Dissertation

The Impact of Nurse Practitioner Scope-of-Practice Regulations in Primary Care

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Abstract

The costs of primary care have been rising and access to it may become limited because of a possible shortage in primary care physicians. Some state governments have addressed this issue by allowing Advanced Practice Registered Nurses (APRNs) to serve the population without the supervision of physicians. About half of the states permit nurse practitioners (NPs) to practice and/or prescribe drugs without physician supervision or collaboration. NPs in primary care charge lower prices than physicians and provide satisfactory quality of care, supported by existent literature. Moreover, increasing the number of NPs could alleviate access problems from a low supply of physicians. NP scope-of-practice (SOP) regulations have been changing in many states. The dissertation focuses on access to health care and addresses three research questions: what is the impact of NP SOP regulations on NP employment, access to primary health care in areas characterized by a relatively low supply of primary care physicians, and how does the Center for Medicaid and Medicare Innovation's Comprehensive Primary Care Initiative affect the use of NPs given state SOP regulations?

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Abbreviations

NP	Nurse Practitioner
NP SOP	Nurse Practitioner Scope-of-Practice
PA	Physician Assistant
PCP	Primary Care Provider
CPCI	Comprehensive Primary Care Initiative
CMMI	Center for Medicare and Medicaid Innovation
APN	Advanced Practice Nursing
CRNA	Certified Registered Nurse Anesthetist
CNM	Certified Nurse Midwife
CNS	Clinical Nurse Specialist
HPSA	Health Professional Shortage Area
MD	Medical Doctor
PPACA	Patient Protection and Affordable Care Act
NMHC	Nurse-managed Health Clinic
DME	Durable Medical Equipment
AANP	American Association of Nurse Practitioners
ED	Emergency Department
APRN	Advanced Practice Registered Nurse
HRSA	Health Resources and Services Administration
FTE	Full Time Employment
AHRQ	Agency for Healthcare Research and Quality
IOM	Institute of Medicine
DEA	Drug Enforcement Administration
CPC+	Comprehensive Primary Care Plus
FFS	Fee-for-service
PMPM	Per-month-per-member
CMS	Centers for Medicare & Medicaid Services
DHHS	Department of Health and Human Services
MOU	Memoranda of understanding
CAP	Corrective action plan
RN	Registered Nurse
PHC	Primary health care
NPI	National Provider Identifier
NSSNP	National Sample Survey of Nurse Practitioners
SCM	Synthetic cohort method
DiD	Difference-in Differences
GLS	Generalized Least Squares
MUA	Medically underserved area
HCC	Hierarchical condition category
HIT	Health Information Technology
CRSE	Clustered robust standard errors

1. Introduction

Policy Issue

Even though the United States spends by far the most money on health care of any country in the world[1], there are still concerns with access to primary care. These concerns are more pronounced in some parts of the country. One possible approach to alleviating access concerns is to expand scope-of-practice (SOP) for nurse practitioners (NPs). Some argue that expanded SOP can improve access and reduce costs, and allow for innovations in more-efficient models of health care delivery. Others argue that NPs provide lower-quality care than physicians and their services might be costlier due to over-prescription of laboratory tests and medications.

The market is primary health care and the regulation under consideration is NP SOP. The distortion or correction that a regulation imposes on a market might have an impact on the prices and quantity of the services available. In the case of the health care market, this involves the safety and quality of care provided. A policy maker who considers modifying NP SOP regulations faces three important objectives: the primary health care provided has to be *safe* and of *good quality*, *accessible* to individuals who need health care, and *cost-efficient*. Many states thereby have different NP SOP laws and regulations, given their state-specific features, environment, and needs.

Health care costs have been rising and the demand for primary health care is expected to increase as the population ages and grows[2]. In addition, there may be a shortage of primary care providers (PCPs) in certain areas of the country[3]. Thus, there is a need to assess primary health care from the provider perspective – NPs and primary care physicians – that would take into account state NP SOP regulation. Access to primary health care depends in part on the number of PCPs in an area as well as the availability of physician and NP graduate programs, which will in turn affect the number of students educated to become PCPs. The supply of PCP services (from both NPs and physicians) depends on the number of PCPs, and any addition to the number of PCPs depends on the availability and size of PCP graduate programs in a particular state, as well as other pertinent factors. In particular, number of NPs practicing in a state could be affected by NP SOP regulations. Therefore, it is important to evaluate the impact of NP SOP regulations on NP employment, access to primary health care, and whether there is any relationship between NP SOP and practices' willingness to adopt any innovative payment and practice models on Primary Care

[1] "Health expenditure, total (% of GDP)," *The World Bank*, 2014. As of May 22, 2017.
[2] "Projecting the Supply and Demand for Primary Care Practitioners Through 2020," 2013. Health Resources and Services Administration. As of May 22, 2017.
[3] Dall, Tim, Terry West, Ritashree Chakrabarti, and Will Iacobucci, "The complexities of physician supply and demand: projections from 2013 to 2025," *Washington: Association of American Medical Colleges*, 2015.

Transformation offered by the Patient Protection and Affordable Care Act (PPACA), such as the Center for Medicare and Medicaid Innovation's (CMMI's) Comprehensive Primary Care Initiative (CPCI). The latter is important to explore as some of the innovative payment and practice models on Primary Care Transformation amplify the role of NPs.

Access, quality, and cost in primary care concern not only health policy makers and state governments, but also payers and patients. The projected increase in PCP demand from the Affordable Care Act and the growing health care requirements of an aging population increase the priority of these concerns[4]. Expanding NP SOP is a policy action that can be taken, but what are its payoffs? If NP SOP reforms are able to decrease the rate of cost growth and increase access to high-quality services, they could help to improve welfare and access to primary health care nationwide.

