NBER WORKING PAPER SERIES

OCCUPATIONAL LICENSING AND THE HEALTHCARE LABOR MARKET

Marcus Dillender
Anthony T. Lo Sasso
Brian J. Phelan
Michael R. Richards

Working Paper 29665
http://www.nber.org/papers/w29665

NATIONAL BUREAU OF ECONOMIC RESEARCH
1050 Massachusetts Avenue
Cambridge, MA 02138
January 2022, Revised January 2022

We thank Sara Markowitz for her very helpful comments on an earlier version of this paper. Lo Sasso gratefully acknowledges a grant for acquiring the data used in this research from the Charles Koch Foundation. The views expressed herein are those of the authors and do not necessarily reflect the views of affiliated organizations or the National Bureau of Economic Research.

Occupational Licensing and the Healthcare Labor Market
Marcus Dillender, Anthony T. Lo Sasso, Brian J. Phelan, and Michael R. Richards
NBER Working Paper No. 29665
January 2022, Revised January 2022
JEL No. I11,J44

ABSTRACT

We examine the labor market impact of states easing occupational license requirements by expanding the scope of practice (SOP) for nurse practitioners (NPs), allowing them to practice without physician oversight. Using data on job postings, we find that employers increase their demand for NPs when states expand NP SOP. We then show that these laws increase NP earnings and reallocate NPs across the healthcare sector, increasing self-employment and changing industrial employment. However, we see no evidence that these laws have increased overall NP employment. Our results suggest that expanding NP SOP has the potential to increase the number of primary care providers, but inelastic labor supply for NPs is largely preventing this from occurring.

Marcus Dillender
Health Policy and Administration
University of Illinois at Chicago
1603 W. Taylor Street
Chicago, IL 60612
and NBER
modillen@uic.edu

Anthony T. Lo Sasso
Economics Department
DePaul University
1 East Jackson
Chicago, IL 60604
USA
alosasso@depaul.edu

Brian J. Phelan
Department of Economics
DePaul University
1 East Jackson Blvd.
Chicago, IL 60604
bphelan2@depaul.edu

Michael R. Richards
Baylor University
Department of Economics
One Bear Place #98003
Waco, TX 76798
michael_richards@baylor.edu

1 Introduction

A growing number of occupations in the United States require workers to obtain a government-issued license that sets forth the tasks they are legally allowed to perform, with nearly 30 percent of American workers currently licensed by the government (Kleiner and Krueger 2013). Despite this growth, the effects of occupational licensing on market efficiency and outcomes remain unclear and likely vary across settings. Occupational licenses may harm market outcomes because they artificially limit the supply of workers—raising some workers' wages, limiting output, and increasing consumer prices. However, occupational licenses could improve market outcomes because they help ensure some minimum level of service quality, which could increase consumer demand if there is customer uncertainty about service quality (Kleiner 2000).[1] In this regard, the benefits of licensing will be larger when service quality varies a lot across providers, when informational asymmetries about quality are high, or when the costs/benefits of service quality are substantial. Thus, the debate about occupational licensing often boils down to comparing the service quality improvements associated with licensing with the distortions created in the labor and product markets that result (Cramer and Krueger 2016).

Occupational licensing is particularly common in the healthcare sector, where more than 75 percent of non-physician practitioners are required to be licensed (Kleiner and Park 2010; Nicholson and Propper 2011). The ubiquity of licensing in the healthcare sector likely stems from the importance of providing quality healthcare services, the potential for large differences in service quality across providers, and the high degree of patient uncertainty about provider quality. That said, excessive licensing in the healthcare sector could unnecessarily limit access to medical care and contribute to rising healthcare costs (Kleiner and Park 2010; Wing and Marier 2014; Timmons 2017)—two problems that continue to plague the sector.

[1] Certifications are another way that the government can offer some quality control in a marketplace. Occupational licenses differ from certifications in that only licensed workers can be employed in occupations that require licenses while anyone can work in an occupation that has certifications (whether they have the certification or not). From a consumer's point of view, licensing requires the consumer to purchase the service from a licensed provider while certification gives consumers the option of buying from a certified provider or not. See Kleiner (2000) for more details on this distinction.

In this paper, we study the labor market impacts of "scope of practice" restrictions pertaining to a nurse practitioner (NP) occupational license. Scope of practice (SOP) refers to the set of actions that a license allows the relevant healthcare provider to legally perform. For NPs, SOP is set by state law and specifically determines the tasks that NPs can perform with and without direct physician oversight.[2]

The stated rationale for limiting NP SOP—like most occupational licenses—centers on the need to ensure patient safety. Physician organizations, in particular, have championed restricting the scope of practice for non-physician healthcare occupations and argue that expanding the scope of practice of non-physician providers harms patients' health without improving access to care.[3] However, research on the effect of expanded NP SOP on patients' outcomes finds evidence that is inconsistent with this claim. Alexander and Schnell (2019) find that expanded NP SOP is associated with improvements in self-reported mental health and decreases in mental health-related mortality. Traczynski and Udalova (2018) find that broadening SOP laws for NPs led to increased frequency of check-ups and reduced emergency room use. Poghosyan et al. (2019) find that states that expanded NP SOP provided greater intensity of care for Medicaid patients without increasing the total costs of care. Lastly, Kleiner et al. (2016) find that laws expanding SOP for NPs did not impact the quality and safety of health services.[4] Thus, there is an absence of evidence that requiring physician oversight of NPs improves patient care.

The potential downsides associated with restricting NP SOP are that it may limit access to primary care and inflate costs by maintaining physicians' centrality to the production process. Indeed, Perry (2009) and Kleiner et al. (2016) both find that expansion of NP SOP lowered physician earnings and raised NP earnings, suggesting that restraining NP substitutability raises demand for costly physicians, leading to elevated physician salaries and potentially higher primary care spending. Relatedly, Kleiner et al. (2016) also show

[2]Oversight in this context can take a variety of forms ranging from the co-provision of a given service to periodic reviews of NP care delivery and decision-making.

[3]For an example, refer to Why Expanding APRN Scope of Practice Is Bad Idea, which was written by American Medical Association reporter Andis Robeznieks and posted to the American Medical Association website on October 30, 2020.

[4]Expanded SOP for other healthcare occupations has also shown no negative effects. Markowitz et al. (2017) find that expanding SOP laws for certified nurse midwives did not impact maternal or infant health outcomes.

that expanded NP SOP decreased the transaction price of well-child visits by 3-16 percent, consistent with the potential for expanded NP utilization to decrease primary care costs. Yet, there is limited information regarding the extent to which expanded NP SOP increases the number of primary care providers (and thus, access to primary care), and in particular the mechanisms behind such changes.[5] An increase in NPs could come from either more people entering the profession or a reallocation of NPs across the healthcare sector. For example, if NPs seek out different job settings when granted clinical independence, such as self-employment or shifting into privately-owned clinics, this reallocation could potentially reduce geographic access disparities, increase the number of NPs engaged in primary care, and encourage greater provider competition—even if the quantity of providers is unchanged. Markowitz and Adams (2022) study the labor supply response of expanded NP SOP for the earlier generation of SOP laws. They find no effects for NPs on employment probabilities, part-time work, holding multiple jobs, and relocation, but some evidence for positive effects on wages as well as large positive effects on self-employment for NPs. Work by Luo et al. (2021), using the same data set as Markowitz and Adams (2022) find that SOP laws were associated with an increase in hours worked and small changes in place of service consistent with care moving to ambulatory care settings. However, little is known about the mechanism behind these impacts, making it an important area of research that speaks to states' ability to expand access to medical services using SOP policy levers.

In this paper, we estimate the impact of states expanding nurse practitioners' scope of practice on states' healthcare labor markets using a difference-in-differences research design over the period 2010-2019. Our emphasis is on understanding how SOP laws affect labor demand, in contrast to earlier efforts that have focused primarily on supply responses. We complement this analysis with an examination of the impact on labor market outcomes, thus providing a plausible way for expanded NP SOP to increase access to primary care. The analyses proceed in two parts. First, we examine the impact of NP SOP on labor demand for NPs and other healthcare providers using a universe of job postings collected by Burning

[5] Alexander and Schnell (2019) find that the positive mental health effects associated with expanded NP SOP tend to be stronger in areas (and among populations) traditionally underserved by physicians, which is suggestive of increases in access. Smith (2022) finds that expanded NP SOP did not change the volume of patients nor the provision of low-value services performed by NPs at primary care practices.

Glass Technologies (BGT). The job posting analysis allows us to assess the magnitude of the change in labor demand as well as whether expanded SOP changes the skills that employers value in new NP hires. Next, we examine how expanded NP SOP changes labor market outcomes of NPs and other healthcare professionals using the American Community Survey (ACS). This analysis allows us to examine how the change in demand (from the BGT data) manifests itself in terms of changes in earnings and overall employment. We are also able to capture other dimensions of changes in NP labor demand that would be difficult or impossible to detect in the BGT data: impacts on self-employment and changes in NP employment across the healthcare sector.[6]

We find that expanded NP SOP increases the number of job postings for NPs without affecting the number of job postings for primary care physicians (PCPs), physician assistants (PA), registered nurses (RN), or licensed practical nurses (LPN). However, the effect occurs with a lag, and the estimates imply that job postings for NPs increased by about 30 percent beginning two years after SOP adoption—with similarly large gains in health professional shortage areas (HPSA) and all other counties within a state. Interestingly, expanded SOP did not substantively change the skill demands in NP job postings. Thus, the more favorable regulatory environment did not lead to different types of NPs being desired by employers or alter employers' expectations about the tasks NPs would perform. Rather, they simply reflect an overall increase in demand for NPs. This change in NP labor demand is also evident in the ACS, where we find that expanding NP SOP increased earnings for NPs but did not change overall NP employment. However, expanded NP SOP does appear to reallocate NP employment across the healthcare industry, increasing self-employment among NPs and shifting the employment of NPs away from hospitals and towards outpatient care centers. This reallocation could be associated with an increase in the number of primary care providers, but we present only suggestive evidence that this is actually occurring. Our results imply that expanding SOP for NPs increases labor demand for NPs and thus, has the potential to increase the number of primary care providers. However, inelastic labor supply for NPs is largely preventing this from occurring in any meaningful way, at least in

[6]Self-employment, for example, would obviously not be reflected in a data set of employers' job postings.

the short-run. Likewise, given the number of years involved to become an NP, movement of the labor supply curve is not something likely to manifest immediately.

Our work makes important contributions to the literature on occupational licensing by examining the labor market effects of licensing regulations in the healthcare labor market. We expand upon the analysis in Kleiner et al. (2016) by quantifying how full clinical independence of NPs affects labor demand, place of employment, and ultimately access to primary care. Our findings also speak to the ways in which occupational licensing can affect the industrial organization within a market including the geographic allocation of firms and number of competitors. In these ways, our research sheds further light on the efficiency and effectiveness of the healthcare workforce (e.g., see Nicholson and Propper 2011) and more broadly contributes to economic research concerned with how labor markets respond to changes in worker tasks, the value of particular job tasks, and changes in technological and institutional constraints (e.g., see Acemoglu and Autor 2011).

2 Background

Below we provide details on scope of practice laws as well as a basic conceptual framework for considering their effects on healthcare labor markets.

2.1 Scope of Practice Laws

The nurse practitioner profession began with a certificate program in the 1960s that aimed to provide nurses with the training to perform more healthcare tasks in response to concerns about healthcare capacity that arose as the creation of Medicaid and Medicare increased demand for medical care (IOM 2010). Since the 1960s, the number of NPs in the United States has grown, as has pressure to allow NPs to practice independently. NPs are currently the fastest growing type of primary care provider in the United States (Auerbach et al. 2020).

