018) found that relaxing NP SOP laws leads to more people

⁶ McMichael and Markowitz (2022) explain the rationales in the context of full practice authority for NPs, but those rationales are equally applicable to remote practice authority for PAs. The only exception is the policy-relevance, since PA organizations have recently begun focusing on optimal team practice. Focusing on optimal team practice as the legal definition for PA SOP laws is not feasible, however, because so few states have adopted it and because these adoptions have occurred very recently.

⁷ Work on the related issue of the regulations governing certified registered nurse anesthetists found that removing physician supervision requirements led to only modest changes in how anesthesia-related care was delivered (Chen et al., 2023). While certified registered nurse anesthetists provide different care than NPs and PAs, the “turf war” between these providers and the anesthesiologists that supervise them is relevant to the more general debate over SOP laws.

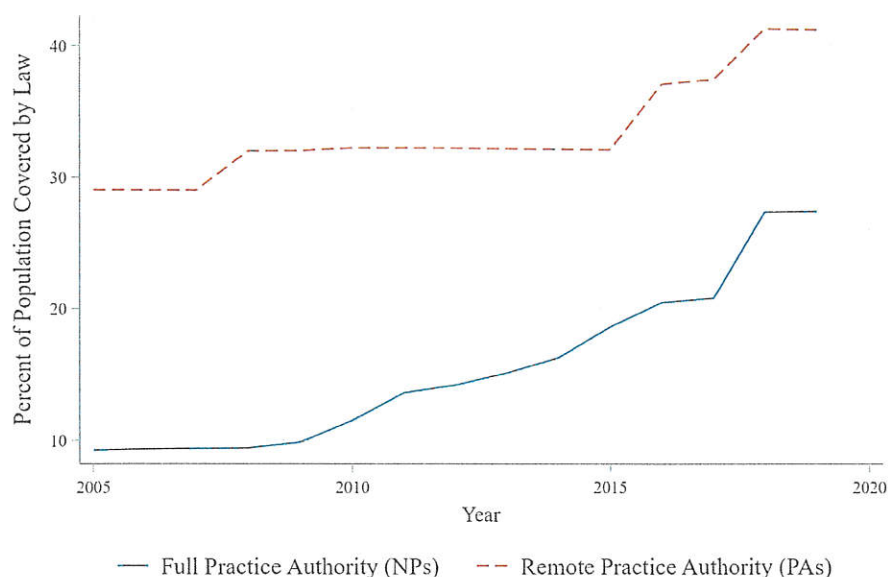


Fig. 1. US Population Covered by Relaxed Scope-of-Practice Laws Notes: Population data come from the National Cancer Institute's Surveillance, Epidemiology, and End Results Program. Information on full practice authority for NPs comes from [McMichael and Markowitz \(2022\)](#), and Appendix Table 1 summarizes the legal information for full practice authority. Information on remote practice authority for PAs comes from the author's legal research, and Appendix Table 2 summarizes the legal information for remote practice authority.

reporting access to a usual source of care and access to care when sick. Similarly, analyses by [Stange \(2014\)](#) and by [Park et al., \(2020\)](#) suggest that NPs and PAs have a bigger impact on the delivery of care when they practice under relaxed SOP laws. [Traczynski and Udalova \(2018\)](#) also found that, with increased access to care, individuals consumed less acute care. Corroborating this evidence, [McMichael et al. \(2019\)](#) found that, following Medicaid expansion, states that granted NPs more autonomy and authority saw a smaller increase in emergency department use than states restricting the practices of NPs.

Beyond access to care in general, broadening SOP laws may decrease disparities in access to care. [Bhai and Mitchell \(2022\)](#) showed that granting NPs full practice authority improved children's health and that this improvement was more pronounced among children from lower family income backgrounds. And [Plemmons et al. \(2023\)](#) found that granting NPs full practice authority better enabled NPs of color to serve Medicare beneficiaries of color.

With respect to healthcare quality, several studies have investigated specific healthcare settings. [Alexander and Schnell \(2019\)](#) found that relaxing NP SOP laws resulted in fewer mental-health related deaths and fewer days of reported poor mental health. [McMichael \(2021b\)](#) examined opioid prescriptions and found that relaxing NP SOP laws reduces opioid prescriptions by between 2% and 6%, and [McMichael \(2021a\)](#) found that opioid-related deaths also decline following the relaxation of NP SOP laws. However, [Grecu and Spector \(2019\)](#) found evidence suggesting that these types of reductions in opioid outcomes occur only when states have prescription drug monitoring programs. Recent work has found that relaxing NP SOP laws induces physicians in specialties that compete with NPs for patients to increase their prescribing of controlled substances, including opioids and anti-anxiety drugs ([Currie, Li, and Schnell 2023](#)).

Focused on more explicit measures of healthcare quality as well as healthcare services utilization and referrals, [Kurtzman et al. \(2017\)](#) found no evidence to support the conclusion that restrictive SOP laws were necessary to ensure quality. [Muench et al. \(2021\)](#) concluded that relaxing NP SOP laws increases medication adherence. Examining the types of services delivered by NPs, [Smith \(2022\)](#) found no evidence that relaxing NP SOP laws leads to the

provision of more low-value services, and [Kleiner et al. \(2016\)](#) found that the price of a common service declined following the relaxation of NP SOP laws.

In general, the existing research provides important insight into the role of SOP laws within specific healthcare settings, and future work should continue to investigate different healthcare contexts. However, the narrow focus of prior work on specific settings, single classes of drugs, and limited populations, inhibits the ability of this work to draw conclusions about the role of SOP laws across the healthcare system generally. I begin to fill this important gap in the literature by focusing on broad measures of both healthcare access and quality.

3. Data

The data analyzed here come from United States National Vital Statistics System (NVSS). Specifically, I examine the restricted-use all-cause mortality files maintained by the NVSS. The dataset includes information on all deaths in the United States, and that information comes directly from death certificates issued by individual states. The restricted-use dataset includes information on the month and year of each death and the decedent's county and state of residence. Importantly, the dataset also includes detailed information on the cause of death. Each death is assigned a cause of death based on the International Classification of Diseases (Tenth Revision) (ICD-10). Using the ICD-10 codes associated with each death, I identify healthcare amenable deaths based on prior research ([Miller, Johnson, and Wherry 2021; Sommers 2017; Sommers, Long, and Baicker 2014; Nolte and McKee 2003; 2011](#)).⁸ Healthcare amenable deaths include, for example, those caused by certain infectious diseases, diabetes, appendicitis, and hypertensive diseases.⁹ The appendix provides a full set of ICD-10

⁸ Prior work has used slightly different definitions of healthcare amenable deaths. I use a relatively expansive version based on [Sommers et al. \(2014\)](#). However, by using this definition, I do not mean to suggest that other definitions are wrong or yield inaccurate results, and nothing in this paper should be interpreted to demonstrate otherwise.

⁹ A complete list of ICD-10 codes for healthcare amenable deaths is available in appendix Table A3.

codes included in the definition of healthcare amenable death with descriptions of each code grouping. Not all deaths are healthcare amenable, however. Common non-healthcare-amenable causes of death, for example, include dementia, Alzheimer disease, and Parkinson disease (ICD-10 codes beginning with F03, G30, and G20).

In general, healthcare amenable deaths represent a useful outcome to consider because they capture the effect of different laws on the healthcare system more broadly than other, narrower measures. Additionally, because they have been developed extensively by other well-executed research, it is possible to compare the impact of NP and PA SOP laws estimated here with other legal (and non-legal) interventions considered in other work (Miller et al., 2021; Sommers, 2017; Sommers et al., 2014; Nolte and McKee 2003; 2011). However, this measure is not without limitations, as some (but not all) healthcare amenable deaths avoided in one year may occur the following year for the same reason. For example, with timely access to the healthcare system, an individual may not die of a certain type of cancer this year. That cancer, however, may cause the person's death the following year. Alternatively, however, some deaths may be avoided in the long term. For example, timely access to healthcare may save an individual from dying of pneumonia, and that person may live another 15 years before dying of Parkinson disease. Because of these issues, healthcare amenable deaths neither represent life-years saved, nor deaths avoided forever (since the same cause can result in a person's death in the next year or year after). Instead, they are better conceptualized as a broad measure of access to quality healthcare. And despite the limitations of this measure, it continues to represent the best way to examine the healthcare system broadly, as demonstrated by the multiple studies that have developed and relied on it for this purpose (Miller et al., 2021; Sommers 2017; Sommers et al., 2014; Nolte and McKee, 2003; 2011).

Next, as a falsification test, I examine externally caused deaths, *i.e.*, those deaths that result from external injuries, which are not considered healthcare amenable. These deaths include those resulting from, among other causes, unintentional injuries and homicides.¹⁰ Unlike healthcare amenable deaths, externally caused deaths should be relatively insensitive to the receipt of healthcare and therefore provide a useful point of comparison to healthcare amenable deaths. I rely on the definition of externally caused deaths provided by the Centers for Disease Control and Prevention (CDC), and the appendix provides a full list of ICD-10 codes included in the definition of externally caused death (Centers for Disease Control and Prevention, 2021).

I examine all deaths occurring between 2005 and 2019. Starting the analysis in 2005 allows sufficient time for several states to change their NP and PA SOP laws, and ending the analysis in 2019 avoids the analytical, legal, and econometric issues arising from the Covid-19 pandemic. Throughout the analysis, I focus on deaths per 100,000 people at the county level, and population data comes from the National Cancer Institute's Surveillance, Epidemiology, and End Results (SEER) Program. I merge the county-level death and population data with data from the Area Health Resource Files (AHRFs). The AHRFs include information on primary care health professional shortage areas (HPSAs) as defined by the United States Department of Health and Human Services from 2007 to 2019 and the rural-urban designation for each county as determined by the United States Department of Agriculture.¹¹ Importantly, the determination of HPSAs relies only on the number of physicians in each county—NPs and PAs are not considered when making this determination—so there is little risk that

HPSAs are endogenously determined with SOP laws (McMichael, 2018).¹²

Using the information from the AHRFs, I create a subsample of rural counties based on the definition of rural used by Kozhimannil et al. (2018)—all other counties are considered urban—and I create a separate subsample of counties that have an HPSA somewhere within the county in the relevant year.¹³ The rural and HPSA counties provide a context in which to examine changes in SOP laws where access to healthcare providers is limited. Examining these groups of counties can offer clearer insight into whether changes in SOP laws increase access to care in underserved areas. Conversely, the urban and non-HPSA counties provide a context in which to examine changes in SOP laws where accessing healthcare providers is relatively easier. If broadening SOP laws reduces healthcare amenable deaths by expanding access to providers, then doing so should have larger impacts in areas with less pre-existing access to healthcare providers relative to areas with better access. The AHRFs also include information on the number of physicians and percent of the population in poverty for each county and year. I use this information to create a series of control variables. I also use population-by-age data from the SEER data to create age profiles for individual counties. These profiles include the percentages of the county population that fall into the following age groups: 0 – 17, 18 – 64, and 65 and over.

To this county-level dataset, I add indicator variables for the following laws: full practice authority for NPs, remote practice authority for PAs, and Medicaid expansion under the ACA.¹⁴ If the relevant law became effective in a given state prior to July 1 of the relevant year, that state is coded as having that law in place during the entire year. If the relevant law became effective on or after July 1, the state is coded as having that law in place the following year.

Fig. 2 provides an overview of healthcare amenable deaths across the United States in 2019—the final year of the study period. Fig. 2 reports the number of healthcare amenable deaths per 100,000 county residents. Because of restrictions imposed by the CDC and in the interest of protecting individuals' privacy, counties with <100 deaths are excluded from Fig. 2—they are reported as “no data.” These counties are included in the primary analysis, however. In general, the Southeast, the Midwest, and Appalachia tend to have the highest rates of healthcare amenable deaths. To supplement the geographic overview in Fig. 2, **Figure A1 in the appendix** reports the evolution of healthcare amenable deaths over time and across different SOP law regimes.