Objectives

This research study will explore the effect of NP SOP regulations on NP employment, access to primary health care with the emphasis on shortage areas, and the use of NPs within practices adopting the CMMI's CPCI innovative payment and practice model on Primary Care Transformation. The dissertation uses the SK&A dataset and rigorous econometric methods to analyze the effect of NP SOP regulations on NP employment, measures of access to primary care, and adoption of the CMMI's CPCI innovative payment and practice model on Primary Care Transformation. The study will add to the existing literature on NP employment, access to primary care, and be an original contribution to the adoption of the CMMI's CPCI in the context of NP SOP in primary care. Specifically, the impact of NP SOP will be explored by answering the following questions:

1. What is the relationship between NP SOP and NP employment?
2. What is the relationship between NP SOP and patient volume?
3. What is the relationship between NP and PA employment along with NP SOP regulations and the practices' adoption of the Center for Medicare and Medicaid Innovation's Comprehensive Primary Care Initiative innovative payment and practice model on Primary Care Transformation?

    i. What is the relationship between employment of NPs and PAs and decision of practices to participate in the Center for Medicare and Medicaid Innovation's Comprehensive Primary Care Initiative innovative payment and practice model on Primary Care Transformation?
    ii. What is the relationship between NP SOP and decision of practices to participate in the Center for Medicare and Medicaid Innovation's Comprehensive Primary Care Initiative innovative payment and practice model on Primary Care Transformation?

[4] "The Complexities of Physician Supply and Demand: Projections from 2014 to 2025," 2016. *IHS Inc*. As of May 1, 2017.

The subsequent chapters will aim to answer the above research questions. Chapter 2 will cover background, literature review[5] on the role of NPs, access to health care, NP SOP, and CPCI. In the next chapter, conceptual framework on NP SOP along with theoretical model will be developed, followed by a chapter that will seek to answer research question on NP employment. Chapter 5 will answer the second research question on patient volume and Chapter 6 will be on the relationship between CMMI's CPCI and NP SOP along with NP and PA employment. The concluding chapter will summarize the findings from the above-mentioned chapters and provide policy recommendations.

[5] Chapter 2 covers background and literature review with the purpose to introduce a reader to the topic. However, Chapters 4, 5, and 6 will have a brief literature review pertinent to their topic solely.

2. Background and Literature Review

The issue of affordable access to health care is one of the most pressing and contentious policy debates in the United States today. Research on any aspect of this topic is complicated by the patchwork of policies and regulations employed by the various states. This chapter covers background and literature review on access to health care with the focus on NPs and NP SOP regulations. Specifically, section 2.1 will cover the role of NPs in primary care, the next section will be on access to health care, section 2.3 will be about NP SOP and how it is defined in the subsequent chapters, and lastly, section 2.4 will present brief background on the CPCI[6].

The role of NPs in primary care

Background

Several studies looked at the role of nurse practitioners, mostly focusing on either the quality of care provided and/or cost-effectiveness of utilizing NPs as a response to primary care provider shortage. The purpose of this section however, is to provide a concise overview of who NPs are and what the existing literature states about their role in primary care.

Who are the NPs and what do they do?

NPs are defined differently depending on the context and state in which they practice. Federal law defines NPs as "a nurse practitioner who performs such services as such individual is legally authorized to perform (in the state in which the individual performs such services) in accordance with state laws and who meets such training, education, and experience required as the Secretary has prescribed in regulations" [7]. The Legislature of California, for example, defines 'Nurse Practitioner' as "a registered nurse who possesses additional preparation and skills in physical diagnosis, psycho-social assessment, and management of health-illness needs in primary health care, and who has been prepared in a program conforming to board standards as specified in Section 1484"[8]. The New York board of nursing defines an NP as "… an RN who has earned a separate license as an NP through advanced clinical nursing education (usually a master's degree) in a distinct specialty area of practice. Nurse practitioners may diagnose, treat, and prescribe for a patient's condition that falls within their specialty area of practice. Nurse practitioner specialty

[6] More detailed background on the CPCI is presented in Appendix A2 and literature review on the CPCI is given in Chapter 6.

[7] United States Code Annotated 42 §1395x(aa)(5)(A) As of June 15, 2017.

[8] California Code of Regulations title 16, § 1480 (a). As of June 15, 2017.

areas include: Acute Care; Adult Health; College Health; Community Health; Family Health; Gerontology; Holistic Nursing; Neonatology; Obstetrics and Gynecology; Oncology; Palliative Care; Pediatrics; Perinatology; Psychiatry; School Health; and Women's Health[9]."

NPs are sometimes referred to as physician extenders, mid-level practitioners, non-physician practitioners, and advanced practice nurses. Moreover, each state has its own way of titling an NP. For instance, Alabama calls an NP a Certified Registered Nurse Practitioner (CRNP), and in Hawaii NPs are Advanced Practice Registered Nurses (APRN).

For the purposes of this research, an NP will refer to any registered nurse whose title at the practice he/she practices in is "Nurse Practitioner" without considering his/her primary and secondary specialization, which SK&A data tracks.

Why are NPs important?

NP programs emerged in the mid-1960s as one of the responses to physician shortage and NPs have been providing health care since then[10]. In particular, there was a need for more medical providers in underserved areas of the nation[11]. Thus, NPs are an important source of primary care especially in underserved areas[12]. Some states allow NPs to be designated as primary care providers (PCPs) for a patient who is enrolled in a managed-care plan[13]. The American Association of Nurse Practitioners describes the role of NPs as follows[14]:

- **NP credibility** - NPs are more than just health care providers; they are mentors, educators, researchers, and administrators. Their involvement in professional organizations and participation in health policy activities at the local, state, national, and international levels helps to advance the role of the NP and ensure that professional standards are maintained.
- **Lower health-care costs** - By providing high-quality care and counselling, NPs can lower the cost of health care for patients. For example, patients who see NPs as their primary care provider often have fewer emergency room visits, shorter hospital stays and lower medication costs.

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[9] "Nursing," September 24, 2013. New York State Education Department Office of the Professions. As of November 25, 2015.