SOP refers to the set of actions that a healthcare provider's professional license allows the provider to legally perform. SOP laws for NPs vary across states and largely govern the types of tasks for which NPs need physician oversight to perform. States with restrictive NP SOP laws require NPs to have formal agreements with physicians to oversee the care NPs

provide. Depending on the state, NPs may need some version of physician involvement to prescribe medications, to order tests, and/or to admit patients to the hospital. In contrast, states with full practice authority for NPs allow NPs to practice without any degree of formal physician oversight or involvement in NP care delivery.

State legislatures have recently taken greater interest in NP SOP rules, with several states doing away with them completely. Specifically, from 2013 to 2017, eight states implemented laws to grant NPs full practice independence. We draw from multiple sources in an effort to carefully classify and code state SOP regulations for NPs, including our own reading of the laws as well as McMichael and Markowitz (2021). Table 1 shows the states expanding SOP for NPs in our study period along with the dates the laws became effective.[7] As of 2020, nearly half of all states have expanded full SOP to NPs. Purported reasons for the expansion of SOP include: meeting increased healthcare demand due to the Affordable Care Act's (ACA) insurance expansions, reducing healthcare costs, and aligning NPs' capabilities with their SOP.[8]

2.2 Conceptual Framework

The expected effects of expanding NP SOP on the healthcare labor market are numerous. In this discussion, we focus on its effect on labor demand and the resulting changes in labor market outcomes.[9] Expanding NP SOP should increase the labor demand for NPs but could also change the tasks performed by NPs and change the allocation of NPs across the healthcare industry (as the increase in demand may be unevenly spread across place of service). This change in labor market outcomes for NPs (resulting from the increase in

[7]Three other states adopted full SOP over the 2011-2019 period. North Dakota and Vermont adopted full NP SOP in 2011. Thus, they are considered "always treated" in our analysis. Illinois adopted full SOP on January 1, 2018. However, there was a 1.5 year delay while the state finalized their administrative rules. See: https://www.americanmedspa.org/news/456401/Illinois-Adopts-Rules-for-Full-Practice-Authority-for-APRNs.htm, last accessed 11/3/21. Thus, Illinois is considered a control state for the job posting analysis, which runs through June 2019, and a treatment state in the ACS, which runs through 2019. Oregon had a smaller change in NP rules in 2013, but has long been a full SOP state. Lastly, Utah was still trying to pass its SOP law as of late 2021.

[8]In response to healthcare needs arising from COVID-19, a majority of the states that had not already granted nurse practitioners full practice authority temporarily expanded nurse practitioners' SOP (AANP 2021). Some stakeholders have since pushed for these temporary expansions of nurse practitioner SOP to become permanent (National Academies of Sciences, Engineering and Medicine 2021).

[9]See Markowitz and Adams (2022) for a detailed discussion of its expected effects on labor supply.

demand) may also spillover and impact the labor demand of adjacent healthcare occupations, such as primary care physicians, which may now face greater competition from NPs. In this section, we discuss these expected effects on labor demand in more detail.

Easing SOP regulations for NPs should increase the labor demand for NPs. Under more-restrictive SOP laws, NPs require physician oversight, which imposes a cost on using NPs. As those costs are reduced through deregulation, the cost of delivering healthcare with NPs falls, increasing demand for NPs. Of course, how this increase in demand manifests itself in terms of higher wages and higher employment levels depends upon the elasticity of labor supply. In the short-run, we might expect that labor supply for NPs is not only quite inelastic but also unlikely to expand—as the additional training required to become an NP (compared to an RN) is fairly extensive, requiring a master's degree in most states, and not all states have licensing reciprocity, which prevents NPs from quickly moving across state lines. Indeed, it is even possible that NP employment could fall in the short-run due to new training requirements frequently imposed on NPs and new administrative rules that must be approved by states before new NP licenses can be issued.[10] To the extent that the supply of NPs is fixed in the short term, expanding NP SOP may have no impact—or even a negative impact—on equilibrium employment, but substantially increase earnings. Over longer time horizons, however, one would expect the labor supply curve to become more elastic and potentially expand as new entrants are attracted to the field, increasing the number of NPs and decreasing the NP wage gains.

Expanding SOP laws for NPs could also affect the allocation of NPs across employers in the healthcare industry since the costs associated with physician oversight may vary across employers. Healthcare firms that employ a large number of physicians, such as hospitals, may face the lowest costs of oversight because of the ready availability of physicians. Conversely, the costs of oversight can be higher in settings with few clinical providers, such as

[10]Expanded NP SOP is often associated with new supervised work requirements that stipulate NPs must first practice under the supervision of a physician for a set number of hours (e.g. 2000 hours in Connecticut) before being able to practice independently. Some employers that previously used NPs may now be hesitant to hire new NPs as they expect many will leave once they are fully trained and able to practice independently. Additionally, expanded NP SOP creates a new administrative burden for states as they need to update their administrative rules for issuing NP licenses. In Illinois, for example, it took a year and a half after the passage of expanded NP SOP to write and approve the new administrative rules for issuing NP licenses. Over that time, no new NP licenses were issued.

a small standalone clinic, due to less physician availability. Thus, easing SOP laws should have a bigger impact on NP labor demand in places where physician oversight had been costly and a smaller impact where physician oversight had been cheaper and more plentiful. The extreme example is self-employment of NPs. Under restrictive SOP laws, the NP would need to bear additional costs to establish a formal arrangement with one or more physicians to satisfy the oversight requirements. Granting full NP independence, consequently, removes these added regulatory compliance costs and allows entrepreneurial NPs to pursue their own clinical business ventures (i.e., become self-employed practice owners), potentially increasing provider competition and geographic access in the local healthcare market.

Expanding NP SOP could also change how healthcare providers utilize NPs and thus, the desired skills of prospective NPs. Since NPs are now allowed to practice independently, employers might seek out NPs that specifically focus on primary care services as well as hold experience with or aptitudes for clinical leadership roles. At the same time, prospective employers may be less likely to seek out NPs to deliver non-primary care services, perform lower skilled clinical tasks, or carry out administrative support functions. If expanded NP SOP does change the skill demands for prospective NPs, this could further influence the growth of NPs providing primary care and the downstream impacts on care access and pricing. However, it may slow the reallocation of NPs into these primary care positions to the extent that the new skill demands introduce some degree of skill mismatch between existing NPs and the demands of prospective employers.

Lastly, expanding NP SOP could alter the labor demand for other healthcare occupations, depending upon the other occupations' substitutability or complementarity with NPs that practice independently. For example, removing the requirement of physician oversight for NPs likely makes NPs more substitutable and less complementary with primary care physicians (PCPs), which may decrease their demand—either because PCPs are no longer needed to oversee NPs or their set of clinical tasks is now further overlapping. Similarly, expanded SOP for NPs could increase the marginal productivity of NPs relative to registered nurses (RNs) and physician assistants (PAs), which would lead to healthcare employers substituting away from RNs and PAs towards NPs in their production processes. At the same time, expanding NPs' SOP also has the potential to make RNs and PAs more valuable

to healthcare employers to the extent that RNs and PAs are complements to NPs. Over longer periods of time, expanded NP SOP could also decrease the supply of other healthcare occupations. For example, more RNs could opt to become NPs through continued training, rather than remain RNs. Thus, it is possible that the labor market outcomes of other healthcare occupations may be impacted by the targeted relaxing of NP SOP.

3 Data

Our empirical analyses use data from two different sources: data on job vacancy postings collected and distributed by Burning Glass Technologies (BGT) and data on the labor market outcomes of healthcare workers from the American Community Survey (ACS). Below, we describe each of these data sources.

3.1 Burning Glass Technologies

Burning Glass Technologies (BGT) collects data on job posting from approximately 40,000 online job boards as well as company websites using a proprietary web-scraping procedure that removes duplicate job postings. For each job posting, BGT collects information about the occupation, desired applicant qualifications including skills, employer characteristics, the job location, and a precise calendar date associated with the posting (among other job characteristics). As such, the BGT database aims to be a near-universe of online job postings, with the company advertising that the data can be used to provide real time analysis on job growth, skill demands, and labor market trends. The BGT data, which are increasingly used in contemporary studies to capture important elements of labor demand (Lazear and Spletzer 2012; Faberman and Mazumder 2012; Deming and Kahn 2018; Hershbein and Kahn 2018; Dillender 2022), are an excellent data source to assess how expanding NP SOP affects the labor demand for NPs and other healthcare occupations.[11]

[11] As of 2016, BGT estimates that it captures roughly 85 percent of job openings (Hershbein and Kahn 2018). Because most healthcare employers post job advertisements on their websites, this share is even higher for the healthcare sector (Lancaster et al. 2019).

We use the BGT data on all vacancies posted online from January 2011 through June 2019 with a work location in one of the 50 US states or the District of Columbia. We then limit the data to job postings for the following healthcare occupations using the Standard Occupation Classification (SOC) codes: nurse practitioners (NPs), primary care physicians (PCP), registered nurses (RNs), licensed practical and licensed vocational nurses (LPNs), and physician assistants (PAs).[12]

Our empirical analysis of the BGT data focuses on two main outcomes: the total number of job postings and the share of job postings that mention specific skills (both of which we aggregate to the state-quarter-year level for each occupation). These variables allow us to assess whether expanding NP SOP impacts overall labor demand for different healthcare occupations and whether employers respond to expanded NP SOP by demanding workers with different types of skills. While the skills included in the BGT data are too numerous to analyze individually, we group the skills into the following eight skill groupings: general healthcare skills, specialized healthcare skills, emergency healthcare skills, mental healthcare skills, healthcare support skills, leadership skills, office support skills, and other skills. Appendix Table A1 presents the mapping between the 574 BGT skills, which they refer to as skill clusters, and our eight derived "skill groupings."

Table 2 presents occupation-specific summary statistics for the average number of job postings per quarter as well as the growth in the number of postings from 2011 to 2018 (i.e., the full-year endpoints for our analytic window). As shown, while NPs are one of the smaller healthcare occupations (of those included in our analysis), they are one of the fastest growing over the most recent decade in terms of the number of job postings. This is consistent with Auerbach et al. (2020), which documents the rapid employment growth of NPs over the same time period. The table also presents summary statistics on the skills demanded in these job postings and how they map to our skill groupings. For NPs, the most frequently mentioned skills in job postings include general care skills (62 percent of postings), healthcare support skills (47 percent of postings), and specialized care skills (41

[12]PCPs include family and general practitioners, general internists, and general pediatricians.

percent of postings).[13] Reassuringly, the skills demanded for other healthcare occupations are largely in line with what one would expect. For example, general care skills are the most frequently mentioned skill for PCPs (74 percent of postings) while healthcare support skills are the most frequently mentioned skills for RNs and LPNs, 59 and 69 percent, respectively.

3.2 American Community Survey

We also analyze the effect of SOP laws on the labor market outcomes of NPs and other healthcare professionals using the American Community Survey (ACS). The ACS is a household-based survey administered by the US Census Bureau that collects economic and demographic information on one percent of the US population each year. While the survey is not specifically designed to analyze outcomes of healthcare workers, the large sample size and extensive labor market information make it a good data source to study the impact of NP SOP.[14] Our ACS analysis complements the analyses of the BGT data because it allows us to assess how the change in labor demand (evident in job postings) manifests itself in terms of labor market outcomes, including earnings, overall employment, self-employment, and employment across the healthcare sector.