Next, Table 1 reports summary statistics for the two types of deaths considered here across different SOP-law regimes and different groupings of counties. All data from 2005 to 2019 are included in Table 1. Among all counties (Panel A), fewer healthcare amenable deaths occurred in counties with full practice authority

¹² Prior work has focused on counties with an HPSA to isolate areas of the country with shortages of healthcare providers (Khouri et al., 2022). However, having an area declared an HPSA requires a specific application to the federal government by a state Primary Care Office, which often submits applications on behalf of specific HPSA candidate areas (Khouri et al., 2022). Because of this application process, the set of counties with an HPSA may not necessarily represent the total set of communities with a provider shortage. It may represent the subset of communities in which relevant actors (the Primary Care Office or a local hospital working with such an office) decide to do something about the paucity of physicians. The HPSA results should be interpreted with this limitation in mind. Despite this limitation, however, I include the HPSA results in the interest of providing a more complete picture of the role of SOP laws in mortality.

¹³ More specifically, rural counties include those with codes of 5, 7, or 9, within the Department of Agriculture's rural-urban coding system. All other counties are defined as urban throughout the analysis. Counties received their designations in 2013.

¹⁴ These SOP-law indicator variables are based on the month of effectiveness provided in Appendix Tables A1 and A2. The Medicaid expansion indicator variable is based on the dates that each state expanded Medicaid (Kaiser Family Foundation, 2022).

¹⁰ A full list of ICD-10 codes for these deaths is available in appendix Table A4.

¹¹ Health professional shortage areas were not defined prior to 2007, and the AHRFs omits information from 2014.

for NPs than in counties located in states that restricted the practices of NPs. Similarly, fewer healthcare amenable deaths occurred in counties with remote practice authority for PAs relative to counties with onsite practice requirements. Healthcare amenable deaths in rural counties and counties with an HPSA generally follow a similar pattern, as reported in Panels B and C. Externally caused deaths do not follow this pattern, however, in any grouping of counties.

4. Empirical strategy

To examine the effect of relaxing NP and PA SOP laws on healthcare amenable deaths, I estimate a series of two-way fixed effect models with the following general specification:

$$\text{Deathspercapita}_{cst} = \alpha +$$

$$\beta_1(\text{FullPracticeAuthority})_{st} + \beta_2(\text{RemotePracticeAuthority})_{st} + \gamma X_{cst} + \delta_c + \tau_t + \varepsilon_{cst} \quad (1)$$

In this model, c indexes counties, s indexes states, and t indexes time measured in years. The primary dependent variable is the number of healthcare amenable deaths per 100,000 county residents. In later models, the dependent variable is the number of externally caused deaths per 100,000 county residents or other types of deaths. The two independent variables of interest are indicators for whether a county was located in a state that had adopted full practice authority for NPs and for whether a state had adopted remote practice authority for PAs. The coefficients of interest, β_1 and β_2 , capture the effects of granting NPs full practice authority and granting PAs remote practice authority on deaths per capita, respectively.

In the primary model specifications, X_{cst} includes an indicator for whether a county was located in a state that had expanded Medicaid, as Medicaid could directly increase access to care and thereby affect the number of healthcare amenable deaths. In a series of robustness checks, X_{cst} also includes variables for the percentage of a county's population living in poverty, the number of physicians per capita, and the age profile of counties. All models include a full set of county and year fixed effects. The county fixed effects control for observed and unobserved county characteristics that are time invariant. The year fixed effects control for linear and non-linear temporal trends. Throughout the analysis, standard errors are clustered at the state level. Members of the University of Alabama research compliance office determined that this study was exempt from full review by the institutional review board.

Next, I estimate a series of event study models to examine both the parallel trends identifying assumption that underlies all two-way fixed effects models and the potential phase-in of legal effects. When estimating these event study models, I employ the following general specification:

$$\text{Deathspercapita}_{cst} = \alpha + \sum_{j=2}^J \vartheta_j (\text{lead}j)_{cst} + \sum_{k=2}^K \kappa_k (\text{lag}k)_{cst} + \gamma X_{cst} + \delta_c + \tau_t + \varepsilon_{cst} \quad (2)$$

In this specification, c , s , t , X , δ , and τ are as defined above. The leads and lags are defined as follows, where Enactment_s is the year state s enacted a new SOP law:

$$(\text{lead}j)_{cst} = 1[t \leq \text{Enactment}_s - j], \quad (3)$$

$$(\text{lead}j)_{cst} = 1[t = \text{Enactment}_s - j] \text{ for } j \in \{1, \dots, J-1\} \quad (4)$$

$$(\text{lead}k)_{cst} = 1[t = \text{Enactment}_s + k] \text{ for } k \in \{1, \dots, K-1\} \quad (5)$$

$$(\text{lead}K)_{cst} = 1[t \geq \text{Enactment}_s + K] \quad (6)$$

In equations focusing on full practice authority for NPs, the leads and lags for full practice authority are included, and the indicator for remote practice authority is included in the vector X . In equations focusing on remote practice authority for PAs, the leads and lags for remote practice authority are included, and the indicator for full practice authority is included in the vector X . The first lead and last lag indicators include the relevant year as well as all earlier (lead) or later (lag) years.

In all event study models, the omitted year is the year before enactment, meaning that the lead and lag coefficients can be interpreted as differences from this pre-enactment year. The primary event study models include the seven years before this pre-enactment year as leads and eight years after enactment as lags, i.e., $J = K = 8$. The appendix reports event studies with different time horizons, and the results are consistent with the primary event study models. In general, I find no evidence that the trends among untreated and yet-to-be-treated states are different, which supports the parallel trends assumption.¹⁵ These results are reported as robustness checks following the main analysis.

Finally, recent research has demonstrated that two-way fixed effects models may yield biased estimates when the treatment—here relaxing NP and PA SOP laws—is implemented at different points in time for different treated groups (Goodman-Bacon, 2021). And as demonstrated in Fig. 1 and the appendix, different states amended their SOP laws at different times. To address this potential source of bias, I follow the approaches of both Callaway and Sant'Anna (2021) and Borusyak, Jaravel, and Spiess (2021). Each group developed separate modeling techniques to address the potential bias in two-way fixed effects models. The results of these models are consistent with those of the two-way fixed effects models described above. Because of this consistency, the primary analysis focuses on the two-way fixed models, reserving the results of the (Callaway et al., 2021) and (Borusyak et al., 2021) models to the robustness checks.

5. Results

Table 2 reports the results from a series of two-way fixed effect models. Panel A includes all counties, Panel B includes only rural counties, Panel C includes only urban counties, Panel D includes only counties with an HPSA, and Panel E includes only counties without an HPSA. All models include the number of healthcare amenable deaths per 100,000 county residents as the dependent variable.¹⁶ In each panel, columns (1) – (6) add different variables building to the preferred specification in column (6). This process of adding variables demonstrates that the effect of each legal indicator variable remains reasonably stable as other legal indicator variables are included in the model. And this stability suggests that each legal variable is capturing the relevant legal effect and not picking up the effects of other laws.

Beginning with all counties in Panel A, granting NPs full practice authority reduces the number of healthcare amenable deaths by approximately 12 per 100,000 county residents in the preferred specification reported in column (6). Similarly, allowing PAs to

¹⁵ I find no such evidence for the following sets of counties: all counties, rural counties, and counties with an HPSA. For urban counties and counties without an HPSA, there is some evidence of differential pre-trends.

¹⁶ In the interest of completeness, Table A5 in the Appendix reports results for the effect of SOP law changes on all-cause mortality. However, these results should be interpreted with some caution because all-cause mortality includes causes of death that should be impacted by changes in SOP laws as well as many causes of death that should be largely insensitive to changes in SOP laws.

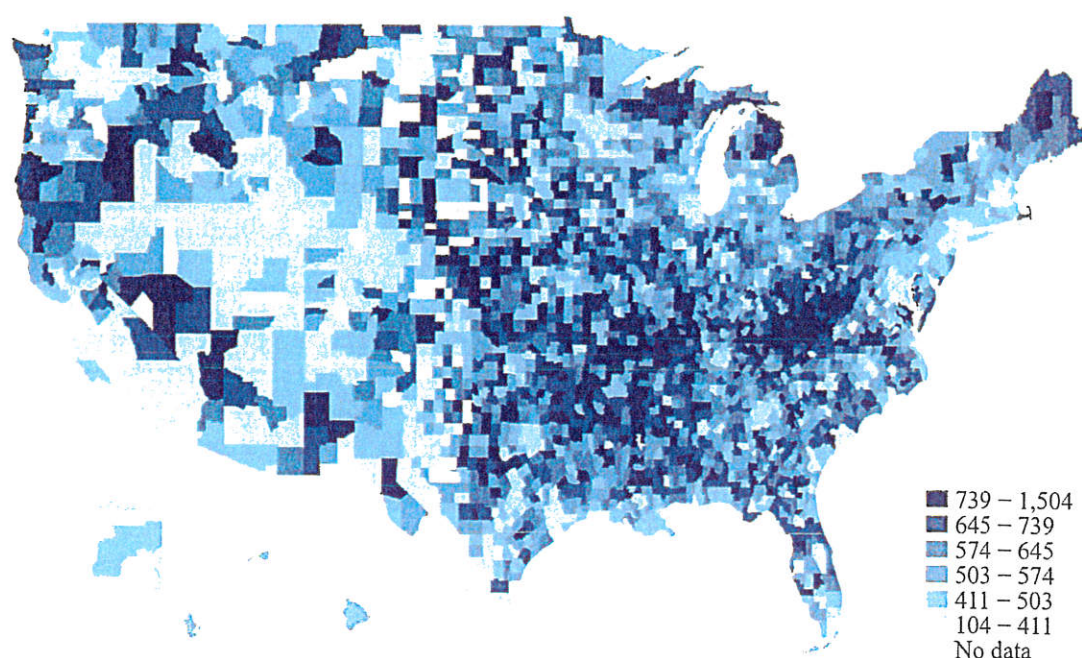


Fig. 2. Healthcare Amenable Deaths Per 100,000 Across the United States in 2019 Notes: Population data come from the National Cancer Institute's Surveillance, Epidemiology, and End Results Program. Data on healthcare amenable deaths are from the National Vital Statistics System. Healthcare amenable deaths include all deaths listed in Appendix Table A3.

Table 1
Summary statistics.

Panel A: all counties					
Death Type	Nurse Practitioners		Physician Assistants		All Counties
	Restricted Practice	Full Practice Authority	Onsite Practice	Remote Practice Authority	
Healthcare Amenable	569.78 (166.39)	514.95 (183.11)	568.57 (169.63)	540.18 (172.99)	558.63 (171.35)
Externally Caused	76.28 (34.36)	83.63 (46.39)	77.47 (35.43)	78.33 (40.38)	77.77 (37.24)
Panel B: Rural Counties					
Death Type	Nurse Practitioners		Physician Assistants		All Counties
	Restricted Practice	Full Practice Authority	Onsite Practice	Remote Practice Authority	
Healthcare Amenable	642.14 (188.37)	535.00 (203.67)	626.46 (195.26)	582.84 (202.62)	610.68 (199.05)
Externally Caused	84.62 (45.94)	90.18 (56.04)	84.71 (45.68)	88.97 (54.72)	86.25 (49.19)
Panel C: Counties with a Health Professional Shortage Area					
Death Type	Nurse Practitioners		Physician Assistants		All Counties
	Restricted Practice	Full Practice Authority	Onsite Practice	Remote Practice Authority	
Healthcare Amenable	579.11 (166.94)	519.71 (184.15)	575.33 (171.10)	547.18 (174.49)	565.63 (172.79)
Externally Caused	78.30 (35.32)	85.84 (46.12)	79.24 (36.42)	81.49 (41.25)	80.01 (38.17)

Notes: Each cell reports the mean number of deaths per 100,000 individuals for the type of death listed to the left and in the subset of counties with the legal regime listed above. Standard deviations are reported in parentheses. Death rates are calculated using data for all years between 2005 and 2019. Population data come from the National Cancer Institute's Surveillance, Epidemiology, and End Results Program. Data on healthcare amenable deaths are from the National Vital Statistics System. Healthcare amenable deaths include all deaths listed in Appendix Table A3.

practice remotely results in approximately 10 fewer healthcare amenable deaths per 100,000. Based on the mean number of healthcare amenable deaths reported in Table 1 above, granting NPs full practice authority reduces healthcare amenable deaths by 2.14% relative to counties in restricted practice states. And

granting PAs remote practice authority reduces healthcare amenable deaths by 1.75% relative to counties in states without remote practice authority. These results do not support the concern that granting NPs and PAs more autonomy and authority will result in lower quality healthcare. Interestingly, the effects of full practice

Table 2
Effect of Scope-of-Practice Laws on Healthcare Amenable Deaths.