[10] Buppert, Carolyn, *Nurse Practitioner's Business Practice and Legal Guide* 5th edition ed.: Jones & Bartlett Learning, 2015, p. 6.

"Nurse Practitioner." Mayo Clinic School of Health Sciences. As of November 25, 2015.

[11] Buppert, 2015, p.6.

[12] Buerhaus, Peter I, Catherine M DesRoches, Robert Dittus, and Karen Donelan, "Practice characteristics of primary care nurse practitioners and physicians," *Nursing Outlook,* Vol. 63, No. 2, 2015, pp. 144-153.

DesRoches, Catherine M, Jennifer Gaudet, Jennifer Perloff, Karen Donelan, Lisa I Iezzoni, and Peter Buerhaus, "Using Medicare data to assess nurse practitioner–provided care," *Nursing Outlook,* Vol. 61, No. 6, 2013, pp. 400-407.

[13] Buppert, 2015, p.8.

[14] "What's an NP." The American Association of Nurse Practitioners. As of November 25, 2015.

- **Patient satisfaction -** With almost 916 million visits made to NPs each year, patients report an extremely high level of satisfaction with the care they receive.
- **Primary care shortage solution** - By offering high-quality, cost-effective, patient-centred health care, NPs provide approximately 205,000 solutions to the primary care shortage facing America today.

NPs today: available facts and data

The American Association of Nurse Practitioners is a major source of facts and data on NPs. Another source of facts on NPs and NP SOP is Linda Pearson's Report, which provides information on state NP scope-of-practice regulations in full details and tracks the number of APRNs. Below, most of the particulars are based on these sources, unless stated otherwise.

How many NPs do we have?

The supply of NPs is increasing. In 2017 there were more than 234,000 NPs licensed[15] in the US, 89.2% of which are prepared in primary care[16], and an estimated 23,000 new NPs completed their academic programs in 2015-2016[17]. According to the AANP, there were approximately 130,000 NPs in 2009 and the number of NPs has increased, reaching more than 234,000 NPs in 2017[18]. Figure 2.1 shows the number of NPs in the United States from 2009 to 2017.

According to the 2017 AANP National Nurse Practitioner Sample Survey, 97.7% of NPs have graduate degrees and 61.4% of working NPs see 3 or more patients per hour[19]. NPs have been in practice an average of 11 years, with the average age of 49 years and a mean, full-time base salary of $105,670 in 2017 [20]. NPs have low malpractice rates – only 1.9% of NPs were named as primary defendant in a malpractice case in 2016[21], and "the rate of lawsuits against NPs is low, compared

[15] It is not clear if the above estimate indicates total number of licenses issued for NPs by 2014. However, Linda Pearson's 2014 NP report estimated that there were 202,615 NPs licensed in the country (as of December 2013) and the 2012 National Sample Survey of NPs estimated that there were 154,057 licensed NPs in the country in 2012. So, the estimates on the number of licensed NPs varies depending on the source and the way they count number of NPs.

[16] AANP identifies certification with primary care focus in such primary care specialties as Adult care, Gerontology, Pediatric care, Women's Health, and Family care. For more details see "NP Facts". The American Association of Nurse Practitioners. June 6, 2017. As of June 30, 2017.

[17] "NP Facts", 2017.

[18] "Historical Timeline." The American Association of Nurse Practitioners. 2017. As of June 30, 2017:

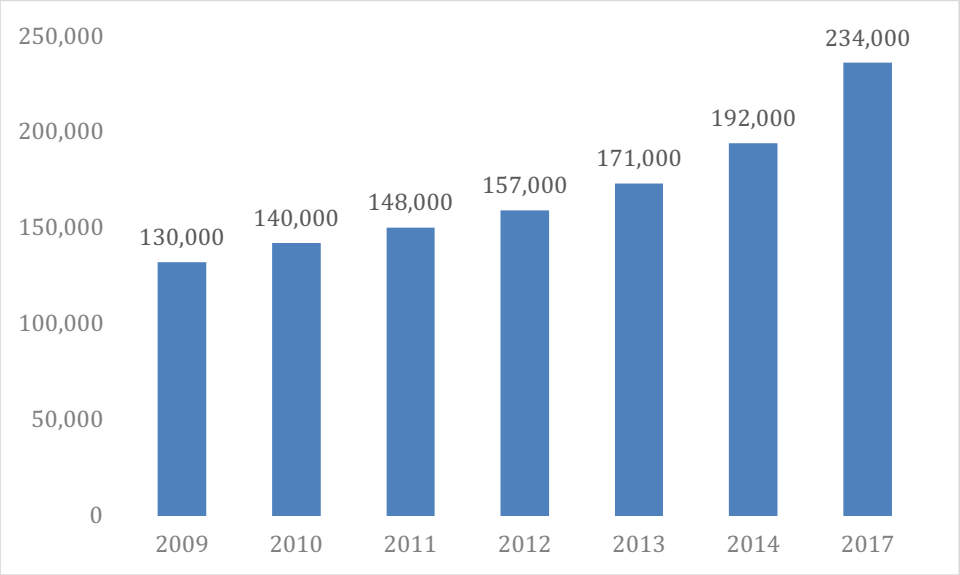
[19] "2017 AANP National Nurse Practitioner Sample Survey ", The American Association of Nurse Practitioners, 2017.

[20] "2017 AANP National Nurse Practitioner Sample Survey ", 2017.

[21] "2016 AANP National Nurse Practitioner Sample Survey," The American Association of Nurse Practitioners, 2016.

with a rate of physicians"[22]. According to the 2017 AANP National Nurse Practitioner Sample Survey, three-fourth of the NPs are in family or adult care practice[23].

