

Nurse Practitioners on the Rise: Do Looser State Regulations Affect Their Population and Wages?

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Abstract

The current supply of primary care providers in the United States falls short in meeting demand, a trend that has been ongoing for decades, and will soon be exacerbated due to the aging population. Nurse practitioners can provide a sustainable solution to this problem, as they can perform many of the same tasks as their physician counterparts and offer their services in regions that commonly experience shortages of healthcare access. The passage of the Affordable Care Act put even more pressure on the primary care workforce, as millions of more people received healthcare access. Along with its passage was a push to both increase the supply of nurse practitioners as well as loosen the restrictions placed upon their ability to practice. However, because state governments control how much autonomy nurse practitioners are given, there is a large disparity between nurse practitioner authorities among states. This paper looks into the effect of varying degrees of regulations between states on the number of total nurse practitioners and nurse practitioner wages. While no significant effect was found on the number of nurse practitioners, a significant impact was found between looser regulations and increasing nurse practitioner wages.

I. Introduction

Primary care, which serves as the consumer's entry point into the healthcare system, is the most utilized form of healthcare by consumers. In 2014, 52% of all office visits to physicians were to primary care physicians, accounting for more than 900 million Americans utilizing primary care within the year (Peterson et al, 2018). Primary care covers a large range of common healthcare needs, including initial diagnosis, medical evaluations, disease screening and prevention, and treatment of ongoing health problems. Because primary care is often the first point of contact to consumers within the healthcare system, primary care also serves as a referral system, where providers can direct consumers to other specialty physicians.

The current healthcare system in the United States has perpetually come up short with providing an adequate primary health care supply to consumers. There has been a longstanding shortage of primary care physicians¹, which continues to grow and has yet to be successfully appeased. The Association of American Medical Colleges projects an estimated shortage of between 14,800 and 49,300 primary care physicians by 2030. At the same time, the projected total population growth by 2030 within the United States is 11%, with the population of those over the age of 65 increasing by 50%, the result of the baby boomer generation aging. The aging population greatly intensifies primary healthcare demand, as the elderly utilize this care more than any other age group. Also, because one third of the current supply of doctors will also be over 65 years old by 2030, concerns over the retirement of a large cohort of physicians contributes to a potential decline in primary care providers (Association of American Medical

¹ Many factors may contribute to the shortage of primary care physicians, such as medical schools producing too few graduates, physicians opting for specialties other than primary care, work overload on practicing physicians, and uneven distribution of physicians regionally across the United States.
"Is There a Shortage of Primary Care Physicians? Evaluating the Claims." *The SGU Pulse: Medical School Blog*. February 19, 2018. Web.

Colleges [AAMC], 2018). The current labor force in primary care continues to prove to be inadequate, and will continue to be a problem if the rising demand is not met with an equal rise in supply.

There is also widespread disparity in primary care access to consumers across the regions of the United States. Known as the “inverse care law,” rural and inner-city areas, which usually have a higher proportion of minority and low-income populations, generally have fewer primary care professionals than their suburban counterparts (Goodell et al [2011]). Because minority groups and low-income populations generally tend to have poorer health than other demographic groups in the United States, demand for healthcare is usually higher in these areas in comparison to suburban areas. Paradoxically, primary care physicians are usually more concentrated in suburbs², contributing to this discrepancy in demand and supply for primary care.

Along with the shortage of access to healthcare, medical costs in the United States have also been rising. In the United States, the total national health expenditures accounted for 17.9% of GDP in 2016, growing 4.3% from the previous year (Centers for Medicare and Medicaid Services [CMS], 2016). The U.S. spends about twice as much on healthcare as any other developed country, due to high administrative and drug costs, utilization of defensive medicine, and high salaries for physicians. Despite this, it is ranked only thirty-seventh in overall healthcare systems worldwide (World Health Organization Ranking, 2018). The increasing medical costs that exist in the United States are relevant to all Americans because a large portion

² Physicians are often more concentrated in suburban areas as opposed to rural or urban areas due to distance from their residence, hospital or private practice location, and preference.
“Study Examines Why Primary Care Physicians Leave Rural Areas.” *American academy of Family Physicians*. Web. 12 July 2017.

of the population regularly utilizes the healthcare system, especially in regards to primary care, and many Americans cannot afford sufficient healthcare due to high costs.

With the passage of the Affordable Care Act (ACA) in 2010, the primary care deficiency was largely exacerbated. The ACA granted 32 million more Americans health insurance coverage, thereby massively increasing healthcare demand—with the greatest increase being in primary healthcare (Sonenberg et al., 2015). In order to prepare for the massive influx of consumers into the healthcare market, the ACA also implemented programs that aimed to expand the amount of primary medical professionals available to consumers, looking beyond just physicians. One major focus was expanding the population and roles of nurse practitioners in medicine, as they can cover many common tasks that primary care physicians also do. The ACA provided funding to hospital systems to expand nursing school enrollment and training, provided financial incentives to clinicians who work in underserved areas, and funded nurse-managed health clinics (Erikson, 2016). Targeting the nurse practitioner labor force could potentially provide a solution to fill the significant gap in the disparity between the supply and demand of primary care professionals.