Table 3 presents summary statistics on the sample of healthcare workers aged 25-60 over the 2010-2019 analysis period from the ACS.[15] We limit the sample to full-time healthcare workers employed as a NP, a physician, a RN, a LPN, or a PA, where we again identify these occupations using the SOC codes, but the SOC codes used by the Census Bureau in the ACS

[13]This description excludes "Other Skills," which are largely composed on an unspecified skill ("na") in the BGT database. For example, "na" makes up 56 percent of all "Other Skills" for NPs and an identical percentage for PCPs.

[14]Kleiner et al. (2016) also use the ACS to examine the impact of full NP SOP (over an earlier period 2001-2013) on the earnings of healthcare workers. In pre-2010 ACS data, the occupations were more aggregated than they currently are—with NPs combined with RNs, nurse anesthetists, and nurse midwives. Auerbach et al. (2020) also use the ACS to document trends in NP employment over the 2010-2017.

[15]Following Goodman-Bacon (2021), we exclude observations from those states that had previously expanded their NP SOP prior to the start of the 2010-2019 period; thus, our control group represents states without expanded NP SOP.

are slightly more aggregated for NPs and physicians than in the BGT data.[16] The sample includes 12,182 NPs as well as 68,755 physicians (MDs),[17] 244,231 RNs, 63,050 LPNs, and 9,298 PAs. Relative to MDs, NPs are more likely to be female, non-immigrants, and white. They are also much less likely to be self-employed than physicians (three vs. 18 percent). When we classify healthcare workers' place of employment using Census Industry Codes, we see that the industrial employment of NPs (like MDs, PAs, and RNs) is highly concentrated in hospitals (40 percent) and physician's offices (26 percent). One difference is that NPs are much more likely to work in outpatient care centers than MDs or RNs (16 percent versus six and five percent, respectively). After these three industries, the employment of NPs is fairly dispersed with Colleges and Universities representing the next most popular place of employment at two percent.

Table 3 also provides summary statistics on earnings by occupation. Earnings data in the ACS are top-coded where the largest two percent of earners in each state in each year have their actual earnings replaced with the average earnings of the highest two percent in the state-year. Top-coding rarely impacts NPs, RNs, PAs, or LPNs, but 29 percent of physicians have top-coded earnings. In our empirical analysis of earnings, we exclude top-coded earnings observations from the main empirical specification because the average earnings levels may be driven by large earnings levels for other (non-healthcare) occupations. We also winsorize the earnings data, excluding the observations with the highest and lowest two percent of earnings within each occupation-state.[18] As shown in Table 3, this does not change the average earnings for NPs. Average earnings for full-time, non-top-coded, and

[16]We define a full-time employed worker as a worker who worked at least 40 weeks over the past year, averaged at least 30 hours worked per week, and reported positive earnings. The nurse practitioner occupation code in the publicly released ACS data also includes nurse midwives; however, there are few nurse midwives in relation to NPs. Additionally, there is no separate occupation code for primary care physicians in the ACS. Instead, we must use the occupation code for all physicians, which also includes surgeons. The inclusion of nurse midwives in our sample of nurse practitioners and surgeons in with our sample of physicians is unlikely to have a large effect on our estimates. According to the 2019 Occupation Employment and Wage Statistics (OEWS), nurse practitioners made up almost 97 percent of this combination and physicians made up more than 95 percent of this combination nationally.

[17]Physicians can be doctors of medicine (MDs) or doctors of osteopathic medicine (DOs). We use the term MD as shorthand for physician for simplicity and because more than 90 percent of physicians are MDs rather than DOs.

[18]We present robustness estimates at the end of the paper that include both topcoded and winsorized earnings levels.

winsorized NPs are $94,000. PAs are paid similarly, but physicians are paid about a third more and RNs are paid a third less.

4 Empirical Methodology

4.1 Empirical Approach for Job Vacancies & Skill Demands

We analyze the effects of expanding NP SOP on job vacancies and skill demands in the BGT data using a two-way fixed effects generalized difference-in-differences estimation strategy, which we also adapt to an event study model. We first estimate:

$$Y_{st} = \alpha Lead_{st} + \beta ShortRun_{st} + \gamma LongRun_{st} + \lambda_s + \nu_t + \epsilon_{st}, \tag{1}$$

where *Lead* represents the period 1 year prior to policy adoption, *ShortRun* represents the period 0-2 years post SOP implementation, and *LongRun* represents the period more than 2 years following SOP implementation. Our regression models, which we estimate separately for our five healthcare occupations, also control for state (λ_s) and quarter-year (ν_t) fixed effects. Information from job listings, which is our outcome Y_{st}, is aggregated to quarter-years by state, where the specific outcomes we examine include the natural logarithm of the total number of job postings, the average number of skills/skill groupings per job posting, and the share of postings mentioning a specific skill grouping. That said, because expanded NP SOP can affect relative demand as well as absolute demand, we also use the ratio of the number of postings for nurse practitioners to job postings for other related healthcare occupations as an outcome variable. This approach will also help control for other trends affecting healthcare employment, such as the ACA. The coefficients α, β, and γ are the parameters of interest, where α helps us to assess the parallel trends assumption and β and γ describe the impact of expanding NP SOP.

We then adapt our two-way fixed effects estimation to an event study framework:

$$Y_{st} = \sum_{j=1}^{J} \alpha_j 1[t - T_s^* = j] + \lambda_s + \nu_t + \epsilon_{st}, \tag{2}$$

where T_s^* represents the time period that state s enacts the full NP SOP policy, 1[.] is the indicator function, and the α coefficients are the parameters of interest. The model is otherwise identical to Equation 1, where we cluster our standard errors at the state level in both sets of estimates.

We are sensitive to the concerns raised in Goodman-Bacon (2021) regarding the potential biases associated with differences in treatment timing. Thus, we drop the always treated states, i.e. those states that had enacted full NP SOP prior to 2011, from our empirical analysis.[19] Moreover, of the nine states that changed their SOP laws during our time period, most did so within a fairly narrow window, five in 2015 alone and seven within the two year period between the middle of 2014 and the middle of 2016 (see Table 1). Later in the paper, we present robustness tests showing the sensitivity of our results using different subsets of full NP SOP adopting states—including when imposing that our treatment group states implement their policy changes within a common time window.

4.2 Empirical Methods for Labor Market Outcomes

Our empirical approach analyzing labor market outcomes of healthcare workers in the ACS is almost identical to Equation 1 and Equation 2, except that the data are annual and at the individual level. Thus, the time fixed effect are year dummy variables (instead of quarter-year dummies) and we include basic demographic controls (X_{ist}) in the regressions. The specific control variables included in X are: a cubic in age and indicators for sex, race, ethnicity, education groupings, and immigrant status.[20] The outcomes we analyze in the ACS are also intentionally different and complementary to the insights offered from the BGT data. Specifically, we analyze the effect of full NP SOP on individual earnings, total occupational employment, self-employment probabilities, and employment across industries. We weight regressions using the ACS sample weights and, like the BGT analysis,

[19]The following 17 states had expanded SOP laws in place over the entire 2011-2019 period: Alaska, Arizona, Colorado, District of Columbia, Hawaii, Idaho, Iowa, Maine, Montana, New Hampshire, New Mexico, North Dakota, Oregon, Rhode Island, Vermont, Washington, and Wyoming. In robustness estimates, we show that the results are very similar if we include these states in the control group.

[20]In the earnings regression, we also include indicators for weeks employed. The indicators follow the ranges of weeks that are reported in the ACS, where weeks worked is a categorical variable: 40-48 weeks, 49-50, and 51-52.

we exclude always treated states and our standard errors are clustered at the state-level. We also implement the same series of robustness checks for the ACS data (e.g., assessing any influence from differential timing in treatment).

5 Results

5.1 BGT Analysis

Table 4 presents our estimates of Equation 1 when the outcome is the natural logarithm of the number of job postings (per quarter). Looking first at NPs in column (1), we see that in the year prior to expanding NP SOP, jobs postings for NPs in full SOP adopting states tended to be somewhat less common than in non-adopting states, although the coefficient is not statistically different than zero. In the first seven quarters after full SOP adoption, there was no measurable change in the demand for NPs (measured as the number of online job postings). However, beginning two years after full NP SOP adoption, the number of job postings for NPs in full SOP adopting states increased by 0.27 (se=0.12) log points, representing a large increase in demand for NPs. Interestingly, this increase in demand for NPs occurs without any corresponding change in the demand for other healthcare occupations including PCPs (column 2), RNs (column 3), LPNs (column 4), and PAs (column 5).[21] Thus, the estimates imply that states that adopted full NP SOP experienced stronger demand for NPs without any subsequent weakening in demand for other credentialed healthcare professionals.

We also estimate Equation 1 using the ratio of total other healthcare job postings to total NP job postings as our outcome variable. These estimates, which we present in Table 5, will help address the negative (although statistically insignificant) leading coefficients across all occupations in Table 4 and better assess changes in relative demand. Under this approach, if the adoption of full NP SOP increases the relative demand for NPs compared to these other healthcare occupations, then the coefficients on the policy adoption variable

[21] While all of the Long Run coefficients in Columns 2-5 are negative, almost all of the Long Run coefficients are actually larger than the pre-trend, i.e. the coefficient associated with job posting levels in the year prior to full SOP adoption, and none are statistically different than zero.

should be negative, i.e., that this ratio falls. Indeed, this is precisely what we see. We again see no measurable differential between adopting and never adopting states prior to the deregulation event or in the first two years after the policy change, but the relative number of job postings for each of these occupations (compared to NPs) falls beginning two-years after full NP SOP adoption. To help assess the magnitudes of these changes in relative demand, we also include the average ratio at the bottom of each column. Interestingly, the decrease in the ratio for each occupation is about 30 percent—almost identical to the change in the number of NP job postings (see Table 4). Therefore, the changes in the ratio of job postings in Table 5 confirm our results in Table 4 that expanding NP SOP to allow NPs to practice independently has increased the labor demand for NPs without harming the labor demand for other healthcare workers. However, the effects appear to materialize with a lag, which can reflect underlying frictions in healthcare labor markets (e.g., if employers cannot instantaneously adjust clinical staffing and roles across labor types) and/or state-level adjustment delays in SOP implementation for credentialing NPs as fully independent providers (e.g., incorporating supervised hours requirements and general updating of the NP licensing process in the deregulated practice environment).

To better understand the timing of these effects on labor demand for NPs, we estimate the event study model in Equation 2, where we continue to use the ratio of job postings (total occupation job postings/total NP job postings) as our key outcome variables of interest. These results—estimated at the half-year level to reduce noise—are presented in Figure 1.[22] The first dashed vertical line in each figure indicates the time period just prior to policy adoption, while the second dashed vertical line is just before the period two-years after NP SOP adoption. One thing to note across all figures is that the ratio of job postings is fairly steady in the quarters leading up to full NP SOP adoption offering additional support for the parallel trends assumption. This is especially the case in Panel B, which presents effects on the ratio of RN job postings to NP job postings. We also see that there is no immediate change in this ratio in the first year after adoption, but the ratio generally starts to decline after a year, and becomes statistically different than zero after two years. Appendix Figure

[22]The data are still summed to the state-quarter-year level with the half-year dummies taking a value of one for each of the two relevant quarters pertaining to a given half-year indicator variable.

A1 presents analogous event study estimates of the effect of full NP SOP adoption on the natural log of NP job postings.

Lastly, we examine geographic heterogeneity in the effect of full NP SOP adoption on the number of NP job postings. Previous research has shown that NPs are an important healthcare provider in traditionally underserved areas (Barnes et al. 2018). This analysis allows us to assess whether expanded SOP could improve access to primary care providers in Health Professional Shortage Areas (HPSAs). Interestingly, we see that full SOP adoption increases demand for NPs among employers located in HPSA as well as non-HPSA areas, with the magnitudes of the growth quite similar across areas (see Table A2).