Figure 2.1.
Number of NPs in the United States



Reimbursement for NP services

NPs are reimbursed differently depending on the payer. There are four major types of third-party payers: Medicare, Medicaid, managed-care organizations, and businesses that contract for certain services. Not every payer will reimburse every NP for every service rendered[24]. For instance, Medicare reimburses NPs at a rate of 85% of the physician fee schedule. However, an NP may be fully reimbursed, i.e. receive 100% of the physician fee schedule, if the care is "incident to a physician's professional service" where the NP provides a service "in a physician's office under a physician's direct personal supervision"[25]. One study found that the "incident-to designation reportedly limits NP autonomy and minimizes the role of NPs as primary care providers"[26].

The Patient Protection and Affordable Care Act (ACA): NPs and Primary care

[22] Buppert, 2015, p. 457.

[23] "NP Facts", 2017.

[24] Buppert, 2015.

[25] Ibid., p. 305.

[26] Yee, Tracy, Ellyn Boukus, Dori Cross, and Divya Samuel, "Primary care workforce shortages: Nurse practitioner scope-of-practice laws and payment policies," *National Institute for Health Care Reform Research Brief,* Vol. 13, 2013, pp. 1-7.

With the increase of about 20 million[27] insured and the emphasis on prevention in primary care under the ACA, the role of NPs expanded[28]. Under the ACA funding, the Health Resources and Services Administration (HRSA) launched two programs, the NHSCS Loan Repayment Program and the NURSE Corps Loan Repayment Program, that offer educational financial assistance to NPs with the condition that they practice in underserved areas[29]. Moreover, under the ACA, Medicaid payment rates for primary care services were increased[30]. However, in compliance with Section 6407 of the ACA, restriction of durable medical equipment (DME) ordering was put in place as part of the anti-fraud initiative, such that NPs may not order certain DME for Medicare and Medicaid patients without written physician consent as well as an in-person encounter with their patient at least 6 months before providing the written order. Osborne[31] concluded that this new requirement for DME will likely generate logistical and SOP nuisance[32]. Further, under the ACA, from 2011 to 2015 a 10 percent primary care bonus was offered to clinicians that participate in the Medicare program, and PCPs, NPs, and PAs that generate 60% of their services in primary care can receive this bonus. Another provision under the PPACA includes "the authorization of funding for nurse-managed health clinics (NMHCs) and school-based health clinics, both of which can be led by nurse practitioners"[33]. For instance, in 2012 under the ACA funding, the DHHS granted $15 million over three years to fund certain nurse-managed health clinics and support training for APNs[34]. Under the ACA health reform, patient-centered medical home models of care were promoted as a way to increase patient access to a regular source of primary care and establish a stable relationship between a patient and primary care provider, including an NP[35]. Overall, these provisions of PPACA were expected to result in an increase of the demand for NPs and the role they play in providing health care. The current proposals in congress could reduce insurance

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[27] Uberoi, Namrata, Kenneth Finegold, and Emily Gee, *Health insurance coverage and the Affordable Care Act, 2010-2016*: Unted States Department of Health and Human Services, 2016.

[28]Clavreul, Geneviève M., "What Health Care Reform Means for Nurses: Expectations for the next eight years." As of November 25, 2015.

[29] "A letter from Dr. Wakefield, January 26, 2015." The American Association of Nurse Practitioners. 2015. As of November 25, 2015.

[30] Snyder, Laura, Julia Paradise, and Robin Rudowitz, "The ACA Primary Care Increase: State Plans for SFY 2015," October 28, 2014.

[31] Osborne, Jean Marie, "Durable Medical Equipment Ruling: Impact on Nurse Practitioner Role," *The Journal for Nurse Practitioners,* Vol. 10, No. 5, 2014, pp. 344-351.

[32] Inability to order home health/durable medical equipment was among the reported barriers to practice for NPs in a study conducted in Georgia. For further details see Shilling, D. L., and D. Hodnicki, "APRN prescribing in Georgia: An evolving environment," *J Am Assoc Nurse Pract,* Vol. 27, No. 6, Jun, 2015, pp. 300-307.

[33] Brothers, Matt, "The PPACA's Impact on the Scope of Practice of Nurse Practitioners," *Ann. Health L. Advance Directive,* Vol. 23, 2013, pp. 79-198.

[34] Vleet, Amanda Van, and Julia Paradise, "Tapping Nurse Practitioners to Meet Rising Demand for Primary Care," January 20, 2015.

[35] Davis, Karen, Melinda Abrams, and Kristof Stremikis, "How the Affordable Care Act will strengthen the nation's primary care foundation," *Journal of general internal medicine,* Vol. 26, No. 10, 2011, p. 1201.

coverage, but their likelihood of enactment is uncertain, and therefore, one may expect that NPs will still experience an increasing demand for their services.

Overview of existing literature

The existing literature on the impact of NPs and NP SOP on quality of care and costs, as well as substitutability of physicians and NPs in primary care is presented in this section. However, before reviewing literature, the definition and succinct background on primary care is given.

Primary care in the United States

According to the American Academy of Family Physicians, primary care is defined as "care provided by physicians specifically trained for and skilled in comprehensive first contact and continuing care for persons with any undiagnosed sign, symptom, or health concern (the 'undifferentiated' patient) not limited by problem origin (biological, behavioral, or social), organ system, or diagnosis"[36]. Primary care entails such health care as health promotion and disease prevention, counselling and patient education, diagnosis and treatment illnesses under different health care settings.

The United States has had a weak primary care foundation. Prior to ACA only two-thirds of adults had access to a PCP and three-quarters experienced difficulty in getting an appointment or off-hours care without going to emergency department (ED), or receiving phone advice[37]. Thus, ACA emphasized the importance of primary care and access to PCPs, especially in underserved areas of the country, and devoted some of its funds to PCPs, including NPs.