Nurse practitioners are registered nurses who have obtained graduate degrees and have also completed additional clinical training. They work in a variety of settings, such as state, local, and private hospitals, as well as physicians' offices, outpatient care centers, clinics, and nursing homes (Bureau of Labor Statistics [BLS], 2017). 65% of all nurse practitioners work in primary care settings and are more likely to work in underserved areas than physicians are. Some of their responsibilities include giving physical examinations, diagnosing illnesses, ordering and interpreting diagnostic tests, performing small procedures, and prescribing medicine. Because many of the tasks they perform are routine and moderately complex, they can have a

comparative advantage over physicians in these tasks (Bana, 2018). Since many of their responsibilities overlap with those of physicians, nurse practitioners can perform them instead, allowing physicians to specialize in more complex procedures that are limited to their authority. Nurse practitioners may be effective substitutes for physicians and therefore could fulfill a need within the healthcare system, increasing the supply of primary care professionals.

Literature Review

Nurse practitioners provide several assets to the primary care labor force. First, they are favorable in regards to lowering medical costs, because they can act as substitutes for doctors in many aspects of the primary care setting and are paid significantly less than their physician counterparts. In 2017, the median salary for nurse practitioners was \$107,480, while the median salary for a primary care physician was \$208,560 (Bureau of Labor Statistics [BLS], 2017). Nurse practitioners also are more likely to deliver care to underserved populations than physicians are, and therefore provide an outlet to patients in areas that lack healthcare access (Sonnenberg et al. [2015]). For instance, nurse practitioners are more likely than physicians to practice in rural or inner-city communities. In addition, McCleery et al. (2014) find that patients who see nurse practitioners instead of physicians see, on average, the same quality of care and health outcomes. This shows that nurse practitioners are competent and effective alternatives to physicians in the primary care setting. Following the passage of the ACA, the number of nurse practitioners employed in the United States has been rapidly growing. They are a plausible solution to the primary care shortage due to their overlap of job functions with physicians, cheaper costs, and ability to increase healthcare access to consumers.

In order for nurse practitioners to continue to extend and increase their role in the primary care workforce, regulations limiting one or more aspects of their jobs should be repealed to allow them more autonomy. Regulations have continued to decrease for nurse practitioners regarding their level of autonomy and ability to prescribe drugs—a trend that has been documented as early as the late 90's. As both the demand for primary care increases and the number of primary care physicians remains largely insufficient to fulfill this need, regulations upon nurse practitioners have simultaneously loosened, allowing them to have more responsibilities and take on new roles that were previously only reserved for physicians. However, because nurse practitioners are regulated at the state level, their autonomy varies depending on what state they practice in. Since the passage of the Affordable Care Act in 2010, regulations have continued to loosen in many states regardless of the severity of its regulations. However, some states relax these regulations to a further degree than others. The more relaxed the regulations are on nurse practitioners, the more able they are to perform the same tasks that primary care physicians are able to perform, thereby increasing availability of services to consumers.

The two main regulations that currently limit nurse practitioners are their practice authority and prescriptive authority. Practice authority is the degree of independence allowed, and can range from requiring strict physician supervision to being able to independently practice and perform procedures. Prescriptive authority stipulates what types of drugs nurse practitioners are able to prescribe, which range from schedule V to schedule II drugs. Since schedule II drugs have the highest potential for abuse, they require the highest level of prescriptive authority. Today, 42 states allow nurse practitioners prescribe schedule II substances and 23 states allow them to work without any physician oversight. Each year, more regulations are lifted and nurse practitioners gain more autonomy across the United States.

The American Association of Nurse Practitioners (AANP) classifies states into three categories based on their degree of regulations—full practice, reduced practice, and restricted practice. Full practice nurse practitioners are allowed full prescriptive authority (allowed to prescribe up to schedule II drugs) and can practice without any physician supervision. The AANP labels full practice states as “green states,” symbolizing the greatest possible degree of authority. Reduced practice states limit one or more of these authorities to nurse practitioners, giving them some degree of autonomy but not as much as the green states, and are labeled as “yellow states.” Finally, restricted practice states have the strictest regulations in one or both of these areas, and are labeled as “red states.” For instance, a green state would allow nurse practitioners to practice without any physician supervision at all, a yellow state may require supervision only during procedures, while a red state would require a physician to be present at all times when a nurse practitioner is in contact with a patient.