We turn next to the impact of full NP SOP adoption on the skills demanded of NPs, which we present in Table 6. Column (1) and (2) show our estimates of full NP SOP adoption on the average number of BGT skills listed per job posting and the average number of skill groupings listed per job posting, where the difference between a "BGT skill" and a "skill grouping" is that a BGT skill includes any of the 574 skills included in the BGT job postings (based on BGT's own proprietary algorithm for classifying skills) and a skill grouping is one of our aggregated skill groupings—eight in total. We find that NP SOP adoption is not changing the average number of BGT skills or skill groupings among NP jobs posting (or PCP jobs postings, see Appendix Table A3). This is somewhat surprising since one might expect that full NP SOP adoption would cause NPs to focus more on tasks related to primary care services. These estimates imply that full NP SOP adoption is not associated with any greater degree of skill specialization among NPs. The effects of full NP SOP adoption on the proportion of jobs mentioning specific skill groupings are presented in Columns 3-10. Interestingly, we see essentially no change in the composition of skill demands in job postings.[23] Thus, full NP SOP adoption does not appear to be changing the specific skills employers are seeking out for their prospective NP hires. Instead, employers are simply demanding more NP clinical labor. These results also suggest that skill mismatch should not hamper the ability of existing NPs to practice independently under full SOP.

[23]A notable exception is that the estimates suggest some decreased frequency of job postings mentioning mental health skills. That said, we do not place a lot of weight on this result given the multiple hypotheses that we are testing (Savin 1984).

5.2 ACS Analysis

We now present results describing how the labor market outcomes of healthcare workers in the ACS respond to the increase in demand for NPs documented in the BGT data. We first present effects on earnings and employment. We then show how NP SOP affects NP employment across the healthcare sector.

Table 7 presents the effects of adopting full NP SOP on earnings for NPs. As shown in column (1), the earnings of NPs are very similar in states that adopt full NP SOP (compared to NPs in states that never adopt SOP) in the year prior to the policy adoption, but earnings for NPs in states that adopt full SOP increase by about 6 percent in the year-of and one-year after adoption. Earnings for NPs remain about 5 percent higher two or more years after adoption. Figure 2 presents our estimates of the event study regression of full NP SOP adoption on earnings. The event study estimates confirm that the adoption of full NP SOP has an immediate, persistent, and positive impact on NP earnings. Indeed, the stability of the earnings effect over time—evident even four or more years after SOP adoption—implies that the labor supply response of NPs may be quite limited, at least in the initial few years following the removal NP SOP restrictions.

Table 7 and Figure 2 also present the estimated effects of full NP SOP adoption on earnings for MDs, RNs, LPNs, and PAs. While the estimates of Equation 1 in Table 7 suggest a potential short-term impact on MD earnings,[24] these effects are not evident in the full event study estimates in Figure 2. We also find no evidence that the earnings of RNs, LPNS, or PAs are affected by the policy change. Thus, only limited evidence suggests that the adoption of full NP SOP is spilling over and affecting the earnings of other healthcare occupations. This contrasts with Kleiner et al. (2016), who find that the earnings of physicians decline when NPs are granted full independent practice authority when examining earlier SOP policy changes.

Table 8 presents the impact of expanded NP SOP on equilibrium employment for NPs and other healthcare workers in the ACS. Panel A presents the effect on the natural loga-

[24]The change in earnings for physicians in the short-run relative to the leading effect is -0.06 (se=0.03). In the long-run, the change in coefficients falls to -0.03 (se=0.02). Thus, there is some evidence that the adoption of NP SOP lowers physician earnings, at least in the short-run.

rithm of overall full-time employment (where occupational employment has been summed to the state-year level) and Panel B presents estimates using the ratio of total employment as the outcome, e.g., total RN employment divided by total NP employment. Thus, if the increase in demand we observe in BGT data is leading to an increase in NP employment, then we would expect positive coefficients in column (1) of Panel A and negative coefficients in all of Panel B. As shown in Table 8, we find no evidence that adoption of full NP SOP is increasing equilibrium employment for NPs or affecting overall employment at any of the healthcare occupations we examine within the first four years post-deregulation.[25] Moreover, when we examine the impact of full SOP adoption on relative employment in Panel B, the estimates imply no change in NP employment relative to other occupations. This result is further supported by the event study estimates in Figure 3.

Even if the adoption of full NP SOP is not increasing overall NP employment, these policies could lead to a reallocation of NPs across different types of healthcare employers in a way that increases access to primary care. As we describe above, once NPs are allowed to practice independently, we expect that this policy change should increase self-employment among NPs and generally increase NP employment at areas where physician employment is less common and thus, physician oversight had been more costly.

Table 9 presents our estimates of the impact of full NP SOP adoption on NP self-employment and place of service in the ACS. Looking at column (1), we find that there is no measurable difference between NP self-employment in adopting and non-adopting states in the year prior to adoption, but self-employment increases by 1.4 (se=0.8) percentage points in the year-of and one-year after adoption and remains 1.8 (se=0.6) percentage points higher two or more years after adoption. This rise in self-employment is unique to NPs, with no other healthcare occupations experiencing any changes (see Appendix Table A4). Moreover, the effect is quite persistent and grows slightly over time. As we show in the event study estimates in Figure 4, NPs are 2.7 (se=0.9) percentage points more likely to be self-employed four or more years after full SOP adoption. Additionally, the magnitudes of

[25] If anything, the estimates in column (1) of Panel A imply that NP employment may be declining. The long-run effect minus the one-year before effect is -0.21 (se=0.13). That said, the estimates are quite noisy.

these effects are quite large, with the long-run effect in Table 9 representing a 60 percent increase above the average rate of three percent.

The adoption of full NP SOP also appears to affect NP place of service with NPs reallocating their employment away from hospitals and towards outpatient care centers, which include clinics and urgent care centers. Ignoring the leading coefficient, the estimates imply that two or more years after full SOP adoption, NP employment at hospitals decreases by 5.6 (se=4.1) percentage points and increases at outpatient care centers by 3.5 (se=1.5) percentage points.[26] If we account for the leading effect, this employment realignment is magnified and suggests that NPs may also be reallocating into physician offices.[27] These changes in place of employment indicate that the need for physician oversight (before full SOP is adopted) is a binding constraint for a lot of NPs making decisions about how to practice and employers contemplating hiring NPs.

The movement of NPs away from hospitals and towards self-employment and employment at outpatient care centers could positively impact the geographic allocation of primary care providers and even increase the number of primary care providers (and thus, access to primary care) even if total NP employment remains fixed. For example, when we look at the place of service for self-employed NPs, the most commonly observed location is "Office of Other Health Practitioner." Thus, much of the movement of NPs into self-employment may reflect the opening of new primary care practices. Additionally, it is not unreasonable to think that NPs employed at outpatient care centers and physician offices may be more likely to be engaged in providing primary care than NPs employed in hospitals.[28] This again points to the idea that the reemployment pattern among NPs that we uncover is consistent with full NP SOP increasing the number of primary care providers, even if it has been unsuccessful at increasing the aggregate number of NPs in the short-run.

[26]Because all NPs are employed at one of the four places of employment, the coefficients in any period sum to zero.

[27]The long-run coefficient minus the leading coefficient is -12.5 (se=6.4) for hospitals, 5.7 (se=2.4) for outpatient care centers, and 7.3 (se=3.7) for physician offices.

[28]One potential concern with this interpretation is that many outpatient care centers and physician offices are associated with hospitals. Many NPs in the ACS that report working in a hospital may be employed in these hospital affiliated physician offices and outpatient care centers, as opposed to working inpatient or emergency care units.

5.3 Robustness

We perform numerous robustness tests of our BGT and ACS analysis to test the sensitivity of our results to minor perturbations to our empirical specification. These estimates are presented in Table 10 (BGT analysis) and Table 11 (ACS analysis). Generally speaking, our results are quite robust to these alternative specifications.

Our main empirical specifications excluded states that allowed NPs to practice independently (i.e., full NP SOP states) over the entire sample period. The exclusion of these "always adopters" from the control group addresses potential biases associated with variation in treatment timing in the two-way fixed effects difference-in-differences empirical approach (Goodman-Bacon 2021; Callaway and Sant'Anna 2021). We examine the sensitivity of our results to these exclusions by presenting estimates that use all states. We also investigate whether the differential timing of SOP law changes is distorting our estimates and inferences. Fortunately, a majority of states that adopted full NP SOP over the period 2010-2019 did so during a relatively compact time horizon from the middle of 2014 to middle of 2016, which allows us to exclude states with shorter pre- (post-) periods in our analytic data and thereby present estimates that limit our treatment sample to the seven states that adopted full NP SOP over this more limited time frame. As we show in columns 2-3 of Table 10 and columns 3-4 of Table 11, neither the BGT nor the ACS results are sensitive to these further restrictions placed on the analytic samples.

We also estimate additional specifications that test the sensitivity of our results to variation in ACA adoption, changes in the skill grouping variables, and small changes to the ACS empirical specification. We find that excluding states that did not adopt Medicaid expansion (under the ACA) does not materially affect our results (see column 4 on Table 10 and column 5 of Table 11); that small changes in our skill grouping variables have no material effects on our results;[29] and that small changes to our ACS empirical specification—such as including top-coded and winsorized earnings or excluding sample weights—also do not substantially change our estimates (see column 2 and 6 of Table 11).

[29]In results not shown, we have tried several reconfigurations of our skills groupings to test the sensitivity of our results to alternative skill groupings. These include: combining healthcare support and office support skills, breaking our "na" from other skills, and creating an "education skills" grouping from the other skills. None of these changes had a material impact on our skills analysis estimates in Table 6.

6 Conclusion

Our paper fits into a broad literature that seeks to understand the impact of occupational licensing and its effect on labor and product markets. Occupational licenses could help provide some quality control in an industry, but they may unnecessarily restrict labor supply increasing consumer prices and limiting output. Evaluating this tradeoff in the healthcare market is especially valuable given the importance of providing high-quality service to consumers but also long-standing concerns around limitations in healthcare access and rising healthcare costs. Past studies have shown that expanded NP SOP does not harm quality of care (Alexander and Schnell 2019; Traczynski and Udalova 2018) and has the potential to lower costs (Kleiner et al. 2016; Timmons 2017). In this study, we extend the literature by leveraging new data and recent NP deregulation activity to assess the mechanisms behind how expanded NP scope of practice affects the healthcare labor market. By using data on job postings combined with ACS data on earnings for NPs and other healthcare providers, we are able to distinguish between labor demand and labor supply effects, as well as measuring spillovers to other primary care providers. Our analysis also speaks to the role that SOP regulations, and occupational licenses more broadly, may impact the industrial organization in the healthcare sector.

Using the BGT data, we find that SOP laws allowing NPs to practice independently increased labor demand for NPs in the form of a 31 percent increase in job postings. At the same time, expanded NP SOP did not affect the number of job postings for other primary care providers, including PCPs and RNs. Thus, the increased demand for NPs does not appear to be displacing employers' demand for other healthcare workers. Interestingly, this increase in demand for NPs is not associated with any changes in the specific skills being sought after by employers. This implies that employers are not seeking different types of NPs but simply more of them.