Quality of care and clinical outcomes

Several studies consider the quality of care or clinical outcomes provided by NPs and the existing literature suggests that NPs provide a quality of care almost on par with physicians. A meta-analysis of NPs in primary care found that in studies, controlling for patient risk in a non-randomized way, patient satisfaction and resolution of pathological conditions were greater for NP patients and NPs were equal to physicians in the majority of variables in controlled studies[38]. Mundinger found that in an ambulatory care setting in which patients were randomly assigned to either NPs or physicians and NPs had the same authority, responsibilities, patient population, and productivity and administrative requirements as physicians, "patients' outcomes were

[36] "Primary Care." The American Academy of Family Physicians. As of November 25, 2015.

[37] Davis et al., 2011.

[38] Brown, Sharon A, and Deanna E Grimes, "A meta-analysis of nurse practitioners and nurse midwives in primary care," *Nursing research,* Vol. 44, No. 6, 1995, pp. 332-339.

comparable"[39]. Another study had similar findings – NP patient health outcomes were similar to those of nurses and doctors in a primary care setting, however patient satisfaction[40] was higher with nurse-led care[41]. A systematic review examining studies from 1990-2008 concluded that APRNs provide "effective and high-quality patient care, have an important role in improving the quality of patient care in the United States, and could help to address concerns about whether care provided by APRNs can safely augment the physician supply to support reform efforts aimed at expanding access to care."[42] Also, NPs have higher likelihood to provide health education services to their patients than physicians[43]. Patients accept a greater role for NPs and many patients have seen and were satisfied by the care they obtained from non-physician providers[44].

Furthermore, studies on NP SOP show that expanded NP SOP have a positive effect[45] on quality of care. For instance, Traczynski and Udalova found that less restrictive NP SOP increases the quality of care, while examining the relationship between NP SOP and patient experience of care[46]. Another study examined the relationship between the level of advanced practice registered nurse (APRN) practice and results of recent nationwide, state level analyses of Medicare or Medicare-Medicaid beneficiaries of potentially avoidable hospitalizations, readmission rates after inpatient rehabilitation, and nursing home resident hospitalizations and concluded that states with full practice authority have lower hospitalization rates in all examined groups and improved health outcomes in their communities[47]. In a study on the effect of NP SOP on quality of care in health centers, "no statistically significant differences were detected among NP visits by states' independence status" on such outcomes as smoking cessation counseling, statin for

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[39] Mundinger, Mary O, Robert L Kane, Elizabeth R Lenz, Annette M Totten, Wei-Yann Tsai, Paul D Cleary, William T Friedewald, Albert L Siu, and Michael L Shelanski, "Primary care outcomes in patients treated by nurse practitioners or physicians: a randomized trial," *Jama,* Vol. 283, No. 1, 2000, pp. 59-68.

[40] Moreover, there exists an opinion that under "the team-based, population health model", NPs and PAs are needed, as one could not "build patient access or patient satisfaction without them". See for further details Japsen, Bruce "Nurse Practitioners More In Demand Than Most Physicians," *Forbes*, July 15, 2015.

[41] Laurant, Miranda, David Reeves, Rosella Hermens, Jose Braspenning, Richard Grol, and Bonnie Sibbald, "Substitution of doctors by nurses in primary care," *Cochrane Database Syst Rev,* Vol. 2, No. 2, 2005.

[42] Newhouse, Robin P, Julie Stanik-Hutt, Kathleen M White, Meg Johantgen, Eric B Bass, George Zangaro, Renee F Wilson, Lily Fountain, Donald M Steinwachs, and Lou Heindel, "Advanced practice nurse outcomes 1990-2008: a systematic review," *Nursing Economics,* Vol. 29, No. 5, 2011, p. 230.

[43] Hing, Esther, Roderick S. Hooker, and Jill J. Ashman, "Primary Health Care in Community Health Centers and Comparison with Office-Based Practice," *Journal of Community Health,* Vol. 36, No. 3, 2011, pp. 406-413.

[44] Dill, Michael J, Stacie Pankow, Clese Erikson, and Scott Shipman, "Survey shows consumers open to a greater role for physician assistants and nurse practitioners," *Health Affairs,* Vol. 32, No. 6, 2013, pp. 1135-1142.

[45] For further details on the impact of changing Scope-of-Practice Laws from restrictive to full practice authority for APRNS see Table 2.1 of Martsolf, Grant, David I Auerbach, and Aziza Arifkhanova, The impact of full practice authority for nurse practitioners and other advanced practice registered nurses in Ohio: Rand Corporation, 2015.

[46]Traczynski, Jeffrey, and Victoria Udalova, "Nurse practitioner independence, health care utilization, and health outcomes," *Fourth Annual Midwest Health Economics Conference, Madison, WI*, 2013.

[47] Oliver, Gina M, Lila Pennington, Sara Revelle, and Marilyn Rantz, "Impact of nurse practitioners on health outcomes of Medicare and Medicaid patients," *Nursing Outlook,* Vol. 62, No. 6, 2014, pp. 440-447.

hyperlipidemia, depression treatment, imaging, physical examinations, and return visits[48]. Sonenberg and Knepper examined effect of NP SOP policy on population and concluded that "it appears that policy affects population health among" the states studied – Alabama, Colorado, Mississippi, and Utah[49]. As a group, these studies indicate that NPs are capable of providing adequate quality of care with patient outcomes comparable to those of physicians and NP SOP might have an impact on quality of care provided.