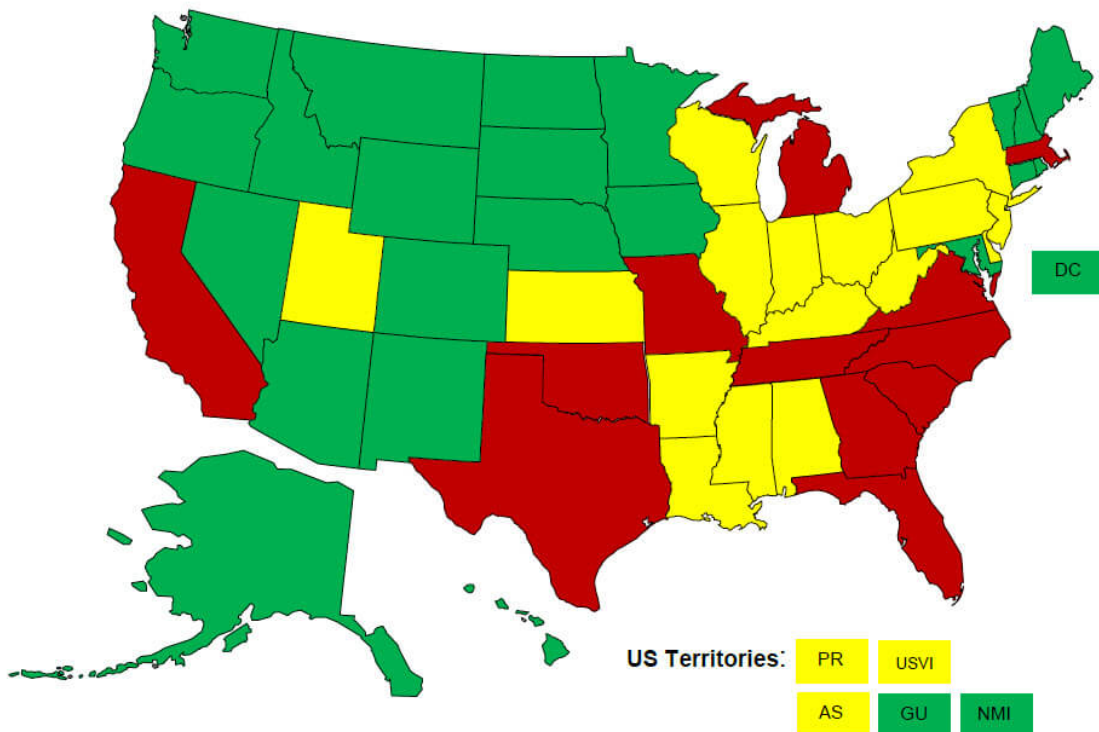
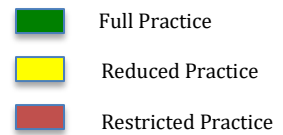


Figure 1: Nurse Practitioner Practice Authority by State³

Several previous studies have noted that states with looser regulations see an increase in the number of nurse practitioners in that state in comparison to states with more restricted regulations. Bana (2018) notes that states that give nurse practitioners more authority see a statistically significant increase in the number of job postings for nurse practitioners. This shows that the demand for nurse practitioners is greater in states with fewer restrictions. Stange (2014) also notes a similar trend. Using nurse practitioner supply and regulation data from 1990-2008, he finds a modest positive correlation between increased prescriptive authority and utilization of nurse practitioners. So, when nurse practitioners are granted more prescriptive authority in their practicing state, they get more patient visits. Stange does however acknowledge that his findings were not as significant as he had expected, seeing that there was a great surge in the aggregate nurse practitioner supply over the same time period. Limitations of his analysis may come from his incomplete data set, which only includes data from partial amount of states, and each year has a slightly differing group of states. Also, Stange’s data accounts for the time period of 1990-2008, which may be too premature to observe a significant difference in nurse practitioner population between more and less restricted states. At that point in time, only a few states allowed nurse practitioners full authority or expanded prescriptive authority, meaning the treatment group sample size was relatively small. In addition, it may be true that not enough time had passed since the loosening of regulations in order to observe a significant change in the nurse practitioner population between states. However, a newer study done in 2013 by Reagan &



³ “State Practice Environment.” American Association of Nurse Practitioners. 2018. <https://www.aanp.org/advocacy/state/state-practice-environment>

Salsberry confirms Stange's findings by also showing that the nurse practitioner growth rate was higher in states with looser regulations in comparison to more strictly regulated states. This study looks at the time period between 2001-2008, a later time period with more complete data, and finds similar results.

In addition, other studies have also shown that nurse practitioners increase primary care access in rural areas. Rural areas have been consistently documented to provide less access to primary care than suburban and urban areas, mostly due to physicians being more concentrated in urban and suburban areas. However, when states allow full practice authority to nurse practitioners, they are 30% more likely than their more restricted counterparts to establish clinics in rural areas (Krein, 1999). In 2007, Kaplan et al did a study in Washington State, which compared the nurse practitioner population in the state's urban and rural areas. They found that nurse practitioners in rural areas are more likely to work for underserved populations and administer primary care in comparison to nurse practitioners in urban areas. Also, they confirmed that Washington's nurse practitioners have similar demographic characteristics to the national nurse practitioner workforce, causing them to speculate that similar trends are likely to be seen across other states as well. Xue et al. (2018) investigated the relationship of the supply of nurse practitioners in rural and "health professional shortage areas (HPSAs)," and the degree of scope of practice allowed to nurse practitioners. Using compiled data from The Area Resource File and National Provider Identifier Registry for the number of nurse practitioners, they found that the supply of nurse practitioners increased in rural and HPSA areas in all states over time, but had the largest increase in states with full scope of practice. They showed that states that grant nurse practitioners full scope of practice rather than reduced or restricted practice leads to a higher number of nurse practitioners in rural and HPSA areas.