Panel A: All Counties						
	(1)	(2)	(3)	(4)	(5)	(6)
Full Practice Authority	−13.425 ^{***} (3.083)		−12.284 ^{***} (3.048)	−13.144 ^{***} (3.119)		−12.177 ^{***} (3.086)
Remote Practice Authority		−12.295 ^{***} (3.168)	−10.093 ^{***} (3.065)		−11.820 ^{***} (3.171)	−9.927 ^{***} (3.073)
Medicaid Expansion				−1.588 (2.059)	−1.815 (2.043)	−0.709 (2.066)
Observations	47,112	47,112	47,112	47,112	47,112	47,112
R-squared	0.773	0.773	0.773	0.773	0.773	0.773
Panel B: Rural Counties						
	(1)	(2)	(3)	(4)	(5)	(6)
Full Practice Authority	−19.091 ^{***} (6.191)		−15.527 ^{**} (6.176)	−19.167 ^{***} (6.227)		−15.620 ^{**} (6.199)
Remote Practice Authority		−30.920 ^{***} (8.479)	−25.520 ^{***} (8.301)		−31.768 ^{***} (8.440)	−26.431 ^{***} (8.226)
Medicaid Expansion				1.132 (5.032)	2.961 (4.982)	3.293 (4.979)
Observations	14,175	14,175	14,175	14,175	14,175	14,175
R-squared	0.661	0.661	0.662	0.661	0.661	0.662
Panel C: Urban Counties						
	(1)	(2)	(3)	(4)	(5)	(6)
Full Practice Authority	−8.720 ^{***} (3.095)		−8.173 ^{***} (3.066)	−7.878 ^{**} (3.075)		−7.507 ^{**} (3.051)
Remote Practice Authority		−6.396 ^{**} (3.041)	−5.322 [*] (2.985)		−5.427 [*] (3.094)	−4.669 (3.051)
Medicaid Expansion				−3.352 [*] (1.935)	−3.820 [*] (1.998)	−2.919 (1.977)
Observations	32,937	32,937	32,937	32,937	32,937	32,937
R-squared	0.839	0.839	0.839	0.839	0.839	0.839
Panel D: Counties with Health Professional Shortage Areas						
	(1)	(2)	(3)	(4)	(5)	(6)
Full Practice Authority	−13.322 ^{***} (3.465)		−11.804 ^{***} (3.457)	−12.520 ^{***} (3.500)		−11.355 ^{***} (3.490)
Remote Practice Authority		−14.319 ^{***} (3.756)	−11.474 ^{***} (3.685)		−12.825 ^{***} (3.756)	−10.467 ^{***} (3.686)
Medicaid Expansion				−4.194 [*] (2.441)	−4.084 [*] (2.429)	−3.048 (2.451)
Observations	31,614	31,614	31,614	31,614	31,614	31,614
R-squared	0.774	0.774	0.774	0.774	0.774	0.774
Panel E: Counties without Health Professional Shortage Areas						
	(1)	(2)	(3)	(4)	(5)	(6)
Full Practice Authority	−10.189 (6.400)		−9.569 (6.394)	−10.693 (6.648)		−10.082 (6.646)
Remote Practice Authority		−11.319 [*] (5.484)	−10.623 [*] (5.449)		−11.371 ^{**} (5.476)	−10.663 [*] (5.441)
Medicaid Expansion				2.664 (3.591)	1.823 (3.393)	2.724 (3.587)
Observations	15,466	15,466	15,466	15,466	15,466	15,466
R-squared	0.825	0.825	0.825	0.825	0.825	0.825

Notes: The dependent variable in each model is the number of healthcare amenable deaths per 100,000 county residents. Each model includes the set of counties listed in the panel title. Each model includes a full set of county and year fixed effects. Standard errors clustered at the state level are reported in parentheses.

^{*} Statistically significant at the $p < 0.1$ level.

^{**} Statistically significant at the $p < 0.05$ level.

^{***} Statistically significant at the $p < 0.01$ level.

authority for NPs and remote practice authority for PAs are larger in magnitude than the effect of Medicaid expansion. Medicaid expansion has (as expected) a negative effect on healthcare amenable deaths, but this effect is not statistically significant.

To explore the issue of access to care in more detail, Panel B reports results for only rural counties, which have historically lacked the access to care enjoyed by more urban counties. Focusing on the preferred specification in column (6), full practice authority reduces rural healthcare amenable deaths by almost 16 per 100,000 residents, and remote practice authority reduces these

deaths by over 26 per 100,000 residents. These results contrast with those in Panel C, which reports results for only urban counties. In column (6), full practice authority reduces healthcare amenable deaths in urban areas by <8 per 100,000 residents. The effect of remote practice authority on healthcare amenable deaths, which is not statistically significant, is even smaller at 5 per 100,000 residents. Collectively, these results suggest that relaxing NP and PA SOP laws can improve access to quality care in areas of the country that typically lack such access while having a smaller and less consistent effect in areas that do not lack access.

Table 3
Effect of Scope-of-Practice Laws on Healthcare Amenable Deaths with Controls.

	(1) All Counties	(2) Rural Counties	(3) Counties with HPSA
Full Practice Authority	-13.287*** (3.283)	-17.007** (6.712)	-13.185*** (3.942)
Remote Practice Authority	-10.656*** (3.260)	-22.986*** (8.570)	-8.571** (3.918)
Medicaid Expansion	-0.843 (2.099)	2.241 (5.046)	-3.269 (2.537)
Percentage in Poverty	204.270*** (42.685)	311.242*** (108.251)	172.319*** (50.971)
Physicians per capita	-0.079** (0.038)	-0.100 (0.103)	-0.115* (0.068)
Observations	40,765	12,284	26,270
R-squared	0.780	0.670	0.782

Notes: The dependent variable in each model is the number of healthcare amenable deaths per 100,000 county residents. Each model includes a full set of county and year fixed effects. Models are limited to the counties listed above each set of coefficients. Standard errors clustered at the state level are reported in parentheses.

* Statistically significant at the $p < 0.1$ level.

** Statistically significant at the $p < 0.05$ level.

*** Statistically significant at the $p < 0.01$ level.

Continuing to explore the issue of access to care, Panel D reports a series of models limited to only counties that the federal government has determined lack adequate access to healthcare providers. In counties with an HPSA, the effects of full practice authority and remote practice authority are comparable to their effects across all counties. Full practice authority reduces healthcare amenable deaths by over 11, and remote practice authority reduces these deaths by over 10. Panel E reports results for those counties that do not include an HPSA. While the estimated coefficients for both full practice authority and remote practice authority are similar in magnitude to those reported in Panel D, the effect of full practice authority is not statistically significant. In general, the results in Table 2 suggest that relaxing SOP laws increases access to high quality healthcare and that this effect is concentrated in areas of the country that lack consistent access to healthcare providers. In other words, supply side policies can meaningfully impact the delivery of healthcare as measured by the number of healthcare amenable deaths avoided.

Because the supply side policies should—and, as demonstrated in Table 2, do—impact areas of the country that lack consistent access to healthcare providers, the remainder of the analysis focuses on all counties, rural counties, and counties with an HPSA. This is not to suggest that urban and counties without an HPSA do not matter. However, because much of the debate around SOP laws focuses on their ability or inability to increase access to healthcare in underserved areas, I focus primarily on these types of counties in addition to estimating the impact of SOP laws across all counties.

Before turning to explicit robustness checks, I estimate a series of alternative models to examine the sensitivity of the main results to my modeling choices. Table 3 reports a series of models that include additional controls for the percentage of a county's population in poverty and the per capita supply of physicians at the county level.¹⁷ An increase in poverty substantially increases the number of healthcare amenable deaths, and in all but the rural-county model, an increase in the supply of physicians decreases the number of healthcare amenable deaths. Importantly, the coefficient estimates for full practice authority and remote practice authority remain statistically significant and are comparable in magnitude to the estimates from the primary analysis. Taking seriously the coefficients on the two SOP law variables and physician supply in column (1), the results imply that granting NPs full practice authority and PAs remote practice authority is roughly equivalent to adding approximately 17 and 13 physicians per capita to the average county, respectively, in terms of healthcare amenable deaths avoided.

Next, I add controls for the age profile of counties, as changes in SOP laws may affect counties with different age makeups differently. Results with these age controls included are reported in **Appendix Table A6**. Specifically, I include variables for the percentage of the county population 17 and under and for the percentage of the county population 65 and older (with an omitted category of individuals between 18 and 64). Unsurprisingly, counties with larger percentages of older individuals experience higher death rates. And while the estimated coefficients on full practice authority and remote practice authority are somewhat smaller in magnitude, they are comparable to the estimates in the primary models and remain statistically significant. Thus, there is little evidence that the observed effects are driven by different age profiles.

Next, to address potential within-year time trends in healthcare amenable deaths, Table 4 reports results from models at the month level instead of the year level—they are otherwise identical to the primary models. These models include 12 times the number of time fixed effects, include legal variables defined at the month level, and better capture any linear or nonlinear trends in healthcare amenable deaths.¹⁸ The coefficient estimates for the legal variables of interest are much smaller, but this stems from the fact that they now represent changes in monthly deaths instead of yearly deaths. Multiplying these coefficients by 12 to arrive at yearly estimates yields substantially the same results as those from the primary analysis.

So far, all the results have been derived from two-way fixed effects models focused on healthcare amenable deaths per capita. Changing approaches, I estimate count-data models that focus on the number of deaths at the county level each year. In particular, Lee and Lee (2021) develop what they call ratio-in-ratios models. These models are roughly analogous to two-way fixed effects models in the count-data context. In two-way fixed effects models, time and group effects are cancelled by double differencing, and Lee and Lee (2021) show that, in ratio-in-ratios models, time and group effects are cancelled by double division. I estimate Poisson quasi-maximum-likelihood count models to implement the Lee and Lee (2021) ratio-in-ratios models.¹⁹ In these models, the coefficient estimates are not directly interpretable, but the semi-elasticity,

¹⁸ To be clear, these models include true month-year fixed effects and not simply year fixed effects with separate month indicator variables. Because of data availability, population is still determined yearly, not monthly.

¹⁹ The general specification for these models is: $Deaths_{cst} = \exp(\beta_1 (FullPracticeAuthority)_{st} + \beta_2 (RemotePracticeAuthority)_{st} + \delta_c + \tau_t + \ln(population_{st}))$. This is analogous to the primary models reported above. The exposure variable, the coefficient of which is constrained to equal 1, is the county population.

¹⁷ Physician supply is defined as the number of physicians per 100,000 residents.

Table 4
Effect of Scope-of-Practice Laws on Healthcare Amenable Deaths (Month Level).

	(1)	(2)	(3)
	All Counties	Rural Counties	Counties with HPSA
Full Practice Authority	−1.192*** (0.248)	−1.590*** (0.495)	−1.083*** (0.279)
Remote Practice Authority	−0.882*** (0.242)	−2.086*** (0.652)	−0.909*** (0.294)
Medicaid Expansion	−0.102 (0.170)	0.115 (0.410)	−0.307 (0.201)
Observations	565,344	170,100	379,704
R-squared	0.239	0.149	0.233

Notes: The dependent variable in each model is the number of healthcare amenable deaths per 100,000 county residents. Each model includes a full set of county and month fixed effects. Models are limited to the counties listed above each set of coefficients. Standard errors clustered at the state level are reported in parentheses. * Statistically significant at the $p < 0.1$ level. ** Statistically significant at the $p < 0.05$ level.