Costs

Several studies examined the impact of NPs and NP SOP on health care costs and majority of studies concluded that usage of NPs has a potential to decrease costs in health care. A simulation-based study estimated the potential cost savings in primary care in Alabama and estimated that removing restrictions in NP/PA SOP regulations would generate more than $729 million in net savings over a 10-year period[50]. Another simulation-based study examined the impact of SOP regulations for APRNS in North Carolina and found that under the scenario of full practice authority the state would have an increase in economic output, gross domestic product, and tax revenue[51]. Spetz examined the costs associated with various NP SOP regulations at retail clinics and concluded that "savings would be $810 million greater if all states allowed NPs to practice independently and $472 million greater if NPs could both practice and prescribe independently"[52]. Another study looked at the relationship of NP SOP to prices of well-child medical exams and concluded that restrictive SOP increases the cost of routine medical care[53]. Timmons examined the impact of NP SOP and PA SOP on the cost of health care for Medicaid patients and concluded that "broadening the scope of practice for healthcare providers may represent a low-cost alternative to providing quality care to America's poor"[54]. The other study analyzed claims data vis-à-vis the percentage of first-visit claims and reimbursement obtained by NPs in states with different NP SOP regulations and found that "NPs billed for a larger share of first-visit claims in states with less restrictive SOPs", although there was no evidence found on whether "states liberalizing their

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[48] Kurtzman, Ellen T, Burt S Barnow, Jean E Johnson, Samuel J Simmens, Donna Lind Infeld, and Fitzhugh Mullan, "Does the Regulatory Environment Affect Nurse Practitioners' Patterns of Practice or Quality of Care in Health Centers?," *Health services research,* Vol. 52, No. S1, 2017, pp. 437-458.

[49] Sonenberg, A., and H. J. Knepper, "Considering disparities: How do nurse practitioner regulatory policies, access to care, and health outcomes vary across four states?," *Nurs Outlook,* Vol. 65, No. 2, Mar - Apr, 2017, pp. 143-153.

[50] Hooker, Roderick S, and Ashley N Muchow, "Modifying state laws for nurse practitioners and physician assistants can reduce cost of medical services," *Nursing Economics,* Vol. 33, No. 2, 2015, p. 88.

[51] Conover, Chris, and Robert Richards, "Economic benefits of less restrictive regulation of advanced practice nurses in North Carolina," *Nursing Outlook,* Vol. 63, No. 5, 2015, pp. 585-592.

[52] Spetz, Joanne, Stephen T Parente, Robert J Town, and Dawn Bazarko, "Scope-of-practice laws for nurse practitioners limit cost savings that can be achieved in retail clinics," *Health Affairs,* Vol. 32, No. 11, 2013, pp. 1977-1984.

[53] Kleiner, Morris M, Allison Marier, Kyoung Won Park, and Coady Wing, "Relaxing occupational licensing requirements: analyzing wages and prices for a medical service," *The Journal of Law and Economics,* Vol. 59, No. 2, 2016, pp. 261-291.

[54] Timmons, E. J., "The effects of expanded nurse practitioner and physician assistant scope of practice on the cost of Medicaid patient care," *Health policy,* Vol. 121, No. 2, Feb, 2017, pp. 189-196.

SOP over time experienced larger growth in the share of claims billed by NPs"[55]. Roblin found that primary care practices that had more NPs and PAs in providing care had lower practitioner labor costs per visit than practices that used less[56]. A report by the American Association of Nurse Practitioners argues that NPs are cost-effective in providing health care, due to fewer years of training and lower wages compared to physicians[57]. One other study found that there was lower cost of care for Medicare beneficiaries "managed by NPs, as compared to those managed by PCMDs[58] across inpatient and office-based settings"[59]. The other study claimed that the cost of training NPs is relatively lower and the length is shorter when compared to the primary care physicians[60]. Overall, these studies uniformly find that NPs have the potential to contribute to cost-containment in primary health care, and expanded NP SOP may yield reduction in healthcare costs too.

Substitutability between physicians and NPs

Several studies looked at the substitutability of NPs for physicians. One study found that 25 percent to 70[61] percent of work done by physicians can be done by nurses[62], where nurses included nurse practitioners among other physician extenders. Kraus and DuBois studied NP independence in primary care and found that MDs "were supportive of a wide variety of NP roles and comfortable with levels of NP independence and autonomy. Physicians and NPs described prerequisites to NP independence that were complementary"[63].

Some studies analyze substitutability between practice nurses and physicians, which include NPs as well and the findings from these studies are relevant to explore in this section. For instance,

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[55] "Impact of State Scope of Practice Laws and Other Factors on the Practice and Supply of Primary Care Nurse Practitioners.," *Westat*, 2015.

[56] Roblin, Douglas W, David H Howard, Edmund R Becker, E Kathleen Adams, and Melissa H Roberts, "Use of midlevel practitioners to achieve labor cost savings in the primary care practice of an MCO," *Health services research,* Vol. 39, No. 3, 2004, pp. 607-626.

[57]"Nurse Practitioner Cost-Effectiveness." The American Association of Nurse Practitioners. As of November 25, 2015.

[58] PCMD – primary care medical doctor.

[59] Perloff, Jennifer, Catherine M DesRoches, and Peter Buerhaus, "Comparing the cost of care provided to Medicare beneficiaries assigned to primary care nurse practitioners and physicians," *Health services research,* Vol. 51, No. 4, 2016, pp. 1407-1423.

[60] Dierick-van Daele, Angelique TM, Lotte MG Steuten, Job FM Metsemakers, Emmy WCC Derckx, Cor Spreeuwenberg, and Hubertus JM Vrijhoef, "Economic evaluation of nurse practitioners versus GPs in treating common conditions," *Br J Gen Pract,* Vol. 60, No. 570, 2010, pp. e28-e35.

[61] In an interview with a physician practitioner in his patient-centered medical home, who has employed advanced practitioners for 25 years, Edward Bujold, for instance, considers that "NPs and PAs can handle 85% to 90% of what comes through the office, with the caveat that there's always a physician to touch base with". For further details see Beaulieu-Volk, Debra "Moving the conversation forward on scope of practice " *Med Econ*, November 10, 2015.

[62] Richardson, Gerald, Alan Maynard, Nicky Cullum, and David Kindig, "Skill mix changes: substitution or service development?," *Health policy,* Vol. 45, No. 2, 1998, pp. 119-132.