Furthermore, previous studies have also demonstrated a direct relationship between nurse practitioner increasing practice autonomy and wages. In 2017, the median salary for nurse practitioners was \$107,480 (Bureau of Labor Statistics [BLS], 2017). Perry (2009) was one of the first to look at the scope of practice-wage relationship, utilizing nurse practitioner wage data from 1992-2004 and comparing it to regulation levels between states. He finds that for every year that nurse practitioners have enhanced prescriptive authority of any degree (allowance to prescribe anything higher than a schedule V drug), their earnings increase on average from the year before by roughly 1.6%. In addition to this, he finds that physician incomes fall by about 7.6% for each year that nurse practitioners have prescriptive authority. In a more recent study, Kleiner et al. (2016) finds that when states that do not grant nurse practitioners full authority, nurse practitioners can see a drop in wages by up to 14%. Kleiner also finds that the inverse is also true—when nurse practitioners are granted prescriptive authority, there is an increase in their wages. Both studies show that an increase in some form of authority for nurse practitioners results in an increase in wages.

Data from previous studies have validated that loosening nurse practitioner regulations, thereby giving them more autonomy, leads to an increase in the number of nurse practitioners, creates more access for consumers to primary healthcare, and results in an increase in nurse practitioner wages. However, many states that are still classified as yellow or red states do not allow nurse practitioners the authority to practice to their full capability, which means that the maximum gains from allowing them full authority may not have been met yet. If allowed to practice to their full potential of training, the AANP projects that nurse practitioners could provide for up to 60% of all office-based primary care visits.

This paper focuses on the varying degrees of regulations in states and specifically, recent regulation changes between 2011-2017 that resulted in looser regulations upon nurse practitioners. This paper looks at the relationship between scope of practice granted to nurse practitioners and the number of nurse practitioners in a state, the number of nurse practitioners in rural and urban counties, and the wages of nurse practitioners. While other studies found a significant impact between increasing autonomy to nurse practitioners and increasing numbers of nurse practitioners in states and also rural areas, this paper finds no such significant results. However, this paper does confirm that looser regulations result in higher wages for nurse practitioners.

Data

Data regarding nurse practitioner regulations was compiled from many sources. Because transitions from a more strict practice environment to less strict one are of importance in this study, the exact year of a regulation change was used as the quantitative measure of this transition. Gadbois et al (2015) compiles regulation changes in prescriptive authority and practice authority from 2001 to 2010 for all states. For regulation changes after 2010, the “State Progress in Removing Barriers to Practice and Care” article enumerates full practice authority year changes. Not all states had available data for prescriptive and full practice authority, so some states had to be omitted from analysis. For instance, changes that occurred before 2001 may not have been documented in available sources because regulation changes for nurse practitioners did not become a major area of interest until the mid 2000s.

Also, this study focuses only on the practice authority regulation data, because it clearly distinguishes green states from yellow and red states. While many states in all three categories allow full prescriptive authority, only the green states also allow nurse practitioners full practice authority. Therefore the transition of a state to becoming green is marked by that state granting full practice authority. Treatment is defined as the year in which a state experiences this law change. This transition correlates with a change from a “red” or “yellow” state to a “green” one. In contrast, the control group is composed of states that have remained “red” throughout the entire 2011-2017 period. Therefore, they have the strictest laws governing how much autonomy is granted to nurse practitioners. The control group signifies the baseline rate of increase of number of nurse practitioners in states that exists if no regulation change takes place. Green states make up the treatment group while red states make up the control group. Yellow states were omitted from being a part of either group because they could contain elements from both the treatment and control in regards to regulation and they were highly variable among each other.

Treatment	Year of Treatment	Control States
Idaho	2005	California
Washington	2006	Texas
Wyoming	2006	Oklahoma
Arizona	2006	Massachusetts
Hawaii	2010	Michigan
Colorado	2010	Virginia
Vermont	2011	Missouri
North Dakota	2011	Tennessee
Nevada	2013	North Carolina
Rhode Island	2013	South Carolina
Minnesota	2014	Florida
Connecticut	2014	Georgia
Maryland	2015	
Nebraska	2015	
South Dakota	2017	
Maine		
New Hampshire		
Alaska		
New Mexico		
Oregon		
Montana		
Iowa		

Table 1: Treatment and Control Group States⁴

⁴ Treatment states with the year of regulation changes and control group states. Note that treatment states with omitted treatment years were known green states with unknown transition years.

Gadbois, Emily A. et al. "Trends in State Regulation of Nurse Practitioners and Physician Assistants, 2001 to 2010." *Medical care research and review : MCRRT2.2* (2015): 200–219. *PMC*. Web. 28 Feb. 2018.