*** Statistically significant at the $p < 0.01$ level.

Table 5
Ratio-in-Ratios Model Results for Effect of Scope-of-Practice Laws on Healthcare Amenable Deaths.

	(1)	(2)	(3)	(4)	(5)	(6)
	All Counties	Semi-elasticities	Rural Counties	Semi-elasticities	Counties with HPSA	Semi-elasticities
Full Practice Authority	−0.017*** (0.006)	−1.686	−0.030** (0.012)	−2.955	−0.017** (0.007)	−1.686
Remote Practice Authority	−0.015** (0.007)	−1.489	−0.050*** (0.018)	−4.877	−0.013* (0.008)	−1.292
Medicaid Expansion	0.012*** (0.004)	1.207	0.008 (0.009)	0.803	0.004 (0.005)	0.401
Observations	47,112		14,175		31,614	

Notes: The dependent variable in each model is the number of healthcare amenable deaths in individual counties. The exposure variable (with a coefficient constrained to equal 1) is the natural logarithm of the county population. Because the coefficients on the legal indicator variables are not directly interpretable, each column reporting regression results is followed by a column reporting the semi-elasticity associated with each legal variable. The semi-elasticity for each coefficient is calculated as $100 * (\exp(\beta) - 1)$. Each model includes a full set of county and year fixed effects. Models are limited to the counties listed above each set of coefficients. Standard errors clustered at the state level are reported in parentheses.

* Statistically significant at the $p < 0.1$ level.

** Statistically significant at the $p < 0.05$ level.

*** Statistically significant at the $p < 0.01$ level.

$100 * (\exp(\beta) - 1)$, is the proportional effect of the relevant law on treated units.

Table 5 reports results from these ratio-in-ratios models. The column following each column of coefficients reports the semi-elasticity associated with each legal variable. Across all counties, the semi-elasticity of granting NPs full practice authority is 1.686, implying that such a grant leads to a 1.7% decrease in healthcare amenable deaths. Similarly, granting PAs remote practice authority reduces healthcare amenable deaths by 1.5%. These percentage decreases are quite close to the percentage decreases calculated from the two-way fixed effects models reported in Table 2, suggesting that the choice of modeling strategy is not driving the results. Turning to rural counties and counties with an HPSA, granting NPs full practice authority and PAs remote practice authority similarly lead to statistically significant reductions in healthcare amenable deaths. Consistent with earlier reported results, the ratio-in-ratios results suggest that relaxing SOP laws for NPs and PAs reduces healthcare amenable deaths.

6. Robustness and extensions

6.1. Event study results

To probe the robustness of the results, I run several different checks. First, I estimate a series of event studies that correspond to the main results detailed in Table 2 above. Fig. 3 reports event studies for granting NPs full practice authority (Panel A) and PAs remote practice authority (Panel B) for all counties, rural counties,

urban counties, and counties with an HPSA.²⁰ Panels C and D report event study results from the models developed by Borusyak, Jaravel, and Spiess (2021), and these models and results are discussed in greater detail in the next subsection.

Each point in Panels A and B represents the lead or lag of the relevant SOP-law variable to capture a 15-year period surrounding the adoption of new SOP laws. The omitted time period is one year before the enactment of a new SOP law, so all coefficients can be interpreted as differences from that period. In both Panels A and B, the pre-trend coefficients oscillate around zero and are individually statistically insignificant. Additionally, I run joint tests of statistical significance for all the pre-trend coefficients, and the coefficients are jointly statistically insignificant in both panels.²¹ Focusing on the results for all counties, Panels A and B of Fig. 3 demonstrate that healthcare amenable deaths declined over time following the relaxation of NP and PA SOP laws. The initial decline is small, but it grows over time. Collectively, these results support the validity of the primary analysis.

Interestingly, the event study results in Panels A and B suggest that the effect of changes in SOP laws becomes strongest around year 5 after the implementation of the new laws before stabilizing thereafter. This pattern of effects may indicate that professionals need time to adjust to the new laws. For example, an NP who practices under the supervision of a physician before full practice authority

²⁰ Appendix Tables A2 and A3 report the same event study results with larger panels and include results for counties without an HPSA.

²¹ P values from these joint tests of statistical significance are reported in Appendix Tables A7 and A8.

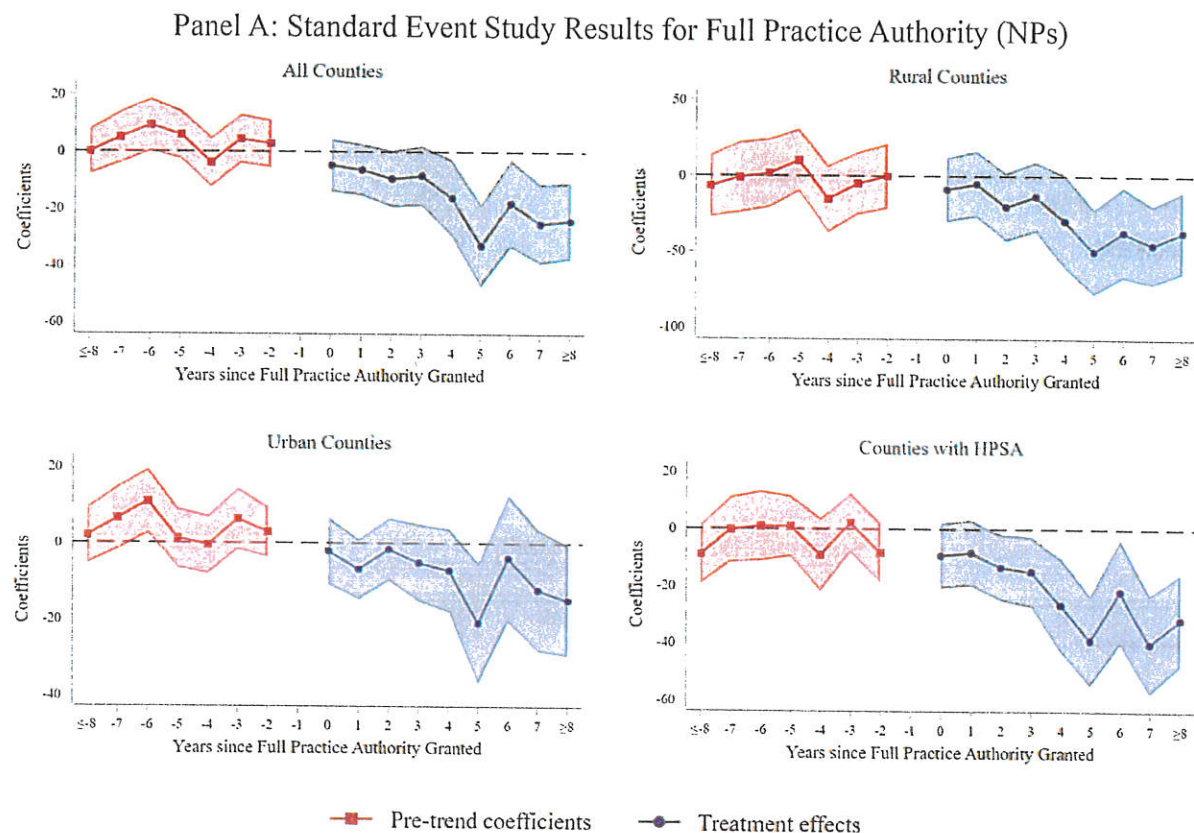


Fig. 3. Event Study Results for Healthcare Amenable Deaths Panel A: Standard Event Study Results for Full Practice Authority (NPs) Panel B: Standard Event Study Results for Remote Practice Authority (PAs) Panel C: Event Study Results (following Borusyak, Jaravel, and Spiess (2021)) for Full Practice Authority (NPs) Panel D: Event Study Results (following Borusyak, Jaravel, and Spiess (2021)) for Remote Practice Authority (PAs) Notes: Each panel reports coefficient estimates on 7 years of leads and 8 years of lags of the relevant indicator variable (with the year before the law became effective as the baseline) for the subset of counties listed above. The regression models from which these coefficients are estimated are similar to those reported in Table 2, with the lead and lag variables replacing the indicator variable for the relevant SOP law. The dependent variable in all models is the number of healthcare amenable deaths per 100,000 county residents. Standard errors are clustered at the state level, and the area around each line represents the 95% confidence interval. Event study results for models all models (including counties without an HPSA) with larger panels are provided in Appendix Tables A2–A5.

is granted would need time to find a new practice site and build a patient base following a grant of full practice authority. Five years is a reasonable amount of time to make such a large life change. Additionally, many NP and PA training programs take between 2 and 3 years to complete. Given this timeframe plus the amount of time necessary to begin treating patients in earnest, it may take 5 years for new graduates to begin affecting death rates. Finally, if current professionals in other states decide to re-locate based on a change in SOP laws, it may take up to 5 years to effect such a change. And recent research suggests that professionals account for SOP laws in their re-location decisions (Shakya and Plemmons, 2020).

In general, the results for rural counties and counties with HPSAs are consistent with the results for all counties. The coefficients on the leads of the legal variables in these models are individually and jointly statistically insignificant, and they tend to oscillate around zero. The coefficients on the lag terms suggest a phase-in period over which the effect of full practice authority and remote practice authority become more pronounced. However, the results for urban counties (and counties without an HPSA, as reported in the Appendix) provide less evidence of an effect of either full practice authority or remote practice authority. There is some evidence of pre-trends in these subsets of counties, and the post-enactment variables are not consistently statistically significant and do not suggest a clear phase-in period. These results are consistent with full practice authority and remote practice authority playing a more important role in healthcare amenable deaths in areas of the country that lack access to healthcare providers.

All figures report results from event studies that include a 15-year window because this corresponds to the length of time covered by the mortality dataset (2005 to 2019). To examine whether other time windows provide similar results, I estimate event studies using time windows of between 3 and 15 years. These results are presented in **Appendix Tables A7 and A8**. In each table reporting event study results, the first lead variable and last lag variable are indicators for the relevant lead or lag as well as all years before or after. To indicate this, the first lead and last lag are reported in bold. In addition to reporting the coefficients on the various lead and lag variables, each table also reports the P value from the relevant test of joint significance for the pre-trend coefficients. Overall, the event study results using different time windows support the same conclusions as the results reported in Fig. 3, A2, and A3. Evidence of different pre-trends is scant in the models for all counties, rural counties, and counties with an HPSA.²² And the evidence generally demonstrates the presence of a phase-in period for the effect of changes in SOP laws.

6.2 Results from alternative models

The primary results and all event studies discussed above rely on traditional difference-in-differences models. However, recent

²² There is some evidence of differential pretrends in the urban county models and the models focusing on counties without an HPSA.