[63] Kraus, E., and J. M. DuBois, "Knowing Your Limits: A Qualitative Study of Physician and Nurse Practitioner Perspectives on NP Independence in Primary Care," *J Gen Intern Med,* Vol. 32, No. 3, Mar, 2017, pp. 284-290. Abstract.

it was found that nurses may carry out much of the health promotion work of family practice[64] and manage chronic diseases[65]. One study argued that nurses can work either as doctor supplements or as doctor substitutes[66]:

> Nurses working as doctor supplements provide services which complement or extend those provided by doctors. The aim is to improve the quality of care and extend the range of services available to patients. In contrast, nurses working as doctor substitutes provide services which otherwise would be provided by doctors alone. The aim is to reduce the demand for doctors.

The same study found that nurse productivity – defined in this study as length of consultation, patient recall, and resource utilization – is lower than doctor productivity, yet, nurses provide usually longer consultations and attain the same health outcomes as doctors[67]. This study concluded that the addition of nurses to physician teams can reduce physician workload or enable them to handle more patients, but may not reduce workload unless steps are taken to make sure physicians do not perform services that nurses could do as efficiently[68].

Another study examined NPs and PAs productivity in the Veterans Health Administration[69], whereas productivity was defined as "work relative value units (wRVUs) divided by the direct clinical full-time equivalent (FTE) of an individual", and identified that NPs and PAs are more productive in adult primary care than in other specialties[70]. Moreover, it was found that "NP productivity was unaffected by supervisory requirements" in the VHA[71]. The review of these studies show that NPs could be either substitutes or complements to physicians, depending on the state NP SOP and the role they attain in an organization they work.

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[64] Langham, Susan, Margaret Thorogood, Charles Normand, John Muir, Lesley Jones, and Godfrey Fowler, "Costs and cost effectiveness of health checks conducted by nurses in primary care: the Oxcheck study," *Bmj,* Vol. 312, No. 7041, 1996, pp. 1265-1268.

Family Heart Study Group, "British family heart study: its design and method, and prevalence of cardiovascular risk factors," *The British journal of general practice: the journal of the Royal College of General Practitioners,* Vol. 44, No. 379, 1994, p. 62.

[65] Aubert, Ronald E, William H Herman, Janice Waters, William Moore, David Sutton, Bercedis L Peterson, Cathy M Bailey, and Jeffrey P Koplan, "Nurse case management to improve glycemic control in diabetic patients in a health maintenance organization: a randomized, controlled trial," *Annals of internal medicine,* Vol. 129, No. 8, 1998, pp. 605-612.

[66] Laurant et al., 2005.

[67] Ibid.

[68] Ibid.

[69] On December 14, 2016, the Department of Veterans Affairs stated that "it is amending provider regulations to permit full practice authority to three roles of VA advanced practice registered nurses (APRN) to practice to the full extent of their education, training, and certification, regardless of State restrictions that limit such full practice authority". For further details see "VA Grants Full Practice Authority to Advance Practice Registered Nurses," *U.S. Department of Veterans Affairs*, December 14, 2016.

[70] Moran, E. A., E. Basa, J. Gao, D. Woodmansee, P. L. Almenoff, and R. S. Hooker, "PA and NP productivity in the Veterans Health Administration," *Jaapa,* Vol. 29, No. 7, Jul, 2016, pp. 1-6.

[71] Ibid.

Summary

The role of NPs in primary care has been increasing, especially since the adoption of the ACA. Therefore, it is expected that NPs will function and adjust to new payment models and provide care in compliance with the health reform. It is also possible that some states, especially the ones that experience shortage of primary care providers, might decide to reconsider and expand their SOP for NPs. As data suggest, NPs are "more likely to care for Medicaid patients and to practice in rural areas than physicians"[72], and thus, their role is considerable in rural areas. Moreover, given the trend among recent graduates of NP schools to specialize in primary care, the NPs would "continue play a critical role in improving access to primary care"[73]. Despite the limitations of the available studies, it is shown that NPs' performance is of high quality and NPs provide cost-efficient health care services. In addition, NPs could to a certain extent substitute for physicians in providing certain services, thereby, increasing access to primary health care as well as freeing up more time for physicians to focus on more tasks requiring their deeper or more specialized training.

The available literature on the role of NPs in primary care puts an emphasis on defining the role of NPs more precisely. One policy recommendation is to more formally define this role at the federal level and work to standardize it between the states, such that organizations where NPs might consider to work would be able to hire NPs and not restrict their practice. For instance, one study claimed that "there remains an extensive amount of variation in how states define" state NP SOP[74]. However, there are barriers to implementing such a recommendation, since legislative changes are slow and Board of Nursing and other nursing organizations need to have a clear agenda on defining NPs role uniformly.

Access

Background

The focus of this dissertation is on access to health, therefore, background and literature review on conceptual frameworks available on access to health care is presented in this section.

Access to health care, depending on the study, may refer to the availability of health care insurance or the availability of a health care provider. Access is often considered with respect to the affordability and availability of timely quality health care. Here, I briefly explore the literature

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[72] Pohl, Joanne , Anne Thomas, Debra Barksdale , and Kitty Werner, "Primary Care Workforce: The Need To Remove Barriers For Nurse Practitioners And Physicians," *Health Affairs Blog*, October 26, 2016.

[73] Chattopadhyay, Arpita, George A Zangaro, and Kathleen M White, "Practice patterns and characteristics of nurse practitioners in the United States: results from the 2012 national sample survey of nurse practitioners," *The Journal for Nurse Practitioners,* Vol. 11, No. 2, 2015, pp. 170-177.

[74] Blackwell, C. W., and D. F. Neff, "Certification and education as determinants of nurse practitioner scope of practice: An investigation of the rules and regulations defining NP scope of practice in the United States," *J Am Assoc Nurse Pract,* Vol. 27, No. 10, Oct, 2015, pp. 552-557.

on measuring access with the aim to present an inventory of the different ways that existing studies measure access to primary care, and health care in general.