"State Progress in Removing Barriers to Practice and Care." *Campaign for Action*. Web 22 January 2019.

Data for the nurse practitioner population by state and by county from the years 2011-2017 was used from the Area Health Resource File. Because this data only went back as early as 2011 for nurse practitioners, likely due to their recent emerging role in the workforce, 2011 was the earliest year that could be utilized for looking at the effects on their numbers due to regulation reductions.

Nurse practitioner wage data was taken from the Bureau of Labor Statistics Occupational Employment and Wages dataset. The wages from 2012 and 2017 were utilized for this analysis in order to capture the wage level before and after regulation changes. Wage data was limited, with 2012 being the earliest year to yield available data. Prior to 2012, nurse practitioners were grouped together within a larger subgroup of nurses in the dataset, making their population indistinguishable from other occupations. Their emergence in the 2012 dataset as a distinct occupational group is likely to their vastly growing numbers.

Table 2: Summary Statistics Table⁵

Control States	NP Wage (2012)	NP Wage (2017)	Number of NPs (2012)	Number of NPs (2017)	Mean State Population (2017)
California	101,140	123,260	9,727	15,684	39,500,000
Texas	95,860	110,070	8,466	16,436	28,300,000
Oklahoma	85,780	99,750	1,035	2,069	3,930,000
Massachusetts	100,470	117,510	5,438	7,831	6,860,000
Michigan	87,650	99,680	3,475	6,093	9,960,000
Virginia	86,370	99,570	3,429	5,796	8,470,000
Missouri	86,550	96,070	3,383	5,694	6,110,000
Tennessee	88,780	95,640	5,077	8,341	6,720,000
North Carolina	87,860	99,530	4,177	6,992	10,300,000
South Carolina	86,030	95,060	1,760	3,393	5,020,000
Florida	87,070	96,700	8,908	16,994	21,000,000
Georgia	84,720	98,770	3,895	7,752	10,400,000
Average	89,856.67	102,634.16	4,897.50	8,589.58	13,047,500
Treatment States (2013-2015)	NP Wage (2012)	NP Wage (2017)	Number of NPs (2012)	Number of NPs (2017)	Mean State Population (2017)
Rhode Island	99,060	109,790	577	876	1,060,000
Connecticut	91,700	111,990	2,188	3,336	3,590,000
Maryland	92,880	105,460	2,807	4,583	6,050,000
Minnesota	93,890	113,530	3,496	4,589	5,580,000
Nebraska	83,440	99,800	915	1,440	1,920,000
Nevada	92,890	103,000	616	1,315	3,000,000
Average	92,310	107,261.67	1,766.50	2,689.83	3,533,333.33
Control States	NPs/100,000 people	Population Over 65 (2014)	Percent of population over 65	Number of Physicians	Physicians/ 100,000 people
California	39.70	4,993,047	12.64	105,907	268.12
Texas	58.07	3,099,081	10.95	61,132	216.01
Oklahoma	52.64	562,531	14.31	8,057	205.01
Massachusetts	114.15	1,016,237	14.81	30,213	440.42
Michigan	61.17	1,530,052	15.36	28,206	283.19
Virginia	68.42	1,146,886	13.54	22,072	260.59
Missouri	93.19	932,215	15.26	16,268	266.25
Tennessee	124.12	985,700	14.67	16,627	247.43
North Carolina	67.88	1,463,362	14.21	25,295	245.58
South Carolina	67.58	761,865	15.18	11,269	224.48

⁵ Averages of important data regarding nurse practitioners. Years 2012 and 2017 were utilized to capture data before and after implementation of regulation changes, respectively. NP stands for nurse practitioner.

“Occupational Employment and Wages, May 2017 29-1171 Nurse Practitioners” *Bureau of Labor Statistics*. Web. 27 Mar. 2018
 “Area Health Resource Files”. *Health Resources and Services Administration*. Web. 24 October 2018.

Florida	80.92	3,791,544	18.05	53,685	255.64
Georgia	74.53	1,251,538	12.03	23,215	223.22
Average	75.20	1,794,504.83	14.25	33,495.5	261.33
Treatment States (2013-2015)	NPs/100,000 people	Population Over 65 (2014)	Percent of population over 65	Number of Physicians	Physicians/ 100,000 people
Rhode Island	82.64	166,147	15.67	3,770	355.66
Connecticut	92.92	555,923	15.49	12,341	343.76
Maryland	75.75	822,260	13.59	22,731	375.72
Minnesota	82.24	780,142	13.98	16,105	288.62
Nebraska	75.00	270,989	14.11	4,426	230.52
Nevada	43.83	401,847	13.39	5,884	196.13
Average	75.40	499,551.33	14.37	10,876.17	298.40

Methods

Effect of Full Practice Authority on Wages

A difference-in-difference model was utilized to compare the effects of differences in degree of practice authority on nurse practitioner wages. By comparing the average change in wages for the control and treatment states from 2012-2017, this model calculates the effect of a positive regulation change on wages. In a difference-in-differences model, it is assumed that, in the absence of treatment (regulation change), treatment and control states would experience a similar change in the wages of nurse practitioners.