We then analyze the ACS data to examine how this increase in labor demand evident in the BGT data manifests itself in terms of labor market outcomes of healthcare workers. We find that the increase in labor demand from states adopting full NP SOP increases earnings for NPs but does not increase total NP employment—either directly or relative to

other healthcare workers. This suggests that the short-run labor supply for NPs is highly inelastic, at least in the first four or five years after full SOP adoption. That said, we do see that full NP SOP is changing the allocation of NPs across the healthcare industry—with NPs moving into self-employment, away from hospitals, and into outpatient care centers (and physicians' offices, to some extent). The increase in self-employment, specifically, reveals the negative effects of tighter regulations on the entrepreneurial activity of NPs. In this way, NP support for full independence policies likely reflects an underlying desire to launch their own primary care business ventures, rather than simply seeking equal clinical standing among their PCP coworkers. Additionally, this broader reallocation of NPs suggests that while full NP SOP is not increasing the overall number of NPs, it may be increasing the number of primary care providers as NPs in self-employment and at outpatient care centers may be more likely to provide primary care than NPs employed at hospitals. This reallocation of NPs also appears to alter the industrial organization of primary care providers—encouraging self-employment and/or encouraging a wider geographic distribution (and potentially more competition) of primary care providers.

Generally, we find no major effects of full NP SOP adoption on the labor market outcomes of other healthcare providers. This is not too surprising since we see that full NP SOP adoption does not affect the job postings for other providers. This contrasts with Kleiner et al. (2016), who find more-direct evidence that physician earnings are affected by the adoption of full NP SOP.

Given the continued efforts to "bend the cost curve" in healthcare, expanding non-physician provider scope of practice laws is an appealing tool for both lowering cost of care and expanding access to care. In this study, we find evidence consistent with expanded NP SOP as a policy lever to increase access to primary care providers (as a downstream outcome from NPs reallocating themselves across the healthcare delivery settings and practice arrangements). However, a large expansion in the number of primary care providers is being held back by the short-term inelastic labor supply of NPs. States that want to use expanded SOP to increase healthcare access should think about combining this policy, which substantially increases the demand for NPs, with other workforce promoting policies that help produce a larger supply of NPs such as expanding training programs within the

state or offering loan repayment programs for NPs that agree to practice within the state for a specified period of time.

References

Acemoglu, D. and D. Autor, "Skills, Tasks and Technologies: Implications for Employment and Earnings," *Handbook of Labor Economics*, 2011, *4*, 1043–1171.

Alexander, D. and M. Schnell, "Just What the Nurse Practitioner Ordered: Independent Prescriptive Authority and Population Mental Health," *Journal of Health Economics*, Jul 2019, *66*, 145–162.

Auerbach, D. I., P. I. Buerhaus, and D. O. Staiger, "Implications of the Rapid Growth of the Nurse Practitioner Workforce in the Us: An Examination of Recent Changes in Demographic, Employment, and Earnings Characteristics of Nurse Practitioners and the Implications of Those Changes," *Health Affairs*, 2020, *39* (2), 273–279.

Barnes, H., M. R. Richards, M. D. McHugh, and G. Martsolf, "Rural and Nonrural Primary Care Physician Practices Increasingly Rely on Nurse Practitioners," *Health Affairs*, 2018, *37* (6), 908–914.

Callaway, B. and P. H. Sant'Anna, "Difference-in-Differences with Multiple Time Periods," *Journal of Econometrics*, Dec 2021, *225* (2), 200–230.

Cramer, J. and A. B. Krueger, "Disruptive Change in the Taxi Business: The Case of Uber," *American Economic Review*, 2016, *106* (5), 177–82.

Deming, D. and L. B. Kahn, "Skill Requirements across Firms and Labor Markets: Evidence from Job Postings for Professionals," *Journal of Labor Economics*, 2018, *36* (S1), S337–369.

Dillender, M., "How Do Medicaid Expansions Affect the Demand for Health Care Workers? Evidence from Vacancy Postings," *Journal of Human Resources*, 2022, *57*.

Faberman, R. J. and B. Mazumder, "Is There a Skills Mismatch in the Labor Market?," *Chicago Fed Letter*, 2012, *300*.

Goodman-Bacon, A., "Difference-in-Differences with Variation in Treatment Timing," *Journal of Econometrics*, 2021.

Hershbein, B. and L. B. Kahn, "Do Recessions Accelerate Routine-Biased Technological Change? Evidence from Vacancy Postings," *American Economic Review*, 2018, *108* (7), 1737–1772.

IOM, "The Future of Nursing: Leading Change, Advancing Health," Technical Report, Institute of Medicine, Washington, DC: The National Academies Press 2010.

Kleiner, M. M., "Occupational Licensing," *The Journal of Economic Perspectives*, 2000, *14* (4), 189–202.

_ , A. Marier, K. W. Park, and C. Wing, "Relaxing Occupational Licensing Requirements: Analyzing Wages and Prices for a Medical Service," *The Journal of Law and Economics*, 2016, *59* (2), 261–291.

_ **and A. B. Krueger**, "Analyzing the Extent and Influence of Occupational Licensing on the Labor Market," *Journal of Labor Economics*, 2013, *31* (S1), 173–202.

_ **and K. W. Park**, *Battles among Licensed Occupations: Analyzing Government Regulations on Labor Market Outcomes for Dentists and Hygienists* 2010.

Lancaster, V., D. Mahoney-Nair, and N. J. Ratcliff, "Technology Report Review of Burning Glass Job-Ad Data," Technical report 2019.

Lazear, E. P. and J. R. Spletzer, "Hiring, Churn, and the Business Cycle," *American Economic Review*, 2012, *102* (3), 575–79.

Luo, Tianyuan, Cesar L Escalante, and Carmina E Taylor, "Labor market outcomes of granting full professional independence to nurse practitioners," *Journal of Regulatory Economics*, 2021, *60* (1), 22–54.

Markowitz, S., E. K. Adams, M. J. Lewitt, and A. L. Dunlop, "Competitive Effects of Scope of Practice Restrictions: Public Health or Public Harm?," *Journal Health Economics*, Sep 2017, *55*, 201–218.

Markowitz, Sara and E Kathleen Adams, "The effects of state scope of practice laws on the labor supply of advanced practice registered nurses," *American Journal of Health Economics*, 2022, *8* (1).

McMichael, B. J. and S. Markowitz, "Towards a Uniform Classification of Nurse Practitioner Scope of Practice Laws," Working Paper 28192, NBER 2021.

National Academies of Sciences, Engineering and Medicine, "The Future of Nursing 2020-2030: Charting a Path to Achieve Health Equity," Technical Report, Washington, DC: The National Academies Press 2021.

Nicholson, S. and C. Propper, "Medical Workforce," in B. V. Elsevier, ed., *Handbook of Health Economics Vol. 2*, 2011, pp. 874–925.

Perry, J. J., "The Rise and Impact of Nurse Practitioners and Physician Assistants on Their Own and Cross-Occupation Incomes," *Contemporary Economic Policy*, 2009, *27* (4), 491–511.

Poghosyan, L., E. J. Timmons, C. M. Abraham, and G. R. Martsolf, "The Economic Impact of the Expansion of Nurse Practitioner Scope of Practice for Medicaid," *Journal of Nursing Regulation*, 2019, *10* (1), 15–20.

Savin, N. E, "Multiple hypothesis testing," *Handbook of econometrics*, 1984, *2*, 827–879.

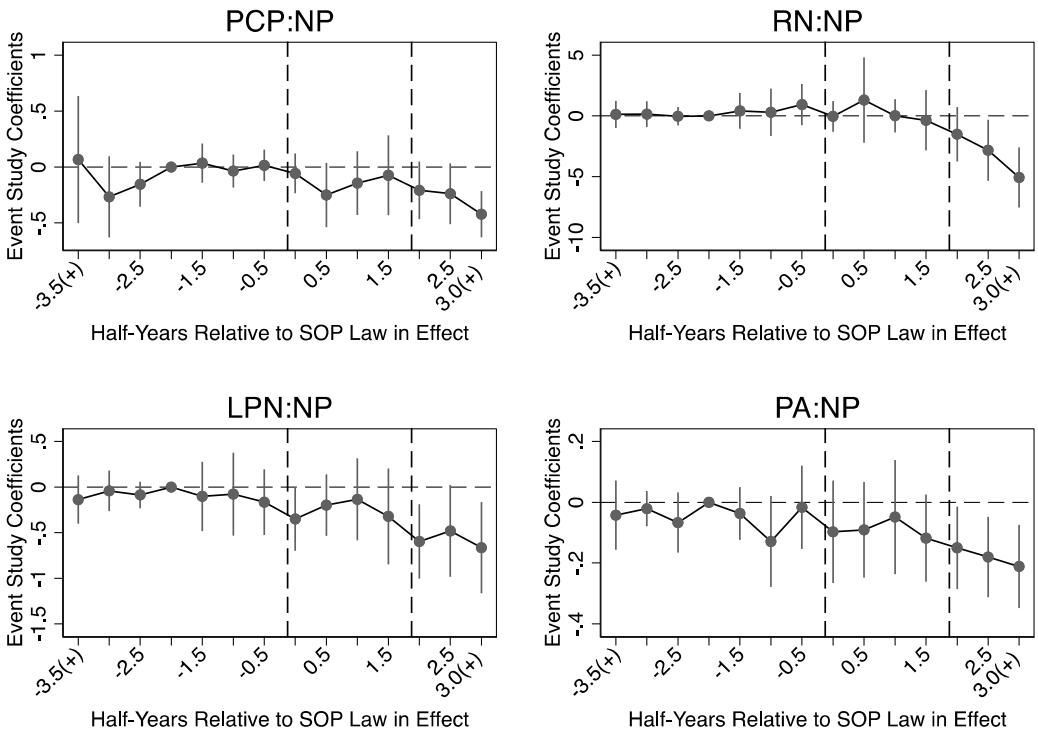
Smith, L. B., "The effect of nurse practitioner scope of practice laws on primary care delivery," *Health Economics*, 2022.

Timmons, E. J., "The Effects of Expanded Nurse Practitioner and Physician Assistant Scope of Practice on the Cost of Medicaid Patient Care," *Health policy*, 2017, *121* (2), 189–196.

Traczynski, J. and V. Udalova, "Nurse Practitioner Independence, Health Care Utilization, and Health Outcomes," *Journal of Health Economics*, Mar 2018, *58*, 90–109.

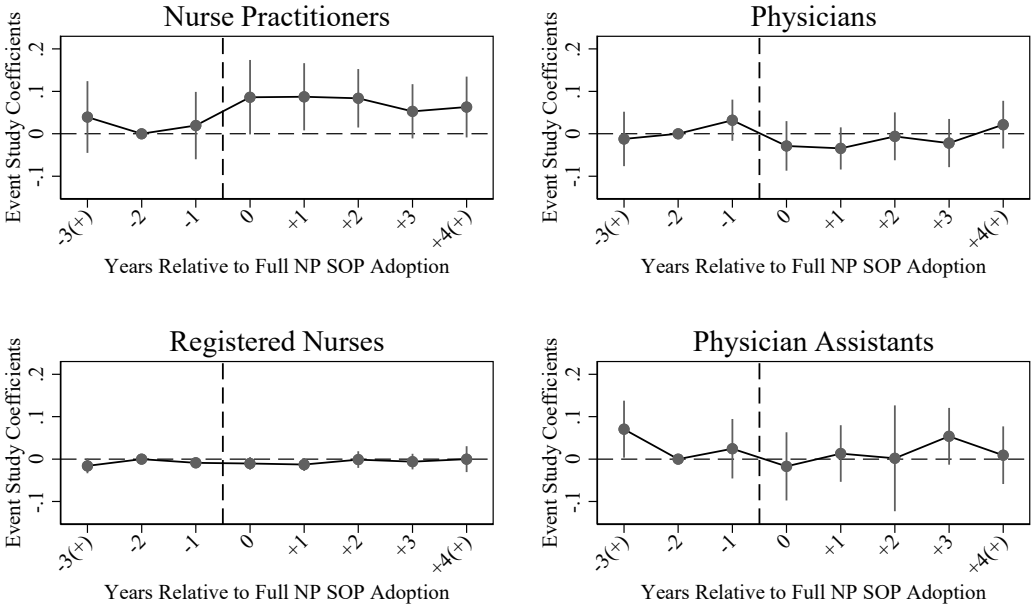
Wing, C. and A. Marier, "Effects of Occupational Regulations on the Cost of Dental Services: Evidence from Dental Insurance Claims," *Journal of Health Economics*, 2014, *34*, 131–143.