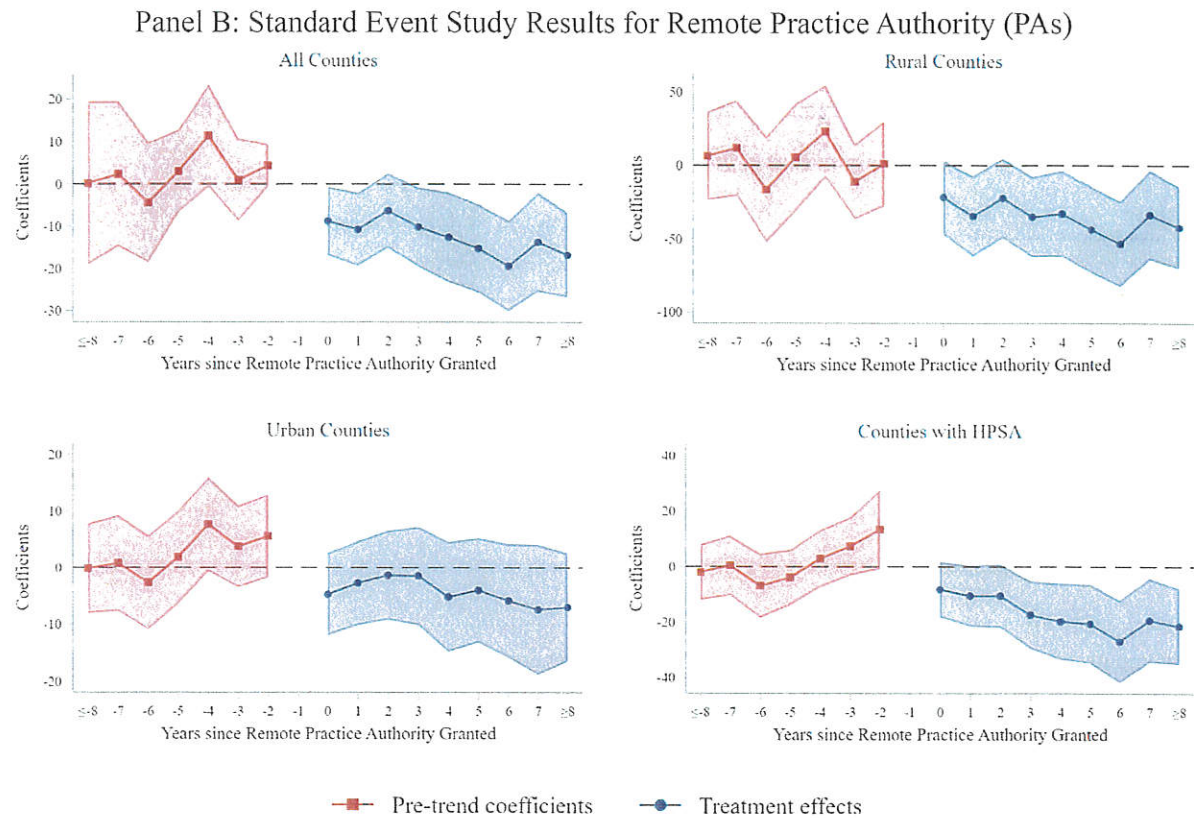


Fig. 3 (continued)

Table 6
Alternative model results for healthcare amenable deaths.

Panel A: Full Practice Authority			
Callaway and Sant'Anna			
Counties Included	ATT	Std. Err.	P-Value
All	-12.569	5.155	0.015
Rural	-17.604	10.072	0.080
HPSA	-16.495	5.655	0.004
Borusyak, Jaravel, and Spiess			
Counties Included	ATT	Std. Err.	P-Value
All	-18.013	3.248	<0.001
Rural	-26.705	6.174	<0.001
HPSA	-20.731	4.192	<0.001
Panel B: Remote Practice Authority			
Callaway and Sant'Anna			
Counties Included	ATT	Std. Err.	P-Value
All	-10.572	5.417	0.051
Rural	-29.695	15.119	0.050
HPSA	-16.456	6.253	0.008
Borusyak, Jaravel, and Spiess			
Counties Included	ATT	Std. Err.	P-Value
All	-13.624	3.618	<0.001
Rural	-28.539	8.344	0.001
HPSA	-16.631	4.835	0.001

Notes: ATT represents the average treatment effect on the treated and is comparable to the coefficient estimates on the relevant law reported in other tables. The dependent variable in each model is the number of healthcare amenable deaths per 100,000 county residents. Each model includes a full set of county and year fixed effects. Models are

work has highlighted a potential threat to the validity of models that rely on the staggered adoption of a policy over time (Goodman-Bacon, 2021). Different groups of researchers have developed new models that explicitly address the potential bias induced by the staggered adoption of treatment, and I follow two

of those approaches here. I estimate models developed by Callaway and Sant'Anna (2021), which construct two-by-two comparisons between treated and untreated units to eliminate the bias introduced by the staggered adoption of a policy. Next, I estimate models developed by Borusyak, Jaravel, and Spiess (2021), which

Table 7
Effect of scope-of-practice laws on other individual types of healthcare amenable deaths.

Death Type	Full Practice Authority		Remote Practice Authority	
	Coefficient	Std. Err.	Coefficient	Std. Err.
Infectious & Parasitic Diseases	-0.564	(0.530)	0.418	(0.618)
Neoplasms	-2.079	(1.600)	-5.256***	(1.412)
<i>Endocrine Deaths</i>	-1.685***	(0.602)	-1.911***	(0.587)
Epilepsy	-0.035	(0.030)	-0.027	(0.036)
<i>Vascular Deaths</i>	-2.371*	(1.229)	-3.809***	(1.189)
All respiratory diseases	-4.336***	(0.930)	-2.181***	(0.778)
<i>Gastrointestinal Deaths</i>	0.097	(0.063)	-0.193***	(0.052)
Infections of the skin and subcutaneous tissue	-0.088***	(0.023)	-0.094***	(0.023)
Infectious arthropathies	-0.004	(0.010)	-0.020**	(0.010)
<i>Genitourinary Deaths</i>	-1.289***	(0.334)	0.095	(0.312)
Pregnancy, childbirth and the puerperium	-0.036***	(0.012)	0.007	(0.016)
Congenital malformations originating in the perinatal period	0.293***	(0.113)	0.118	(0.147)
Misadventures to patients during surgical and medical care	-0.196***	(0.031)	-0.042	(0.038)

Notes: The dependent variable in each model is the number of deaths from causes listed on the left per 100,000 county residents. Types of deaths listed in italics include multiple sub-groups of deaths as described in Appendix Table A3. Each model includes an indicator for Medicaid expansion and a full set of county and year fixed effects. In the interest of clarity and readability, each row reports results from a separate regression model. Standard errors clustered at the state level are reported in parentheses to the right of the associated coefficient.

* Statistically significant at the $p < 0.1$ level.

** Statistically significant at the $p < 0.05$ level.

*** Statistically significant at the $p < 0.01$ level.

essentially impute a full counterfactual treatment matrix for use as a comparator. These models take different approaches to address the source of bias identified by Goodman-Bacon (2021), so estimating both sets of models offers a robust approach to addressing any bias in the results reported above.

Table 6 reports the results from these alternative models. Each row of Table 6 reports the average treatment effect on the treated (ATT) for the set of counties listed to the left and the SOP law listed in the panel title. Panel A reports results for full practice authority, and Panel B reports results for remote practice authority. The ATTs listed in Table 6 can be compared to the coefficient estimates in Table 2. All estimated ATTs from both sets of models are statistically significant. Focusing on the Callaway and Sant'Anna (2021) models, the ATTs reported in Table 6 for all counties are almost identical to those reported in Panel A of Table 2 above. In Table 2, the coefficient on full practice authority is -12.177, and the estimated ATT is -12.569 in Table 6. For remote practice authority, the estimates are -9.927 and -10.572 from Table 2 and Table 6, respectively. With respect to the results for rural counties and counties with an HPSA, the Callaway and Sant'Anna (2021) models yield ATTs larger than the estimated coefficients in Panels B and D of Table 2. Similarly, the ATTs estimated in the Borusyak, Jaravel, and Spiess (2021) models are consistently larger than the corresponding estimates in Table 2. This suggests that, to the extent the results reported above suffer from bias, the bias is toward zero (i.e., against finding an effect).

While the two sets of models in Table 6 address the issues identified by Goodman-Bacon (2021), they do not directly examine the parallel trends assumption. The results in Panels C and D of Fig. 3 address this issue. Specifically, I follow the approach of Borusyak, Jaravel, and Spiess (2021) in estimating a series of event study models. Panel C reports results for the effect of full practice authority on healthcare amenable deaths across all counties, rural counties, urban counties, and counties with an HPSA. Panel D does the same for remote practice authority. The results of these models largely parallel those seen in the event study models in Panels A and B of Fig. 3. They reveal no evidence of statistically significant pre-trends, and they demonstrate a phase-in period over which the impact of full practice authority and remote practice authority on healthcare amenable deaths becomes stronger. Results with larger panels are reported in the Appendix (see Figures A4 and A5). In

general, the models reveal little evidence of statistically significant pre-trends and suggest a phase-in period for the impact of SOP laws.

6.3 Results for components of healthcare amenable deaths

Next, to further explore the plausibility of the results, I examine individual types of healthcare amenable deaths. It is important to emphasize that this analysis serves as a robustness check and is not an exhaustive, independent analysis. While the various types of healthcare amenable deaths are certainly important and future research should investigate each type in substantial depth, that is not the purpose of my analysis—I am only examining the plausibility of the main results. Additionally, because some types of healthcare amenable deaths occur infrequently, the estimates of the impact of NP and PA SOP laws on these deaths will be noisier than the main results focusing on all healthcare amenable deaths. And the results should be interpreted with that limitation in mind. Finally, while NPs and PAs can impact many types of healthcare amenable deaths, they will not impact every type of these deaths and will not necessarily impact them in the same way. Thus, while relaxing SOP laws reduces healthcare amenable deaths overall, this is not necessarily true of each individual type of healthcare amenable death. The Appendix reports event study results for each individual type of healthcare amenable death, and these event studies demonstrate that relaxing SOP laws does not have a clear effect on each type of healthcare amenable death.²³

To examine different types of healthcare amenable deaths, I group healthcare amenable deaths by the type of death under individual ICD-10 chapters. The ICD-10 coding system is divided into chapters, with each chapter including related conditions that are grouped by the nature of the condition or the body system (e.g., endocrine system) they affect. Table A3 in the appendix lists individual sets of healthcare amenable deaths and groups together sets of healthcare amenable deaths from the same chapter (using italicized headings). For example, deaths from diabetes mellitus and

²³ Appendix Figures A6 and A7 report event study models for each of the individual types of healthcare amenable deaths. Figure A6 reports results for full practice authority, and Figure A7 reports results for remote practice authority. Collectively, the event study results provide a more comprehensive picture of the impact of different SOP laws on different types of healthcare amenable deaths.

thyroid gland disorders represent separate sets of healthcare amenable deaths, but they are grouped into the ICD-10 chapter on conditions affecting the endocrine system. Other sets of deaths include entire ICD-10 chapters (e.g., respiratory diseases) or subsets of individual ICD-10 chapters (e.g., epilepsy) and are not grouped with other chapters.

Table 7 reports results from 13 separate regression models that follow the preferred specification described above but replace all healthcare amenable deaths per 100,000 county residents with specific groupings of healthcare amenable deaths per 100,000 county residents. In the interest of succinctness, only the coefficients (and associated standard errors) on full practice authority and remote practice authority are reported for each model, and the models are presented horizontally instead of vertically. The results in Table 7 are informative as to the types of deaths that are more sensitive to NP and PA SOP laws.

The types of deaths that are most sensitive to a grant of full practice authority include endocrine deaths, vascular deaths, respiratory deaths, and genitourinary deaths. The decline in endocrine deaths (which include diabetes-related deaths) attributable to full practice authority is roughly half the size of the decline in diabetes deaths attributable to mandating diabetes coverage in health insurance policies, as estimated by recent work (Son 2022). Deaths involving pregnancy, childbirth, and malformations during the perinatal period appear to respond to a grant of full practice authority. These results should be interpreted with caution, however, because certified nurse midwives likely play a large role in impacting these deaths. The SOP laws governing certified nurse midwives, who care for pregnant women and provide labor and delivery services, are correlated with those governing NPs (McMichael and Markowitz 2022). Thus, the pregnancy and perinatal results may not represent solely the effect of SOP laws governing NPs.

The types of deaths that are most sensitive to a grant of remote practice authority to PAs include neoplasms (cancer), endocrine deaths, vascular deaths, and respiratory deaths. The larger impact of remote practice authority on cancer deaths (relative to full practice authority) is consistent with PAs providing more specialty care than NPs typically do. The same is true for vascular deaths, which may be more likely to be avoided when emergency departments are well staffed. And PAs are more likely to practice in emergency care than NPs. The larger effect of full practice authority on respiratory deaths relative to remote practice authority is consistent with NPs providing more primary care than PAs do (as respiratory deaths may be more sensitive to primary care than emergency care). The small and statistically insignificant impact of remote practice authority on pregnancy-related deaths is consistent with PAs providing relatively little obstetric care—and recent surveys

suggest they do not provide substantial obstetric care (National Commission on Certification of Physician Assistants, 2019). In general, the results reported in Table 7 support both the validity and plausibility of the primary results.