Because a regulation change is likely to take time to produce its effect, only changes between the years of 2013-2015 were utilized to ensure that the effects on wages were captured. This time period was also used in order to avoid an overlap effect between the data. Some reasons for the delay of seeing effects could be the period it takes to train a new nurse

practitioner or the time it takes for an individual nurse practitioner to become aware of the regulation change.

The regression used to compare the effect of full practice authority states against restricted authority states on the dependent variable, wage, was utilized:

$$Y_{st} = \beta_0 + \beta_1 Treat_s + \beta_2 Post_t + \beta_3 Treat * Post_{st} + \epsilon_{st}$$

The dependent variable, Y_{st} , corresponds to wage. Subscripts “s” and “t” represent state and time period, respectively. Wage data from the years 2012 and 2017 is utilized for each state. $Treat_s$ will equal 0 if the state was not treated and 1 if that state did see treatment from 2013-2015. Treatment is defined as being given full practice authority. $Post_t$ is the time measurement: it will equal 0 in 2012, prior to treatment, or 1 in 2017, after the treatment period. $Treat * Post_{st}$ represents the effect of the regulation change on the treated states. It will equal 1 when $treat = 1$ and $post = 1$, which represents a treated state in the year 2017. If either one of the variables or both equal 0, $treat_post$ will also be 0.

In addition, another regression was run identical to the one used above, but a dependent variable of \ln_wages was used instead. This allows for a direct comparison of the numerical effect on wages that resulted from a regulation change.

Effect of Full Practice Authority on Number of Nurse Practitioners

This analysis captures the effect of a shift to full practice authority on the number of nurse practitioners in a given state. Unlike the wage regression, which used just one pre-

treatment and one post-treatment year, seven different years (2011-2017) are used in this model.

The regression used was:

$$\ln(NP)_{st} = \beta_0 + \beta_1 \text{Treat}_{st} + \mu_s + \lambda_t + \epsilon_{st}$$

Here, μ_s represents a state fixed effect, which mean a dummy variable is included for each state. Similarly, λ_t is a year fixed effect as well, meaning that it estimates the difference in the number of nurse practitioners between a given year and the base year, which is defined as 2010. The “ $\beta_1 \text{Treat}_{st}$ ” variable will therefore only equal one in the case that treatment exists and it occurs in that specific year. For this model, several regressions were calculated. One compared only the treated states from 2013-2015 to the control group and another included all the treated states from 2010-2017 to the control group, looking at total number of nurse practitioners in a given state. Lastly, an analysis was done to see if there was a significant difference between rural and urban areas in states that were treated or control.

Results

Effect of Full Practice Authority on Wages

Table 3: Effect of Full Practice Authority Transition on Nurse Practitioner Wages

Wage						
Variable	Coefficient	Standard Error	t-value	p-value	95% Confidence Interval	
Treat2	905.36	346.51	2.61	0.009	226.09	1584.63
Post	12655.03	164.2	77.07	0	12333.14	12976.91
Treat*Post2	4096.77	549.6	7.45	0	3019.37	5174.16
_cons	88690.8	97.02	914.11	0	88500.6	88881

This analysis suggests that there was a significant impact of full practice authority on the wages that nurse practitioners earned in states that loosened regulations between 2013-2015. $_Cons$ represents the constant wage, or the average wage of a nurse practitioner in an untreated state in 2012. The coefficient for $Treat2$ predicts the additional salary that a nurse practitioner will earn if they are in a treated state. $Post$'s coefficient represents the additional amount of salary that will occur in 2017 for nurse practitioners, in treated and control states. $Treat_post$ predicts the additional amount earned by a nurse practitioner in 2017 who resides in a treated state. All coefficients are significant at the 0.01 level. These data imply that nurse practitioners in treated states, or states with looser regulations, experience higher wages on average than nurse practitioners in control states. These results confirm previous findings in other papers, such as Perry (2009) and Kleiner et al. (2016), who also demonstrate an increase in wages due to more lax regulations.

Table 4: Effect of Full Practice Authority Transition on Nurse Practitioner Ln_Wages

Ln_Wage						
Variable	Coefficient	Standard Error	t-value	p-value	95% Confidence Interval	
Treat2	0.0102	0.0039	2.62	0.009	0.0026	0.0178
Post	0.1327	0.0016	81.18	0	0.1295	0.1359
Treat*Post2	0.0386	0.0056	6.91	0	0.0277	0.0495
$_cons$	11.3912	0.0011	11000	0	11.389	11.3933

From this data, the Treat*Post2 variable yields a coefficient of 0.0386. Because the log of wages was utilized as the dependent variable, this coefficient can be understood to mean that the regulation change in treatment states led to a 3.86% increase in nurse practitioners wages as compared to the control states. Notably, Perry (2009) also finds a similar trend, with a 1.6% increase in wages due to looser regulations. Interestingly, this study finds a larger increase in wages as compared to Perry’s (2009) work. This may be due to a difference in time period studied, since this paper looked at data from 2012-2017, while Perry looked at data from 1992 to 2004. Because regulations have recently been changing more drastically due to the increasing demand and perpetuating primary care shortage, larger wage increases may have been occurring after the period that Perry studied.