Figure 1: Effect of Full NP SOP on Relative Job Postings



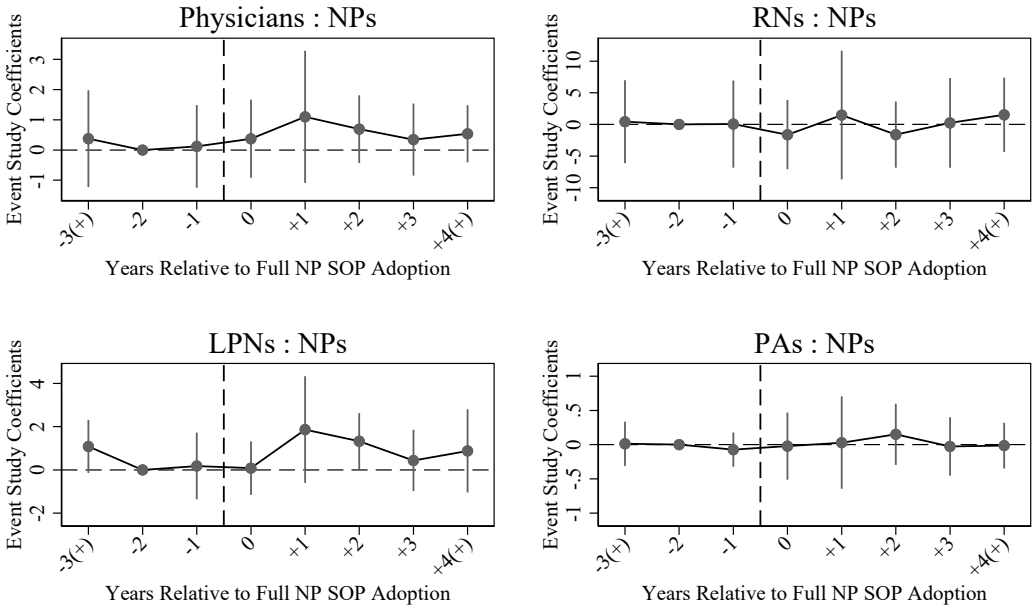
Notes: This figure plots the coefficients and 95 percent confidence intervals of the event study estimates showing the effect of Full NP SOP adoption on the relative number of NP job postings (at the state-quarter-year level) in the BGT data. All coefficients are relative to the effect two years prior to adoption. The first dashed vertical line is just prior to adoption, the second one is two years after adoption.

Figure 2: Effect of Full NP SOP Adoption on Natural Log of Earnings



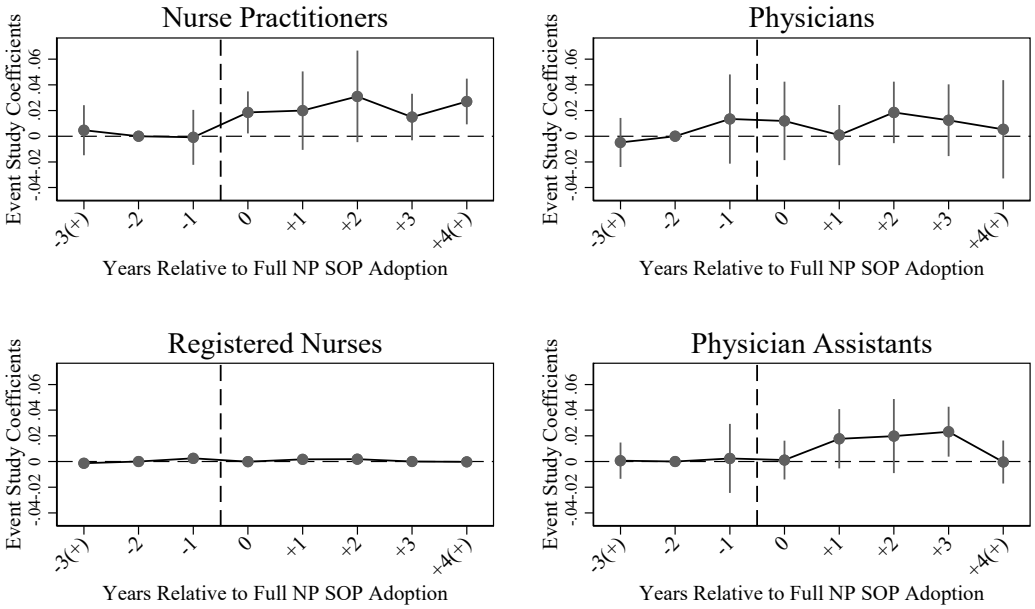
Notes: This figure plots the coeffiecients and 95 percent confidence intervals of the event study estimates showing the effect of Full NP SOP adoption on the natural log of earnings for different health care occupations in the ACS. All coefficients are relative to the effect two years prior to adoption.

Figure 3: Effect of Full NP SOP Adoption on Relative NP Employment



Notes: This figure plots the coeffiecients and 95 percent confidence intervals of the event study estimates showing the effect of Full NP SOP adoption on relative employment for different health care occupations in the ACS. All coefficients are relative to the effect two years prior to adoption.

Figure 4: Effect of Full NP SOP Adoption on Self Employment



Notes: This figure plots the coeffiecients and 95 percent confidence intervals of the event study estimates showing the effect of Full NP SOP adoption on self-employment for different health care occupations in the ACS. All coefficients are relative to the effect two years prior to adoption.

Table 1: Full Nurse Practitioner Scope of Practice Adoption, 2011-2019

State	Full NP SOP Effective Date
Connecticut	7/1/2014
Delaware	9/1/2015
Illinois	7/1/2019
Maryland	10/1/2015
Minnesota	1/1/2015
Nebraska	3/1/2015
Nevada	7/1/2013
New York	1/1/2015
South Dakota	7/1/2017
West Virginia	6/1/2016

Notes: SOP effective date information was compiled from state legislation documents, state nursing licensing information, media reports, and existing NP SOP literature. We cross-referenced this information with McMichael and Markowitz (2021).

Table 2: Summary Statistics for Burning Glass Technologies Healthcare Job Postings, 2011Q1-2019Q2

	Nurse Practitioners	**Primary Care Physicians**	**Registered Nurses**	**Licensed Practical Nurses**	**Physician Assistants**
Average Quarterly Job Postings	23,545	23,177	214,330	34,140	10,153
Growth in Job Postings, 2011-2018	97.6%	49.9%	150.5%	111.1%	16.9%
Avg Number of Skills per Posting	6.5	4.1	6.8	7.1	5.8
Avg Number of "Skill Groupings" per Posting	3.1	2.1	3.3	3.5	2.8
% of Postings for Specific Skill Groupings					
General Care Skills	62.0	74.0	58.1	64.5	53.1
Specialized Care Skills	40.9	35.4	38.1	27.5	46.4
Mental Health Skills	18.9	3.3	7.7	6.9	5.9
Emergency Care Skills	28.0	11.3	43.2	42.4	35.3
Healthcare Support Skills	47.2	21.2	58.8	69.4	35.6
Office Support Skills	32.8	18.2	31.6	37.5	28.7
Leadership Skills	8.9	3.6	12.4	10.0	7.2
Other Skills	75.5	47.0	83.3	90.2	67.6
N	800,545	788,010	7,287,228	1,160,759	345,197

Notes: Not all BGT job postings include skills, but these omissions are rare (typically 1% or less of postings for a given provider type). "Skill Groupings" are our combined skill measurements, grouping the individual BGT skills into more aggregated combinations of skills. The specific BGT skills included in each "skill grouping" are presented in Appendix Table A1. "Other Skills" include unspecified skills, designated "na" by BGT. Indeed, unspecified skills make up a majority of "Other skills," including 56 percent for nurse practitioners.

Table 3: Summary Statistics from American Community Survey, Sample of Healthcare Workers Aged 25-60, 2010-2019

	Nurse Practitioners	**Physicians**	**Registered Nurses**	**Licensed Practical Nurses**	**Physician Assistants**
Age	42.7	42.8	42.6	42.5	38.5
Female	0.91	0.40	0.89	0.89	0.70
Immigrant	0.11	0.30	0.16	0.15	0.13
Hispanic	0.05	0.07	0.07	0.11	0.09
Asian American	0.06	0.24	0.10	0.05	0.09
Black	0.09	0.07	0.13	0.28	0.08
Other Non-White	0.01	0.02	0.02	0.04	0.03
College Degree	0.98	1.00	0.60	0.05	0.84
Full-Time Employment	0.85	0.87	0.80	0.75	0.82
Self Employed	0.030	0.180	0.008	0.016	0.028
Topcoded Earnings	0.01	0.29	0.00	0.00	0.01
Earnings ($1000s)					
All Employed	88.1	197.5	58.6	34.6	85.3
Full-Time Employed	96.9	218.8	67.0	41.9	97.6
Full-Time and Non-topcoded	94.6	124.1	65.8	41.0	91.6
Full-time, Non-topcoded, and Winsorized	94.0	120.5	64.7	39.7	89.6
Industry					
Hospitals	0.40	0.48	0.64	0.26	0.44
Physicians Offices	0.26	0.34	0.04	0.08	0.31
Outpatient Care Centers	0.16	0.06	0.05	0.07	0.10
Other Industry	0.19	0.13	0.27	0.60	0.15
N	12,182	68,755	244,231	63,050	9,298

Notes: Nurse Practitioners include nurse midwives because the ACS combined the two occupations into a single occupation. According to the 2019 Occupation Employment Statistics (OES), Nurse Practitioners made up almost 97 percent of this combination nationally. Full time employed is defined as working at least 40 weeks over the past year, averaging at least 30 hours per week, and reporting positive earnings. The ACS topcodes the highest two percent of earnings in each state in each year. The winsorized sample excludes the observations with the highest and lowest two percent of earnings within each occupation grouping.

Table 4: Effects of Full NP SOP on Job Postings, BGT Data, 2011Q1 - 2019Q2

	Nurse Practitioners	**Primary Care Physicians**	**Registered Nurses**	**Licensed Practical Nurses**	**Physician Assistants**
	(1)	(2)	(3)	(4)	(5)
1 Year Pre	–0.10	–0.06	–0.07	–0.13*	–0.20*
	(0.10)	(0.11)	(0.04)	(0.07)	(0.11)
SOP Short-Run	0.01	–0.03	–0.02	–0.12	–0.10
	(0.11)	(0.14)	(0.08)	(0.10)	(0.16)
SOP Long-Run	0.27**	–0.07	–0.07	–0.08	–0.04
	(0.12)	(0.17)	(0.05)	(0.09)	(0.13)
State FE	Yes	Yes	Yes	Yes	Yes
Yr-Qtr FE	Yes	Yes	Yes	Yes	Yes
N	1,156	1,156	1,156	1,156	1,156

Notes: Outcome is the natural log of the total number of job postings for a given occupation in each state-quarter-year. SOP Short-Run is defined as the quarters associated with the year of adoption and one year after adoption. SOP Long-Run is defined as the quarters associated with two or more years after adoption. Always treated SOP states are excluded from the analyses. Standard errors are clustered at the state level. *p<0.1; **p<0.05; and *** p<0.01.