6.4 Falsification test

To this point, all models have focused on healthcare amenable deaths. The models in Table 8, however, examine externally caused deaths, and these models serve as a falsification test for the main results. Unlike healthcare amenable deaths, externally caused deaths should be largely insensitive to changes in SOP laws. Externally caused deaths include motor vehicle accidents, homicides, and unintentional injuries—a full list is provided in the appendix. Some of these deaths may be avoided if emergency departments are better staffed following the relaxation of SOP laws, but externally caused deaths generally should not change as much as healthcare amenable deaths in response to changes in SOP laws. If they do, in fact, change in response to SOP laws, that may suggest the primary results are picking up secular changes in death rates generally or some other reason for a change in death rates. If externally caused deaths do not change as much in response to SOP laws, however, that suggests the primary results represent changes in healthcare amenable deaths attributable to the role of SOP laws within the healthcare system.

Granting NPs full practice authority has no statistically significant impact on externally caused deaths, and the coefficient estimates are quite close to zero for all counties, rural counties, and counties with an HPSA. This supports the validity of the main results and suggests full practice authority works to improve access to quality healthcare. In the all-county and HPSA-county models, granting PAs remote practice authority similarly has a small and statistically insignificant impact on externally caused deaths. However, remote practice authority reduces externally caused deaths by approximately 8 per 100,000 residents in rural counties, which is smaller than the reduction in healthcare amenable deaths reported in Table 2 (approximately 26 per 100,000). Collectively, this evidence supports the conclusion that PA SOP laws work through the healthcare system, but future work should focus on the role PAs play in rural emergency departments. As noted above, PAs work in emergency medicine to a greater extent than NPs, which is consistent with the results in Table 8.

6.5 Plausibility test

The robustness checks and falsification tests described above broadly support the validity of the primary results, but neither the primary results, nor the robustness checks, allow me to specif-

Table 8
Effect of Scope-of-Practice Laws on Externally Caused Deaths.

	(1)	(2)	(3)
	All Counties	Rural Counties	Counties with HPSA
Full Practice Authority	0.524 (1.001)	-0.399 (2.092)	0.532 (1.244)
Remote Practice Authority	0.464 (1.193)	-7.926** (3.546)	1.392 (1.430)
Medicaid Expansion	3.111*** (0.644)	-0.292 (1.550)	2.527*** (0.840)
Observations	47,112	14,175	31,614
R-squared	0.379	0.260	0.383

Notes: The dependent variable in each model is the number of externally caused deaths per 100,000 county residents. Each model includes a full set of county and year fixed effects. Models are limited to the counties listed above each set of coefficients. Standard errors clustered at the state level are reported in parentheses. * Statistically significant at the $p < 0.1$ level.

** Statistically significant at the $p < 0.05$ level.

*** Statistically significant at the $p < 0.01$ level.

ically test which potential mechanism is driving improvements in healthcare amenable death rates. An increase in access to care and the provision of quality care following the adoption of relaxed SOP laws are both necessary for an improvement in healthcare amenable deaths, but the data do not allow me to specifically test which one is driving the reduction in healthcare amenable deaths. A principal benefit of the data I analyze here is that it can elucidate the general effects of SOP laws, but that benefit comes at the cost of an inability to attribute improvements in death rates to changes in access or quality specifically. Specific attribution of that sort requires more specific patient data such as that analyzed by Smith (2022), who found that NP autonomy increased following the relaxation of SOP laws.

While the data analyzed here do not allow me to attribute changes in healthcare amenable deaths to specific mechanisms, I examine (1) whether changes in SOP laws plausibly work through the healthcare system to improve healthcare amenable death rates and (2) whether the size of the estimated effects are plausible. Specifically, I analyze publicly available data on Medicare claims attributable to individual providers. As discussed above in connection with other studies relying on Medicare data, the publicly available data may misattribute NP- and PA-supplied care to physicians. This represents a significant limitation and all Medicare results should be interpreted with this important limitation in mind (Patel et al. 2022). However, these data nevertheless represent the best available information on provider-specific care at the county level. The data are available from the Centers for Medicare and Medicaid Services between 2013 and 2019. This short data window limits the analysis to a greater extent than the main analysis (which includes more than twice as many years), and it makes estimating event-study models with longer time horizons difficult. But the data can still offer some insight into how the delivery of care changes following the adoption of broader SOP laws for NPs and PAs.

To create a consistent sample, I do not consider all Medicare claims because such a sample could be sensitive to specialty procedures or services. Instead, I focus on four individual subsets of Medicare claims for services that are consistently delivered by NPs and PAs. First, I examine two subsets of evaluation and management codes that providers use for office visits from individual patients. Current procedural terminology codes 99211, 99212, 99213, 99214, and 99215 represent office visits by established patients, *i.e.*, those that the provider has seen and treated before. Current procedural terminology codes 99201, 99202, 99203, 99204, and 99205 represent office visits by new patients. Next, current procedural terminology codes 99217, 99218, 99219, 99220, 99221, 99222, 99223, 99224, 99225, 99226, 99231, 99232, 99233, 99234, 99235, and 99236 represent services provided within hospitals. Finally, current procedural terminology codes 99281, 99282, 99283, 99284, and 99285 represent services provided in emergency departments.

The first two sets of codes capture services delivered in outpatient settings and may be relevant for avoiding deaths associated with diabetes or other similar causes. The second two sets of codes capture services delivered in hospital settings and may be relevant for avoiding other types of healthcare amenable deaths, *e.g.*, vascular deaths. Of course, the analysis of these code subsets is simply for the purpose of examining the plausibility of the observed reductions in healthcare amenable deaths. Prior work has investigated and future work should continue to investigate the role of SOP laws in healthcare delivery generally, which may involve these and other subsets of current procedural terminology codes for different types of care delivery.

For each year between 2013 and 2019, the Medicare public-use data include the number of individual beneficiaries each provider billed using one of the above codes and the number of times a pro-

vider billed for each code. The number of services provided under each code captures the total volume of care for that code, and the number of beneficiaries captures the number of individuals served by the provider. Using these data, I calculate counts of beneficiaries and services for all codes within one of the specific subsets outlined above.

For this analysis, I estimate a series of ratio-in-ratio models. These models provide estimates of the semi-elasticity between relaxed SOP laws and the number of Medicare beneficiaries treated and the number of services provided by NPs (when examining full practice authority) and PAs (when examining remote practice authority). I estimate these models because the semi-elasticities offer a more direct comparison to the results above than beneficiaries per capita or services per capita (especially since the relevant population is different than the above, as Medicare primarily covers those 65 and older). By estimating ratio-in-ratio models, I avoid the need to indirectly calculate the percentage increase or decrease in the relevant metric. Thus, estimating semi-elasticities avoids unnecessary steps and provides estimates that are relevant to the question of the plausibility of the main results.²⁴

In the ratio-in-ratio models, the dependent variable is either the number of beneficiaries treated or the number of services provided by NPs or PAs as appropriate, and the exposure variable is the natural logarithm of the county population aged 65 and over. After estimating the models, I use the results to predict the number of beneficiaries treated and services provided by NPs or PAs in each county in each year of the data. I then estimate the correlation coefficient between these predicted amounts and the number of healthcare amenable deaths across all available counties and years. The correlation coefficients provide insight into whether the counties predicted to be the most heavily served by NPs and PAs see smaller numbers of healthcare amenable deaths.

Table 9 reports the results of the Medicare analysis. In the interest of parsimony, only the models that individually include the full practice authority (Panel A) and remote practice authority (Panel B) indicator variables are reported. The correlation coefficient between the predicted beneficiaries treated (or services provided) and healthcare amenable deaths per capita is reported beneath each set of model coefficients. In Panel A, full practice authority is associated with increases in the number of beneficiaries served of between 2.9% and 8.1%, depending on the category of care. Similarly, the number of services provided by NPs increase by between 3.8% and 10.3%, depending on the category of care. These increases are not generally statistically significant (with the exception of hospital evaluation and management services), though they are in line with the reduction in healthcare amenable deaths reported in the primary models above.

The correlation coefficients between healthcare amenable deaths and both beneficiaries and services attributable to NPs are negative and statistically significant across all types of care considered. These negative correlations suggest that, as NPs care for more beneficiaries and provide more services, the number of healthcare amenable deaths decreases. These negative correlations and the size of the estimated semi-elasticities support the plausibility of the main results reported above.

Turning to PAs and remote practice authority in Panel B, the estimated semi-elasticities suggest that the number of beneficiaries served increases by between 8.7% and 14.5% when PAs have been granted remote practice authority. Similarly, the number of services provided by PAs increases by between 8.1% and 13.6% when PAs can practice remotely. The coefficients in Panel B are not uniformly statistically significant, but they are consistently positive,

²⁴ Future work focused on Medicare outcomes would likely want to consider a range of outcomes and models. However, because the Medicare analysis here serves as a robustness check, I avoid reporting a large number of different approaches.

Table 9

Scope-of-practice laws and changes in medicare billing patterns.

Panel A: Full Practice Authority (NPs)				
	(1)	(2)	(3)	(4)
	Established Patient	New Patient	Hospital	Emergency
Beneficiaries	0.029 (0.023)	0.042 (0.041)	0.081 (0.050)	0.081 (0.060)
Corr. Coef.	−0.242***	−0.220***	−0.243***	−0.214***
Services	0.038 (0.024)	0.042 (0.041)	0.103** (0.052)	0.079 (0.060)
Corr. Coef.	−0.260***	−0.220***	−0.238***	−0.212***
Panel B: Remote Practice Authority (PAs)				
	(1)	(2)	(3)	(4)
	Established Patient	New Patient	Hospital	Emergency
Beneficiaries	0.087** (0.034)	0.040 (0.045)	0.145** (0.074)	0.084* (0.051)
Corr. Coef.	−0.239***	−0.237***	−0.216***	−0.246***
Services	0.081** (0.035)	0.040 (0.045)	0.136* (0.081)	0.081 (0.051)
Corr. Coef.	−0.257***	−0.237***	−0.211***	−0.246***

Notes: The dependent variable in each model is the number of Medicare beneficiaries treated or services provided by NPs (Panel A) and PAs (Panel B). Column headings indicate the type of service provided. The exposure variable (with a coefficient constrained to equal 1) is the natural logarithm of the county population aged 65 or older. Each model includes a full set of county and year fixed effects. Models include observations for the years 2013 – 2019. Standard errors clustered at the state level are reported in parentheses. Beneath the regression results, correlation coefficients are reported for the correlation between the predicted number of NP (PA) beneficiaries or services from the indicated regression and the number of healthcare amenable deaths per capita. For the purposes of statistical significance of the correlation coefficients, bootstrapping was used.

* Statistically significant at the $p < 0.1$ level.

** Statistically significant at the $p < 0.05$ level.

*** Statistically significant at the $p < 0.01$ level.

which supports the plausibility of the reduction in healthcare amenable deaths reported above. As with the correlation coefficients in Panel A, the correlation coefficients in Panel B are consistently negative and statistically significant. This suggests that, when PAs provide more care to Medicare beneficiaries, fewer healthcare amenable deaths occur. In general, the Medicare results support the plausibility of the main healthcare-amenable-death results, though they should be interpreted with the limitations described above in mind.²⁵

Overall, the robustness checks and extensions reported here support the validity of the main results. There is little evidence that the key assumptions of the two-way fixed effects models reported above are violated. And a series of falsification and plausibility tests suggests that relaxing SOP laws works primarily through the healthcare system to reduce healthcare amenable deaths.

7. Discussion and conclusion

The results of the primary analysis suggest that relaxing the SOP laws governing NPs and PAs leads to a statistically significant reduction in healthcare amenable deaths. While these reductions amount to a small percentage of all healthcare amenable deaths annually, they nevertheless translate into meaningful changes in the number of deaths. A back-of-the-envelope calculation suggests that, had all states restricting the practices of NPs and PAs relaxed their SOP laws on January 1, 2019, more than 40,000 healthcare

amenable deaths would not have occurred that year. This does not mean that granting NPs and PAs more autonomy is a silver bullet to drastically reduce the number of deaths in the United States, but it does suggest that relaxing SOP laws can improve the functioning of the healthcare system in terms of deaths avoided. In other words, the results of the analysis reported above suggest that relaxing SOP laws improves the delivery of care. And those results offer no support for the concern that granting NPs and PAs more autonomy and authority will result in the delivery of harmful or low-quality care.