Effect of Full Practice Authority on Number of Nurse Practitioners

Ln_np						
Year	Coefficient	Standard Error	t-value	p-value	95% Confidence Interval	
2011	0.0509	0.145	0.35	0.726	-0.2235	0.3353
2012	0.1238	0.1457	0.85	0.396	-0.162	0.4096
2013	0.1637	0.1457	1.12	0.262	-0.1221	0.4495
2014	0.2787	0.1805	1.54	0.123	-0.0754	0.6328
2015	0.3556	0.2474	1.44	0.151	-0.1297	0.8409

2016	0.415	0.2478	1.67	0.094	-0.0711	0.9011
2017	0.4651	0.2489	1.87	0.062	-0.0232	0.9534
Treat	0.0258	0.201	0.13	0.898	-0.3685	0.4201
_cons	2.0096	0.1015	19.79	0	1.8104	2.2088

Table 5: Effect of Full Practice Authority Transition on Nurse Practitioner Number for 2013-2015 Treatment States

As noted by the Treat variable, no significant effect was found on the impact of full practice authority on the number of nurse practitioners by state, for states treated from 2013-2015. This is significant because previous studies have shown the opposite effect—that number of nurse practitioners increases in states that have looser regulations. Two examples of such findings are Stange (2014) and Reagan & Salsberry (2013), who find a positive correlation between looser regulations and number of nurse practitioners.

Table 6: Effect of Full Practice Authority Transition on Nurse Practitioner Number for 2010-2017 Treatment States

In_np						
Year	Coefficient	Standard Error	t-value	p-value	95% Confidence Interval	
2011	0.0833	0.0543	1.53	0.125	-0.0321	0.1897
2012	0.1634	0.0544	3	0.003	0.0567	0.27
2013	0.2243	0.0546	4.48	0	0.1374	0.3513
2014	0.3453	0.0552	6.25	0	0.237	0.4535
2015	0.453	0.0562	8.07	0	0.3429	0.563
2016	0.5285	0.0565	9.36	0	0.4178	0.6391

2017	0.6104	0.0573	10.64	0	0.498	0.7228
Treat	-0.0425	0.0697	-0.61	0.541	-0.1791	0.094
_cons	2.144	0.0383	55.99	0	2.0689	2.219

This analysis was expanded to include all states that were treated from 2010-2017, increasing the time period and number of states that were included in the regression. These results confirm the findings from the previous analysis, as the Treat variable is not significant, showing that there is no significant difference in the number of nurse practitioners in treated states and untreated states.

Effect of Full Practice Authority in Rural Areas on Number of Nurse Practitioners

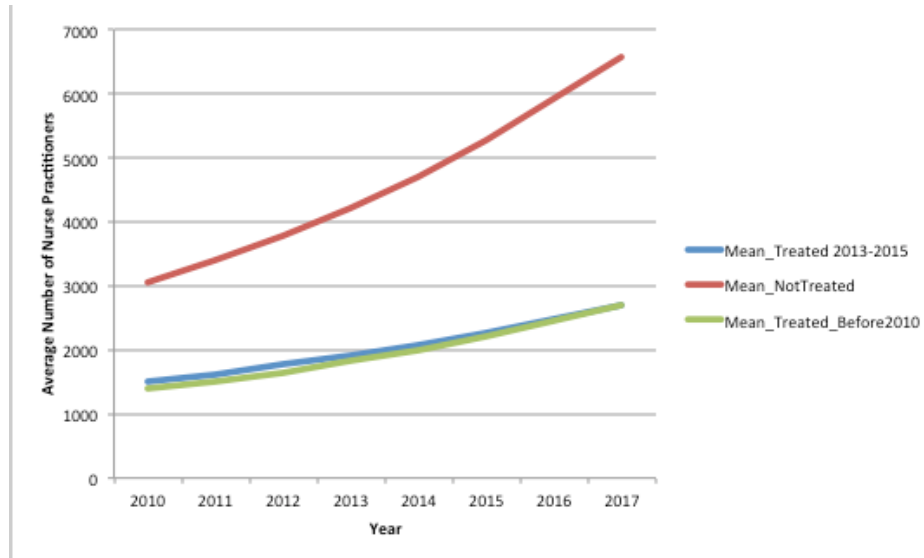
Table 7: Effect of Full Practice Authority Transition on Nurse Practitioner Number in Rural Areas for Treatment States

Ln_np						
Year	Coefficient	Standard Error	t-value	p-value	95% Confidence Interval	
2011	0.0323	0.1154	0.28	0.779	-0.1941	0.2589
2012	0.1047	0.118	0.89	0.375	-0.1268	0.3363

2013	0.1634	0.1192	1.37	0.171	-0.0706	0.3975
2014	0.2552	0.1518	1.68	0.093	-0.0427	0.5531
2015	0.3034	0.2016	1.5	0.133	-0.0922	0.6991
2016	0.3481	0.2029	1.72	0.087	-0.05	0.7462
2017	0.3716	0.205	1.81	0.07	-0.0308	0.774
Treat	0.0592	0.1645	0.36	0.719	-0.2637	0.3821
_cons	1.208	0.00792	15.26	0	1.0526	1.3634

These results, which compared the number of nurse practitioners in rural and urban areas in the same state, compared the 2013-2015 treatment states to the control group states. These results also show no significant difference between the number of nurse practitioners in rural and urban areas in treated and control states.