Table 5: Effects of Full NP SOP on Relative Job Postings, BGT Data, 2011Q1-2019Q2

	Total Occupation Job Postings: NP Job Postings			
	Primary Care Physicians	**Registered Nurses**	**Licensed Practical Nurses**	**Physician Assistants**
	(1)	(2)	(3)	(4)
1 Year Pre	0.02	0.50	–0.03	–0.04
	(0.14)	(0.77)	(0.14)	(0.05)
SOP Short-Run	–0.10	0.11	–0.16	–0.05
	(0.19)	(1.05)	(0.14)	(0.06)
SOP Long-Run	–0.29*	–3.79***	–0.52***	–0.15***
	(0.15)	(1.15)	(0.18)	(0.05)
State FE	Yes	Yes	Yes	Yes
Yr-Qtr FE	Yes	Yes	Yes	Yes
N	1,156	1,156	1,156	1,156
Sample Mean	1.1	9.8	1.8	0.4

Notes: The outcome is the ratio of the number of job postings for different healthcare occupations to the number of nurse practitioner postings in each state-quarter-year. SOP Short-Run is defined as the quarters associated with the year of adoption and one year after adoption. SOP Long-Run is defined as the quarters associated with two or more years after adoption. Always treated SOP states are excluded from the analyses. Standard errors are clustered at the state level. *p<0.1; **p<0.05; and *** p<0.01.

Table 6: Effects of Full NP SOP on Skills in BGT Job Postings for Nurse Practitioners, BGT Data, 2011Q1 - 2019Q2

			Skill Groupings							
	Number of BGT Skills	**Number of Skill Groupings**	**General Care Skills**	**Specialized Care Skills**	**Emergency Care Skills**	**Mental Health Skills**	**Healthcare Support Skills**	**Office Support Skills**	**Leadership Skills**	**Other Skills**
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
1 Year Pre	0.47	0.08	0.01	–0.03	0.01	0.03	0.05	0.02	–0.01	–0.00
	(0.42)	(0.12)	(0.02)	(0.02)	(0.02)	(0.03)	(0.03)	(0.02)	(0.01)	(0.02)
SOP Short-Run	0.18	–0.03	–0.02	–0.00	–0.02	0.02	–0.00	0.00	0.01	–0.01
	(0.37)	(0.11)	(0.02)	(0.02)	(0.01)	(0.02)	(0.03)	(0.03)	(0.01)	(0.02)
SOP Long-Run	–0.26	–0.09	–0.02	0.00	–0.04***	0.02	–0.01	–0.02	–0.00	–0.00
	(0.45)	(0.14)	(0.03)	(0.02)	(0.01)	(0.03)	(0.03)	(0.03)	(0.01)	(0.02)
State FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Yr-Qtr FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1,156	1,156	1,156	1,156	1,156	1,156	1,156	1,156	1,156	1,156
Sample Mean	6.8	3.2	0.62	0.40	0.18	0.29	0.49	0.34	0.09	0.78

Notes: The outcome is either the average number of skills per job posting (columns 1 and 2) or the probability that a job posting includes a skill associated with a specific skill grouping (columns 3-10) – both computed at the state-quarter-year level. SOP Short-Run is defined as the quarters associated with the year of adoption and one year after adoption. SOP Long-Run is defined as the quarters associated with two or more years after adoption. Always treated SOP states are excluded from the analyses. Sample means differ slightly from the means in Table 2 because these means are based on a straight average of state-quarter-year averages and the means use only the analytic sample. Standard errors are clustered at the state level. *p<0.1; **p<0.05; and *** p<0.01.

Table 7: Effects of Full NP SOP on Earnings, ACS Data, 2010-2019

	Nurse Practitioners	**Physicians**	**Registered Nurses**	**Licensed Practical Nurses**	**Physician Assistants**
	(1)	(2)	(3)	(4)	(5)
1 Year Pre	0.00	0.04**	0.01	-0.01	-0.03
	(0.03)	(0.02)	(0.01)	(0.02)	(0.04)
SOP Short-Run	0.06***	-0.02	0.00	0.01	-0.06**
	(0.02)	(0.02)	(0.01)	(0.01)	(0.03)
SOP Long-Run	0.05**	0.01	0.01	-0.03	-0.04
	(0.02)	(0.01)	(0.01)	(0.02)	(0.03)
State FE	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes
N	9,591	32,530	184,587	44,724	7,049

Notes: The outcome is the natural log of individual earnings and each column presents results from a separate regression on full-time aged 25-60 workers in a specific occupation. SOP Short-Run is defined as the year of adoption or one year after adoption. SOP Long-Run is defined as two-years or more after adoption. Always treated SOP states are excluded from the analyses. Standard errors are clustered at the state level. *p<0.1; **p<0.05; and *** p<0.01.

Table 8: Effects of Full NP SOP on Employment, ACS Data, 2010-2019

	Nurse Practitioners	**Physicians**	**Registered Nurses**	**Licensed Practical Nurses**	**Physician Assistants**
	(1)	(2)	(3)	(4)	(5)
Panel A: Natural Log of Total Employment					
1 Year Pre	0.16	0.14**	0.03*	0.00	-0.03
	(0.11)	(0.07)	(0.02)	(0.07)	(0.09)
SOP Short-Run	0.02	0.10	-0.02	0.07	0.08
	(0.13)	(0.09)	(0.03)	(0.07)	(0.14)
SOP Long-Run	-0.05	0.03	-0.03	0.10	0.10
	(0.09)	(0.05)	(0.03)	(0.06)	(0.11)
N	338	340	340	340	337
Panel B: Relative Employment					
1 Year Pre		-0.16	-0.21	-0.65	-0.08
		(0.81)	(4.00)	(0.74)	(0.12)
SOP Short-Run		0.43	-0.51	0.13	-0.01
		(0.60)	(2.34)	(0.86)	(0.20)
SOP Long-Run		0.26	-0.45	0.13	0.04
		(0.49)	(2.04)	(0.71)	(0.11)
N		333	328	330	326
Sample Mean		6.06	21.06	2.71	0.77

Notes: The outcome in Panel A is the natural log of total occupational employment at the state-year level. The outcome in Panel B is the ratios of total employment for each healthcare occupation relative to the total NP employment. All employment totals are limited to workers aged 25-60 employed full-time. All specifications include state and year fixed effects. SOP Short-Run is defined as the year of adoption or one year after adoption. SOP Long-Run is defined as two-years or more after adoption. Always treated SOP states are excluded from both analyses and relative employment ratios more than two standard deviations from the mean (within each occupation) are also excluded from the ratio analysis. Standard errors are clustered at the state level. *p<0.1; **p<0.05; and *** p<0.01.

Table 9: Effects of Full NP SOP on NP Place of Service, ACS Data, 2010-2019

		Employer Type Among Non-Self Employed			
	Self-Employment	**Hospitals**	**Physicians Offices**	**Outpatient Care Centers**	**Other**
	(1)	(2)	(3)	(4)	(5)
1 Year Pre	-0.003	0.071	-0.064	-0.022	0.015
	(0.015)	(0.089)	(0.065)	(0.034)	(0.035)
SOP Short-Run	0.014*	0.015	-0.034	-0.011	0.030
	(0.008)	(0.054)	(0.032)	(0.024)	(0.024)
SOP Long-Run	0.018**	-0.056	0.007	0.035**	0.013
	(0.006)	(0.041)	(0.044)	(0.015)	(0.028)
State FE	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes
Sample Mean	0.03	0.40	0.26	0.16	0.19
Observations	12,182	11,790	11,790	11,790	11,790

Notes: The outcome is an indicator for being self-employed (column 1) or for being employed at a different employer type (column 2-5). The sample includes all NPs aged 25-60, where columns 2-5 exclude self-employed NPs. SOP Short-Run is defined as the year of adoption or one year after adoption. SOP Long-Run is defined as two-years or more after adoption. Always treated SOP states are excluded from the analyses. Standard errors are clustered at the state level. *p<0.1; **p<0.05; and *** p<0.01.

Table 10: Robustness Estimates for NPs in BGT Analysis

	Preferred Specification	**All States**	**Common Adoption Period**	**Exclude No ACA Exp. States**
	(1)	(2)	(3)	(4)
Panel A: Effect on Natural Log of NP Job Postings				
1 Year Pre	–0.104	–0.105	–0.009	–0.122
	(0.10)	(0.10)	(0.13)	(0.11)
SOP Short-Run	0.01	–0.033	0.10	–0.034
	(0.11)	(0.01)	(0.09)	(0.12)
SOP Long-Run	0.27**	0.20*	0.30**	0.21
	(0.12)	(0.12)	(0.15)	(0.13)
N	1,156	1,734	1,054	816
Panel B: Effect on Relative Number of Job Postings (RNs : NPs)				
1 Year Pre	0.49	0.46	–0.60	0.56
	(0.77)	(0.74)	(0.71)	(0.82)
SOP Short-Run	0.11	0.25	–1.13	0.44
	(1.05)	(1.01)	(0.67)	(1.18)
SOP Long-Run	–3.79***	–3.34***	–3.96***	–3.20**
	(1.15)	(1.13)	(1.28)	(1.28)
N	1,156	1,734	1,054	816

Notes: See notes for Tables 4-5. Column (2) presents estimates that use always treated states as control states. Column (3) presents estimates when we limit our treatment sample to Full NP SOP adopting states over the two-year period (7/1/14 - 6/1/16) as the treated states. Column (4) presents estimates when we exclude states that did not expand Medicaid from the control sample. SOP Short-Run is defined as the year of adoption or one year after adoption. SOP Long-Run is defined as two-years or more after adoption. Standard errors are clustered at the state level. *p<0.1; **p<0.05; and *** p<0.01.

Table 11: Robustness Estimates for NPs in ACS Data

	Preferred Specification	No Earnings Restrictions	All States	Common Adoption Period	Exclude No ACA Exp. States	No Sample Weights
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A: Effect on Natural Log of Earnings for NPs working Full-Time						
1 Year Pre	0.00	0.01	-0.01	-0.01	-0.01	0.02
	(0.03)	(0.03)	(0.03)	(0.04)	(0.03)	(0.01)
SOP Short-Run	0.06***	0.05**	0.06***	0.05***	0.06***	0.04***
	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.01)
SOP Long-Run	0.05**	0.08**	0.04*	0.04*	0.04*	0.04
	(0.02)	(0.03)	(0.02)	(0.02)	(0.02)	(0.02)
N	9,591	10,071	10,901	9,147	6,126	9,591
Panel B: Effect on Self-Employment						
1 Year Pre	-0.003		-0.004	0.012	-0.005	-0.002
	(0.015)		(0.015)	(0.013)	(0.012)	(0.014)
SOP Short-Run	0.014*		0.016**	0.021**	0.013	0.011
	(0.008)		(0.008)	(0.008)	(0.010)	(0.009)
SOP Long-Run	0.018***		0.021***	0.017***	0.018**	0.016*
	(0.006)		(0.006)	(0.005)	(0.007)	(0.009)
N	12,182		13,916	11,616	7,772	12,182
Panel C: Effect on Relative Employment (RNs : NPs)						
1 Year Pre	-0.21		0.72	-0.84	-1.76	-0.65
	(4.00)		(4.02)	(4.20)	(3.37)	(3.88)
SOP Short-Run	-0.51		-0.44	-1.27	0.10	-0.33
	(2.34)		(2.26)	(2.49)	(3.05)	(2.33)
SOP Long-Run	-0.45		-0.62	-0.79	0.74	-0.73
	(2.04)		(2.09)	(2.33)	(1.72)	(1.91)
N	328		483	228	301	328

Notes: See notes for Tables 7-9. Column (2) presents estimates when we include topcoded and winsorized earnings levels. Column (3) presents estimates that use always treated states as control states. Column (4) presents estimates when we limit our treatment sample to Full NP SOP adopting states over the two-year period (7/1/14 - 6/1/16) as the treated states. Column (5) presents estimates when we exclude states that did not expand Medicaid from the control sample. Column (6) presents results when we do not use the sample weights as weights in our estimates. SOP Short-Run is defined as the year of adoption or one year after adoption. SOP Long-Run is defined as two-years or more after adoption. Standard errors are clustered at the state level. *p<0.1; **p<0.05; and *** p<0.01.