To provide more context for the results, it is helpful to compare the effect of relaxing SOP laws with alternative policies that are designed to improve access to quality care. One useful point of comparison in terms of alternative supply side policies is the use of financial incentives to facilitate better access to care. Myriad such policies exist, and prior work has investigated many of these policies. For example, [Clemens and Gottlieb \(2014\)](#) found that increasing payments to physicians by 2 percent increases care provision by 3 percent. Relatedly, several studies have investigated the ability of financial incentives to increase the supply of physicians (and therefore access to care). [Falcettoni \(2021\)](#) and [Kulka and McWeeny \(2019\)](#) considered different incentives designed to reduce physician shortages and found that physicians generally do not respond strongly to such incentives—though, [Kulka and McWeeny \(2019\)](#) did find small positive effects for loan forgiveness programs. [Ghosh \(2021\)](#) similarly estimated that loan forgiveness programs increase the number of physicians by 5%.

Most relevant to the analysis here, [Khouri et al. \(2022\)](#) focused on supply-side policies designed to increase access to providers in underserved areas by examining various incentives associated with an HPSA designation. Physicians are eligible for several different incentive programs when practicing in HPSAs. They may receive 10% higher reimbursement from Medicare, loan forgiveness, and visa extensions. Analyzing HPSA designations between 2012 and 2017, [Khouri et al. \(2022\)](#) estimated that an HPSA designation increases physician supply by 1.14 physicians per 100,000

²⁵ To examine the robustness of the Medicare results, I follow [Lee and Lee \(2021\)](#) to examine the pre-trend assumption that underlies all ratio-in-ratio models. Instead of including leads and lags, [Lee and Lee \(2021\)](#) explain that the appropriate method to examine the pre-trend assumption is to include an interaction between the time variable and the relevant legal indicator variable. [Table A9](#) in the Appendix reports relevant results from this approach. Additionally, though [Lee and Lee \(2021\)](#) do not suggest the inclusion of lead variables as an appropriate test for the pre-trend assumption of ratio-in-ratio models, [Appendix Figures A8 and A9](#) report results with lead variables included to facilitate the visual inspection of potential pre-trends in the Medicare models.

residents. Comparing this result with the results detailed above suggests that relaxing SOP laws may have a more salient effect than existing financial incentives for physicians. Specifically, the results above imply that relaxing NP and PA SOP laws is equivalent to adding 17 and 13 physicians per 100,000 residents, respectively, in terms of healthcare amenable deaths avoided. This effect is roughly an order of magnitude larger than the effect of current financial incentives on physician supply as estimated by Khoury et al. (2022).²⁶ Importantly, the SOP laws I examine and the financial incentives considered by Khoury et al. (2022) are not mutually exclusive, and policymakers could certainly pursue both policies simultaneously if they wish. However, in terms of effectiveness in reducing healthcare amenable deaths, relaxing SOP laws may be more effective.

Next, the inclusion of Medicaid expansion throughout the analysis provides a relevant point of comparison between SOP laws and an important demand-side policy. Many policymakers favor Medicaid expansion as a means to increase access to care and improve health outcomes. The analysis reported here suggests that relaxing SOP laws is also a viable policy option to achieve these goals. While the coefficients on the full practice authority and remote practice authority variables are consistently statistically significant and suggest a reduction in healthcare amenable deaths between 9 and 12 per 100,000 residents, the coefficients on Medicaid expansion are both consistently smaller and statistically insignificant.

To be clear, the results reported here should *not* be interpreted as demonstrating Medicaid does or does not work as intended. Multiple studies have previously evaluated the role of Medicaid in preventing deaths, and these offer more specific results (and models calibrated to detect effects) than are provided here with respect to Medicaid. In general, the evidence on the impact of Medicaid on mortality and healthcare outcomes more broadly is mixed. (Finkelstein et al., 2012; Miller et al., 2021; Sommers, 2017; Finkelstein et al., 2016; Courtemanche et al., 2023; Baicker et al., 2013). For example, Baicker et al. (2013) and other examinations of the Oregon Medicaid experiment (in which Medicaid coverage was effectively randomly assigned) found no improvement in various clinical outcomes. On the other hand, Sommers (2017) found that early Medicaid expansions reduced all-cause mortality by 6%, with much of this reduction concentrated among healthcare amenable deaths. Miller et al., (2021) showed that Medicaid expansion reduced deaths among low-income near-elderly adults by 9.4%, with no comparable changes among other populations. Most recently, Courtemanche et al. (2023) found no evidence that early Medicaid expansions reduced all-cause or healthcare-amenable mortality.

In general, these studies demonstrate that the question of whether Medicaid expansion reduces deaths, healthcare amenable or otherwise, remains contested. They also demonstrate that, to the extent Medicaid expansion saves lives, those lives tend to be concentrated among specific populations (Miller et al., 2021; Sommers, 2017). My analysis is not limited to those specific populations, so it may not provide a clear answer on the question of Medicaid expansion. Importantly, however, that analysis demonstrates that relaxing SOP laws can impact the entire population. Thus, to the extent the goal of policymakers is to improve access to care and healthcare outcomes across the entire population, they may wish to consider relaxing SOP laws alongside Medicaid expansion as a viable policy option to do so.

A principal strength of the analysis here is that it applies to the healthcare system broadly. Healthcare amenable deaths include deaths that are sensitive to a wide variety of healthcare. By exam-

ining an outcome that is germane to the healthcare system generally, the results here extend narrower results from the existing literature to show that relaxing SOP laws improves the healthcare system overall. Importantly, however, the breadth of the measure examined here and the nature of the data mean that the analysis cannot directly identify potential mechanisms of effect.

For example, while the analysis can, and does, demonstrate that relaxing SOP laws improves the healthcare system, it does not demonstrate the specific avenues through which this improvement occurs. Indeed, some results imply that full practice authority for NPs may reduce deaths principally through primary care and that remote practice authority for PAs may reduce deaths through more specialized routes (such as emergency medical care). Similarly, the broad approach taken here cannot track how patients change their consumption of care following a change in SOP laws. With more NPs and PAs available to deliver primary care, physicians may find themselves with more capacity to treat higher complexity patients. Additionally, the analysis cannot reveal whether improvements in healthcare amenable deaths occur primarily among Medicaid or privately insured populations. These questions represent important strands of research going forward that future work with different data and focused on narrower questions should explore.

While future research should continue to explore the impacts of SOP laws on different aspects of healthcare delivery, the results here offer broad insight into the question of whether relaxed SOP laws improve care. The analysis suggests that they do and that policymakers may want to consider these laws alongside other approaches to bolster the healthcare system. As the debate over healthcare law and policy continues to develop, relaxing SOP laws should feature more prominently if policymakers remain focused on improving healthcare access and outcomes.

Data availability

The data that has been used is confidential.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Appendix A. Supplementary material

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.jpubeco.2023.104901>.

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²⁶ In alternative models, I estimate smaller effects of NP and PA SOP laws, but even these effects are generally larger than the comparable effects estimated by Khoury et al. (2022) for physician financial incentives associated with an HPSA designation.

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The effects of expanded nurse practitioner and physician assistant scope of practice on the cost of Medicaid patient care

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ABSTRACT

The provision of health care to low-income Americans remains an ongoing policy challenge. In this paper, I examine how important changes to occupational licensing laws for nurse practitioners and physician assistants have affected cost and intensity of health care for Medicaid patients. The results suggest that allowing physician assistants to prescribe controlled substances is associated with a substantial (more than 11%) reduction in the dollar amount of outpatient claims per Medicaid recipient. I find little evidence that expanded scope of practice has affected proxies for care intensity such as total claims and total care days. Relaxing occupational licensing requirements by broadening the scope of practice for healthcare providers may represent a low-cost alternative to providing quality care to America's poor.

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1. Introduction

Providing health care to low-income Americans remains an ongoing policy challenge. Occupational licensing laws typically dictate the tasks that healthcare professionals are allowed by law to complete. Occupational licensing laws have begun to come under increased scrutiny as a result of a recent White House report documenting the costs and benefits of the laws [1]. The American Medical Association has historically exerted great influence over the licensing of physicians and other healthcare professionals and was described by Milton Friedman as the “strongest trade union in the United States.” [2], p. 150.

Two types of healthcare professionals that are becoming a more important part of healthcare delivery in the United States are nurse practitioners (NPs) and physician assistants (PAs). Each state has different rules for the

scope of practice of NPs and PAs. According to the Controlled Substances Act of 1970, controlled substances are drugs or chemicals that are illegal to sell without first obtaining a prescription from a health care provider as a result of their potential for abuse. Controlled substances are assigned into five different “schedules”—Schedule V substances have little potential for abuse and Schedule I substances have a very high potential for abuse. In some states, PAs are allowed to prescribe controlled substances with physician supervision; in others, they are not. The same is true for NPs. However, some states grant NPs the authority to prescribe controlled substances *without* physician supervision—effectively allowing them to practice autonomously.

Although this paper is primarily focused on the US, the PA occupation also exists in countries such as Canada, Ghana, the Netherlands, India, and the United Kingdom. NPs work in other countries such as Canada and nurses can obtain prescriptive authority in the United Kingdom as well. Whether the scope or practice of these professions in

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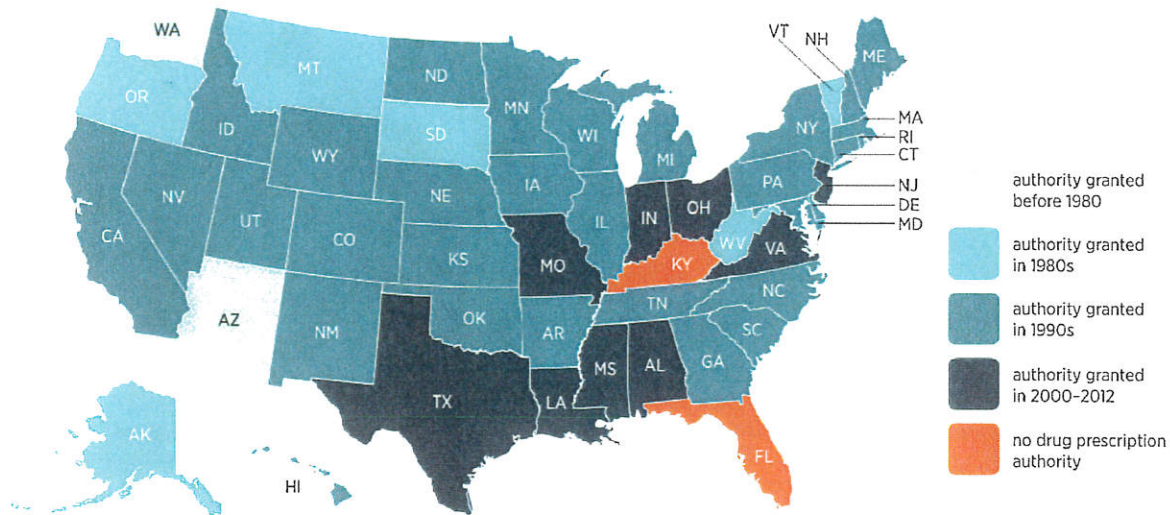


Fig. 1. Where physician assistants have authority to prescribe controlled substances—2012.

Source: Based on data from the American Academy of Physician Assistants.