Figure 3: Average Number of Nurse Practitioners For Treated and Untreated States by Year



As can be seen in Figure 3, both treated groups and the non-treated group show positive growth in the number of nurse practitioners. Interestingly, the average growth rate is much higher for the non-treated group than the treated groups. This could be the result of the small sample size of the Mean_Not Treated group, as it only includes 6 states, which could have coincidentally been slower-growing than the rest of the treatment states. Overall, however, numbers of nurse practitioners appear to be rapidly growing in all states, showing future signs of growth.

Discussion

Currently, there is a shortage of primary care physicians in the United States that will become exacerbated in the coming years due to the large growing number of people over the age of 65 from the baby boomer generation. Because the physician supply will not be able to fulfill the demand for primary care on their own, steps are being taken by the federal and state

governments to integrate other primary care professionals, such as physician assistants and nurse practitioners, into the workforce. Nurse practitioners in particular present as a viable substitute for physicians in primary care due to their advanced training and ability to perform many tasks that physicians can. Though there are some procedures that only a physician is licensed to perform on patients, nurse practitioners are able to cover many common and routine procedures, such as examinations and diagnoses of illnesses. In this way, they can cover many of the physicians' routine responsibilities and mitigate the shortage of care to patients, while also freeing up physicians' time to perform more complex procedures that nurse practitioners cannot do. Because nurse practitioners prove to be an effective and efficient addition to the primary care workforce, their numbers have been growing rapidly each year and will likely continue to grow in the future.

As the role of nurse practitioners has been increasing, many states have taken action to further enhance the extent of their autonomy, by reducing or completely abolishing restrictions that had been originally placed upon them. While states range greatly in the degree of autonomy that they currently allow to nurse practitioners, more and more regulations are loosened every year. It is likely that in a few decades most current "red" and "yellow" states, if not all, will transition to "green" states, allowing for the maximum extent of nurse practitioner authority. Because states differ greatly in autonomy allowed to nurse practitioners, many studies have been conducted to see if there are any significant effects due to this difference. The two dependent variables looked at in this paper were the number of nurse practitioners and nurse practitioner wage by states. Many previous studies found that looser-regulated states saw an increase in the number of nurse practitioners as compared to more strictly regulated states. However, this study found no such significant correlation. Similarly, Kaplan et al. and Xue et al. find that that rural

areas have higher numbers of nurse practitioners than urban areas in states with looser regulations as compared to states with strict regulations. This study, however, does not find any significant correlation. Differences in results found may be due to the data sets used or time period studied. Also, another reason for not finding significant effects in regards to total number of nurse practitioners in the state and in rural areas may be due to a lag effect. Changes that occurred between 2013 and 2015, especially in the more recent years, may not have produced a noticeable impact yet. Because a nurse practitioner is required to complete a four-year nursing bachelor's degree program, followed by 2-4 years to complete additional training and gain a master's degree, they do not enter the workforce after deciding to be a nurse practitioner for several years. Therefore, these effects may not be revealed for years after their implementation. This can be further explained by considering supply and demand in the short run. If we assume that nurse practitioners may take time to enter the market due to training time, supply would be inelastic in the short run, but not in the long run. Inelastic means that a price change, which in this case would be wage, would not alter the supply of nurse practitioners in the short run. Therefore, a right shift in the demand curve can occur without supply changing, which would explain the results found in this analysis.

Several studies also found a correlation between increased nurse practitioner autonomy and increased nurse practitioner wages. This paper confirms this, as a positive correlation was found for decreasing regulations and increasing wages.

Because nurse practitioners have recently become a major occupation within the workforce, a lot of data regarding them, such as population and wages, has only recently become available. As a result, there is a limited time period that economists can run regressions on. In the future, it would be interesting to observe the long term effects that varying state regulations has

on nurse practitioners and other aspects of the healthcare system. Also, this and many other papers only focus on the primary care sector of healthcare because that is where the main shortage of healthcare providers is seen, but it would also be interesting to see if nurse practitioners see similar demand and growth in other areas as well.

The nurse practitioner occupation is growing rapidly, due to a demand for more primary care professionals and the expansion of authority allowed to them by many states. Their future job outlook looks bright, especially for those residing in the looser-regulated states. Their increasing role in primary care, along with other potential substitutes for physicians, may alleviate some of the medical professional shortage that is currently being experienced within the primary healthcare sector.

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