APPENDIX

Figure A1: Event Study for Full NP SOP on Natural Log Total NP Job Postings

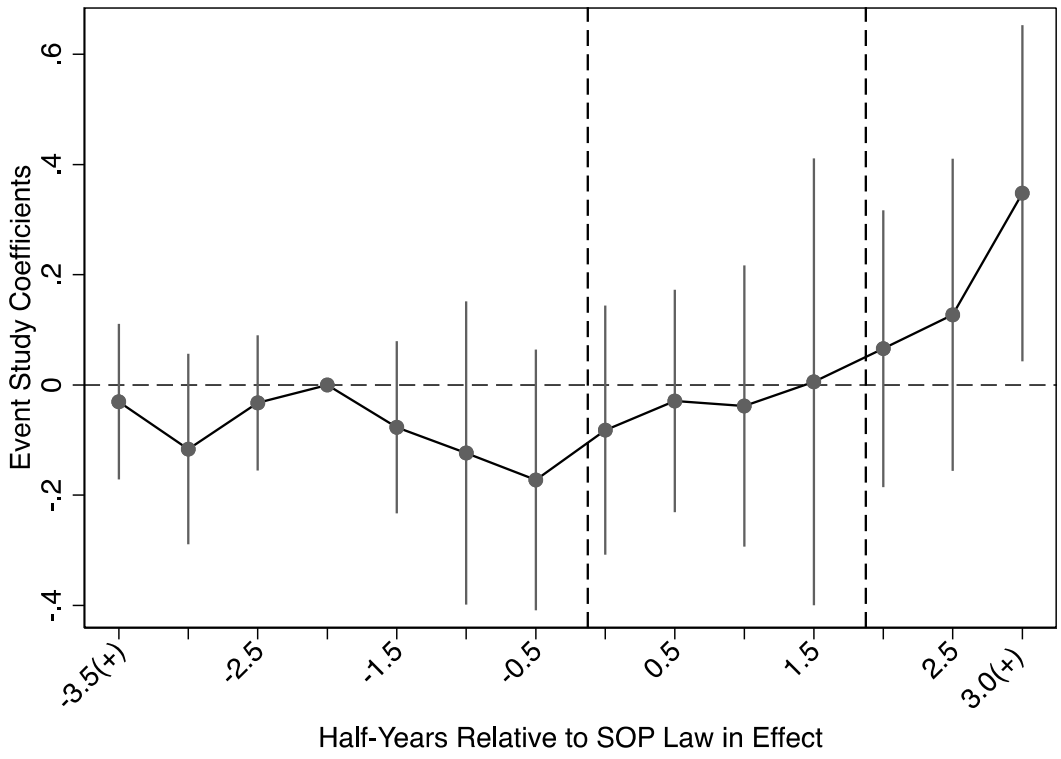


Table A1: BGT Skills Included in our Skill Groupings

General Care Skills
Advanced Patient Care
Basic Patient Care
General Medical Tests and Procedures
General Medicine
Geriatrics
Healthcare Procedure and Regulation
Injury Treatment
Pediatrics
Routine Examination Tests and Procedures

Specialized Care Skills
Allergies
Anesthesiology
Cardiology
Cellular Biology
Dental Care
Dermatology
Ear, Nose, and Throat
Endocrinology
Eye Care
Gastroenterology
Genetics
Infectious Diseases
Nephrology
Neurology
Neuroscience
Nuclear Medicine
Obstetrics and Gynecology (OBGYN)
Oncology
Orthopedics
Pathology
Pharmacy
Pulmonology
Radiology
Speech Language Pathology
Surgery
Urology

Emergency Care Skills
Emergency and Intensive Care
Emergency Services

Mental Healthcare Skills
Mental and Behavioral Health Specialties
Mental Health Diseases and Disorders
Mental Health Therapies

Healthcare Support Skills
Alternative Therapy

Healthcare Support (continued)
Basic Living Activities Support
Blood Collection
Exercise Training
First Aid
Healthcare Procedure and Regulation
Medical Procedure and Regulation
Medical Support
Mobility Assistance
Nutrition and Diet
Occupational Health and Safety
Patient Education and Support
Patient Physical Measurements
Physical Abilities
Physical Therapy
Public Health and Disease Prevention
Rehab Therapy
Rehabilitation
Social Work

Office & Business Support Skills
Administrative Support
Advanced Customer Service
Auditing
Basic Customer Service
Billing and Invoicing
Brand Management
Budget Management
Business Communications
Business Process and Analysis
Business Solutions
Claims Processing
Clinical Data Management
Compensation and Benefits
Computer and Information Technology Industry Knowledge
Contract Management
Customer Relationship Management (CRM)
Cybersecurity
Data Management
Data Techniques
Database Administration
Dictation
Employee Relations
Enterprise Resource Planning (ERP)
Financial Advisement
Financial Management
Financial Reporting
Financial Risk Management
General Accounting
General Administrative and Clerical Tasks

Office & Business Support (continued)
General Marketing
General Networking
General Sales
General Sales Practices
General Shipping and Receiving
Graphic and Visual Design Software
Health Information Management and Security
Housekeeping
Human Resource Management and Planning
Labor Compliance
Management Information System (MIS)
Market Analysis
Marketing Management
Marketing Strategy
Medical Billing and Coding
Medical Documentation and Abstraction
Medical Records
Microsoft Development Tools
Microsoft Office and Productivity Tools
Office Machines
Operations Management
Order Management
Patient Reception
PHP Web
Process Improvement
Procurement
Product Development
Project Management
Public Relations
Quality Assurance and Control
Recruitment
Regulation and Law Compliance
Sales Management
Scheduling
Social Media
Software Development Principles
Specialized Sales
System Design and Implementation
Web Development

Leadership Skills
Business Development
Business Management
Business Strategy
Employee Training
Leadership and Management
Office Management
People Management
Performance Management

Leadership (continued)
Program Management

Other Skills
Art and Illustration
Biologics Industry Knowledge
Biology
Broadcasting Industry Knowledge
Chemical Analysis
Chemistry
Child Care
Child Development
Civil and Architectural Engineering
Clinical Informatics
Clinical Research
Construction Management
Data Analysis
Drug Development
Education Administration
Environmental Work
Equipment Repair and Maintenance
Food and Beverage Service
Foreign language skills
Hazardous Waste Management
Instructional and Curriculum Design
Laboratory Research
Law Enforcement and Criminal Justice
Lean Manufacturing
Litigation
Mathematics
Medical Research
Molecular Biology
Music
na
Peer Review
Physics
Research Methodology
Retail Industry Knowledge
Robotics
Simulation
Social Services Industry Knowledge
Surveillance
Talent Management
Teaching
Technical Support
Telecommunications
Training Programs
Writing

Notes: This figure excludes any BGT skill (called "skill clusters" in the BGT data) comprising less then 0.01 percent of all skills mentioned in the BGT postings, in terms of frequency. This (includes three "Specialized Care" skills together comprising 0.018 percent of skills mentioned), three "Healthcare Support" skills (together comprising 0.004 percent of all skills mentioned), (133 "Office and Business Support" skills together comprising 0.382 of all skills mentioned), and 246 "Other" skills (together comprising 0.301 percent of all skills mentioned). Thus, this table lists more than 99 percent of all skill mentioned in the BGT data, in terms of frequency of being mentioned. BGT Skills within skill groupings are organized alphabetically.

Table A2: Full NP SOP on NP Job Postings Effects by HPSA Designation

	Full HPSA Counties	**Full Other Counties**
	(1)	(2)
1 Year Pre	–0.11	–0.21
	(0.10)	(0.19)
SOP Short-Run	0.05	–0.12
	(0.12)	(0.17)
SOP Long-Run	0.31**	0.30*
	(0.14)	(0.17)
State FE	Yes	Yes
Yr-Qtr FE	Yes	Yes
N	1,089	1,156

Notes: See notes from Table 4. *p<0.1; **p<0.05; and *** p<0.01.

Table A3: Effects of Full NP SOP on Skill in BGT Job Postings for Primary Care Physicians
BGT Data, 2011Q1 - 2019Q2

			Skill Groupings							
	Number of BGT Skills	**Number of Skill Groupings**	**General Care Skills**	**Specialized Care Skills**	**Emergency Care Skills**	**Mental Health Skills**	**Healthcare Support Skills**	**Office Support Skills**	**Leadership Skills**	**Other Skills**
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
1 Year Pre	0.19	–0.06	–0.00	–0.02*	–0.01	–0.00	–0.01	–0.01	–0.01	–0.01
	(0.18)	(0.06)	(0.02)	(0.01)	(0.01)	(0.01)	(0.02)	(0.02)	(0.01)	(0.02)
SOP Short-Run	–0.07	–0.09	–0.02*	0.00	–0.00	–0.01	–0.02	–0.01	–0.01	–0.03
	(0.14)	(0.06)	(0.01)	(0.02)	(0.01)	(0.01)	(0.02)	(0.01)	(0.00)	(0.03)
SOP Long-Run	0.01	–0.02	–0.00	–0.02	–0.01	–0.01	–0.02	–0.00	0.01	0.02
	(0.17)	(0.08)	(0.01)	(0.01)	(0.01)	(0.02)	(0.03)	(0.02)	(0.01)	(0.04)
State FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Yr-Qtr FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Sample Mean	4.2	2.2	0.73	0.36	0.03	0.12	0.22	0.18	0.04	0.48
N	1,156	1,156	1,156	1,156	1,156	1,156	1,156	1,156	1,156	1,156

Notes: The outcome is an either the average number of skills per job posting (columns 1 and 2) or the probability that a job posting includes a skill associated with a specific skill grouping (columns 3-10) – both computed at the state-quarter-year level. SOP Short-Run is defined as the quarters associated with the year of adoption and one year after adoption. SOP Long-Run is defined as the quarters associated with two or more years after adoption. Always treated SOP states are excluded from the analyses. Sample means differ slightly from the means in Table 2 because these means are based on a straight average of state-quarter-year averages and the means use only the analytic sample. Standard errors are clustered at the state level. *p<0.1; **p<0.05; and *** p<0.01.

Table A4: Effects of Full NP SOP on Self-Employment
ACS Data, 2010 - 2019

	Physicians	Nurse Practitioners	Licensed Practical Nurses	Physician Assistants
	(1)	(2)	(3)	(4)
1 Year Pre	0.019	0.003**	0.002	0.004
	(0.016)	(0.002)	(0.005)	(0.011)
SOP Short-Run	0.014	0.002*	-0.003	0.008
	(0.009)	(0.001)	(0.003)	(0.006)
SOP Long-Run	0.018	0.001	-0.004	0.013*
	(0.013)	(0.001)	(0.005)	(0.007)
State FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Sample Mean	0.18	0.008	0.016	0.028
N	68,755	244,231	63,050	9,298

Notes: The outcome is an indicator for being self-employed. SOP Short-Run is defined as the year of adoption or one year after adoption. SOP Long-Run is defined as two-years or more after adoption. Always treated SOP states are excluded from the analyses. Standard errors are clustered at the state level. *p<0.1; **p<0.05; and *** p<0.01.