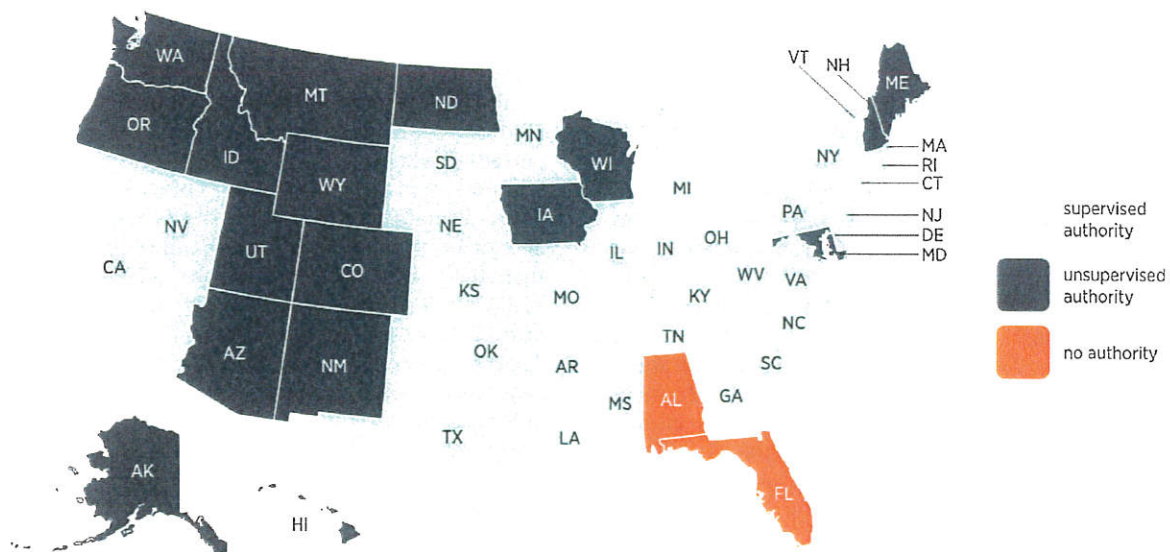


Fig. 2. Where nurse practitioners have prescription authority and autonomy, 2012.

Sources: Based on data from Kevin Stange, "How Does Provider Supply and Regulation Influence Health Care Markets? Evidence from Nurse Practitioners and Physician Assistants," *Journal of Health Economics* 33, no. 1 (2014); and Morris Kleiner et al., "Relaxing Occupational Licensing Requirements: Analyzing Wages and Prices for a Medical Service" (NBER Working Paper No. 19906, National Bureau of Economic Research, Cambridge, MA, February 2014).

is thus likely to reduce overall cost of care. Alternatively, if allowing PAs and NPs to prescribe controlled substances augments the complementary relationship between the three providers, we would expect an increase in care intensity and an ambiguous effect on cost. Physicians would likely switch focus to more complex tasks and the overall amount of care delivered may increase, but the physicians would continue to be providing care at similar intensity and thus the cost savings from substitute may not be achieved.

A small but growing economics literature has emerged estimating the effects of occupational licensing [9,10]. A number of papers estimate the effects of occupational licensing of healthcare professions ranging from dentists

to radiologic technologists [11,12]. Researchers generally find evidence that more restrictive entry requirements for healthcare professionals have resulted in higher professional salaries and higher prices for consumers, but researchers have been unable to find definitive evidence of improvements in the quality of care delivered to consumers [13]. A subset of the occupational licensing literature has focused specifically on the issue of scope of practice. The existing literature documents "battles" between dentists and dental hygienists and among chiropractors, physical therapists, and physicians [14,15]. A few papers have specifically focused on competition among NPs, PAs, and physicians. Perry [16] examined the effects of liberalizing

CMS-MSIS data were then merged with data counting the number of employed PAs and NPs in each state from the American Community Survey and the Annual ARPN legislative update from the *Nurse Practitioner* magazine (Phillips [26] is the most recent version), respectively. These data sources were chosen for two main reasons: the data were publicly available and the data were available for all of the years (1999–2012) included in the CMS-MSIS data. The merged CMS-MSIS and ACS data were then merged with information on the prescription authority and autonomy of PAs and NPs. Data on prescription authority for PAs and NPs was obtained from the American Association of Physician Assistants and the previous work of Stange [18] and Kleiner et al. [17] respectively. Data on real personal income per capita (in 2012 dollars) and state unemployment rates also were included and were obtained from the St Louis Federal Reserve Economic Data resource.

2.4. Measures and analysis

To analyze the effect that allowing PAs and NPs the authority to prescribe controlled substances, regression analysis will be employed to estimate the following equation:

$$\begin{aligned} \text{Medicaid outcome}_{s,t} = & \alpha + \beta_{s,t}(\text{scope of practice}) + \mu_{s,t} \\ & (\text{professional density}) + \gamma_{s,t}(\text{state controls}) \\ & + \Psi_{s,t}(\text{state and year fixed effects}) + \varepsilon_{s,t}, \end{aligned}$$

Medicaid outcomes include total Medicaid claims per beneficiary in 2012 dollars, total outpatient Medicaid claims per beneficiary in 2012 dollars, and total prescription drug Medicaid claims per beneficiary in 2012 dollars, as well as the total Medicaid claims (in 2012 dollars) and total care days (in thousands of days). The claim values per beneficiary are meant to capture the cost of providing care. Total Medicaid claims and total care days are meant to proxy for care intensity. Presumably, higher total claim amounts and care days would potentially support higher levels of care intensity. Higher total claim amounts may also result from more expensive patient treatments that are not necessarily consistent with increased care intensity. I am unable to distinguish each of these effects with total claim amounts and therefore this measure only proxies for care intensity.

Professional density is measured by taking the number of each employed professional (NP or PA) in state s at time t and dividing by the state's population at time t in thousands of persons to construct measures of NP density and PA density. *State controls* are meant to capture differences in Medicaid enrollment across states that may vary over time. I use real state personal income per capita (in 2012 dollars) and the state unemployment rate to control for these changes. The *state and year fixed effects* variables refer to binary indicator variables (coded as either 0 or 1) for each year and each state in the sample. These variables allow me to control for any state- or time-specific differences in Medicaid outcomes. For example, the fact that health outcomes are below average in poorer states like West Virginia

is accounted for with a “West Virginia” indicator variable. As an additional control, I include both linear and quadratic state-specific trends in the regressions. The inclusion of the trend variables in the regression control for variations in Medicaid outcomes across states that may change over time.

The main variable of interest in the analysis, *scope of practice*, is measured differently given the nature of the regulatory differences for each profession. According to data obtained from the American Academy of Physician Assistants, states fall into one of two categories: either allowing PAs to prescribe controlled substances with physician supervision or not allowing PAs to prescribe controlled substances. To measure the effect of allowing PAs to prescribe controlled substances, I count the number of years that have elapsed since the law took effect. I then separate states into groups and construct dummy variables using the number of years that PAs have had the authority to prescribe controlled substances with physician supervision: PAs not allowed to prescribe controlled substances, PAs allowed to prescribe controlled substances for 1–5 years, PAs allowed to prescribe controlled substances for 6–10 years, and PAs allowed to prescribe controlled substances for 11 years or more. I also measure the ability of PAs to prescribe controlled substances using a simple indicator variable equal to 1 if PAs are permitted to prescribe controlled substances with physician supervision in state s in year t and zero otherwise. For NPs, states fall into one of three categories: states that allow NPs to prescribe controlled substances without physician supervision, states that allow NPs to prescribe with physician supervision, or states that do not allow NPs to prescribe controlled substances at all. In this case, to properly separate cases, I use simple indicator variables: an indicator for if NPs are able to prescribe controlled substances without physician supervision in state s and year t and a different indicator if NPs are able to prescribe controlled substances only with physician supervision in state s and year t . For example, Tennessee first allowed NPs to prescribe controlled substances in 2000. Tennessee observations from 1999 and 2000 are coded as 0 and then 1 thereafter for the *NP Prescriptions with Supervision* indicator variable. All Tennessee observations are coded as 0 for the *NPs Prescribe without Supervision* indicator variable.

To better understand the effect of expanded scope of practice for NPs and PAs has had on Medicaid patients, the methodology of difference-in-differences regression analysis will be used to estimate how these changes have affected Medicaid patients in each state. The methodology will rely on those states that changed status (either from not allowing PAs or NPs to prescribe controlled substances to allowing them to prescribe controlled substances or from allowing NPs to prescribe with supervision to no longer requiring supervision) and controls for state- and time-specific factors that may have influenced Medicaid outcomes. All of the analysis is done at the state level.

3. Results

Table 1 presents the results of the regression estimations. In Table 1, I measure PA scope of practice by grouping

about 11.8–14.4% evaluated at the mean level of outpatient claims per beneficiary) and appears to take effect in the first few years after PAs are allowed to prescribe controlled substances with physician supervision. I find less convincing evidence that allowing NPs to prescribe controlled substances has had a similar effect, although it should be noted that the coefficient on the dummy variable indicating that NPs can prescribe controlled substances without physician supervision is large and negative in both specifications but is not statistically significant. Taken together with the coefficient estimates on care intensity, these results are consistent with broader PA scope of practice better allowing PAs to substitute for physicians as explained earlier in the paper.

As an additional robustness check of the results presented in Tables 1 and 2A, I re-estimate the same equation, but separate states that grant PAs more limited privileges to prescribe controlled substances. Alabama, Arkansas, Georgia, Iowa, Louisiana, Maine, Missouri, and West Virginia do not allow PAs to prescribe schedule II controlled substances. Schedule II controlled substances are potentially highly addictive (for example, opioids fall into this category). I construct two new dummy variables: full controlled substance privilege and partial controlled substance privilege. The variables are coded in a similar fashion as the indicator variable reported in Table 2A. Table 3A reports the results of this estimation. There is additional evidence that giving PAs the authority to prescribe controlled substances is associated with reduced outpatient claims per beneficiary. The savings is notably higher (\$148 vs. \$69 or 16% vs. 7.5% evaluated at the mean) in those states that grant PAs full prescription privileges (including schedule II controlled substances).

4. Discussion

Taken together, the results in the previous section are fairly consistent with the findings in the literature that looks at the effects of broadening NP and PA scope of practice on access to and quality of care for all patients. As noted in the preceding section, the existing literature finds evidence that broadened scope of practice has increased access to care without infringing on the quality of service delivered to patients. Results from Tables 1–3A suggest that broader PA scope of practice may have reduced the cost of outpatient services delivered to Medicaid patients. Taxpayers more broadly may also stand to benefit if the costs of services delivered to low-income Americans are reduced. I am unable to find evidence that allowing PAs or NPs to prescribe controlled substances affects care intensity. This result seems to be consistent with the hypothesis that broadening the scope of practice for each professional allows PAs and NPs to be better positioned to substitute for some of the services provided by physicians. One key contribution of this study is the length of time period examined and the ability to explore how these important changes in PA and NP scope of practice have affected healthcare cost. Some limitations of this study are the inability to simultaneously explore how each of these changes has affected healthcare access and care intensity in a more direct fashion. For example, Oliver et al. [25] explore some of these

issues in their study, but rely on a single cross section (single year of data). Barnes et al. [20] and Cross and Kelly [22] also rely on data from a single cross section. Ideally, future research would be able to explore each of these issues simultaneously using a rich panel or longitudinal data set over several years.

5. Conclusion

In this paper, I have estimated the effects that modifications to existing occupational licensing laws allowing NPs and PAs to prescribe controlled substances have had on the cost and intensity of health care for Medicaid patients. The results suggest that broader scope of practice for PAs is correlated with cheaper outpatient care (an 11.8–16.0% reduction, depending on specification) without negatively affecting intensity of health care. There are at least two important policy takeaways from these results. First, policymakers in Kentucky, the only state that prohibits PAs from prescribing controlled substances, should consider broadening the scope of practice of PAs to allow them to prescribe controlled substances with physician supervision. Second, states that do not currently allow both NPs and PAs to prescribe controlled substances without physician supervision should consider changing their laws to allow them to do so. The results of this paper, combined with findings of other researchers, suggest that broader scope of practice for NPs and PAs has little effect on the quality of care delivered, increases access to health care, and also potentially reduces the cost of providing health care to patients. More generally, broadening the scope of practice of non-physician healthcare providers and reducing the monopoly power of physicians in the healthcare market is very likely to improve consumer welfare.

Appendix A. Supplementary data

Supplementary data associated with this article can be found, in the online version, at <http://dx.doi.org/10.1016/j.healthpol.2016.12.002>.

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