Definition of health care access

Health care access is defined as the ability of a person to receive health care services, which is a function of availability of health care personnel and supplies and the person's ability to pay for those services[75]. Basically, access to health care refers to "the ease with which an individual can obtain needed medical services"[76].

How is access measured in primary health care?

The dimensions of access to health care comprise (1) insurance coverage, (2) services, (3) timeliness, and (4) workforce. The first one refers to having health insurance. An expanded view of insurance would also include the deductible, copay, covered services and pharmaceuticals (i.e., the "benefit" provided via the insurance). The second refers to the availability of regular care, clinical preventive care, and emergency services. The third refers to whether the services are available at the time needed. The fourth to the availability of health care providers, including primary care providers[77].

The measures of access used in existing studies are diverse and include the percentages of the population with health insurance; employers offering health insurance to employees; people who were unable to obtain or delayed in obtaining needed medical care, dental care, or prescription medicines; population using emergency rooms as the usual source of care; population with a specific source of ongoing care; and the number of patients served by a federally qualified health center and the availability of primary care providers in a community. Access in primary care is usually characterized "as the achievable access to appointments with clinical professionals, although it is not routinely measured in most practices"[78].

Facts/Data available on access to primary health care

Before examining existing literature on access to primary health care, it is informative to consider some data and facts about access to primary health care.

Access to primary health care

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[75] "Health care access," in *McGraw-Hill Concise Dictionary of Modern Medicine.* The McGraw-Hill Companies, Inc., 2002. As of December 16, 2015

[76] "Health Care Access." RAND. As of December 16, 2015.

[77] "Access to care measurement strategies." County Health Rankings & Roadmaps. As of December 16, 2015.

[78] Jones, Wendy, Glyn Elwyn, Peter Edwards, Adrian Edwards, Melody Emmerson, and Richard Hibbs, "Measuring access to primary care appointments: a review of methods," *BMC Family Practice,* Vol. 4, No. 1, 2003, p. 8.

Access to primary care depends on the availability of primary care providers (supply) and how many PCPs are needed to serve a certain demand. In this view, access to primary care is a function of supply and demand for PCPs. Since PCPs include not only primary care physicians, but also NPs and PAs, access to primary health care should take into account the supply of these PCPs as well.

The demand for primary care is expected to rise as the population ages and grows[79]. The following are the Health Resources and Services Administration (HRSA) projections between 2010 and 2020 with regards to primary care[80]:

> •The number of primary care physicians is projected to increase from 205,000 FTEs in 2010 to 220,800 FTEs in 2020, an 8-percent increase.
> •The total demand for primary care physicians is projected to grow by 28,700, from 212,500 FTEs in 2010 to 241,200 FTEs in 2020, a 14-percent increase.
> •Without changes to how primary care is delivered, the growth in primary care physician supply will not be adequate to meet demand in 2020, with a projected shortage of 20,400 physicians. While this deficit is not as large as has been found in prior studies, the projected shortage of primary care physicians is still significant.
> •The supply of primary care NPs is projected to increase by 30 percent, from 55,400 in 2010 to 72,100 in 2020. The supply of primary care PAs is projected to increase by 58 percent, from 27,700 to 43,900 over the same period.
> •Under a scenario in which the rapidly growing NP and PA supply can effectively be integrated, the shortage of 20,400 physicians in 2020 could be reduced to 6,400 PCPs.
> •If fully utilized, the percent of primary care services provided by NPs and PAs will grow from 23 percent in 2010 to 28 percent in 2020. Physicians would remain the dominant providers of primary care, only decreasing from 77 percent of the primary care services in 2010 to 72 percent in 2020.

According to these projections, including NPs and PAs will decrease but not eliminate the shortage of primary care providers. The projections assume that NPs and PAs cannot be substituted for physicians on a one-for-one basis. The number of NPs and PAs are projected to increase by 16,700 and 16,200, or a total of 32,900, but the projected PCP shortage decreases by only 14,000. This raises the question of whether NPs and PAs can become closer substitutes for physicians, which in turn may relate to the range of their training and scope of practice guidelines, which vary by state. Hence, in the long run, supply of PCPs should be increased to meet the rising demand in primary care services. Primary care providers are imperative to the general health of the communities in which they work and it is pivotal to increase and track the number of practicing PCPs[81].

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[79] "Projecting the Supply and Demand for Primary Care Practitioners Through 2020", 2013.

[80] Ibid.

[81] "Access to Health Services." Office of Disease Prevention and Health Promotion. As of December 16, 2015.

Overview of Existing Literature

Several studies looked at access to health care and developed a conceptual framework, under which access is defined and further viewed. This section examines major studies on access with the emphasis on NPs in primary care.

How access is defined and measured in different studies

Access is defined as*:* "the timely use of personal health services to achieve the best possible health outcomes"[82] or "people's ability to use health services when and where they are needed"[83]. Access could also be viewed as an ability to "secure a specified set of healthcare services with certain level of quality, subjected to a specified maximum level of personal inconvenience and cost, while in possession of a specified amount of information"[84]. Guagliardo argued that the "most basic problem in defining 'access' is that it is both a noun referring to potential for healthcare use, and a verb referring to the act of using or receiving healthcare"[85]. One study concluded that access "is a broad and often vaguely defined concept that incorporates various dimensions of health care providers, health insurance coverage and problems that individuals encounter in getting care"[86]. Moreover, Regmi and Randhawa contended that the meaning of "access to health care appears rather a political than an operational", and there are two aspects of concept that emerged in the literature: "first people often try to equate it with the demographic profiles of the population (for example, income, race, residence); second, it relates to health systems (distribution of resources, available services including health and non-health human resources)"[87].

Given that there is no definite way to define "access to healthcare", the measurement of access varies from a study to a study, depending on the context and purpose of the study under consideration. For instance, medical socialists view access as "quality with some degree of services quantity with customer's satisfaction"; health economists view it as a cost attribute; health geographers see it via geographic variation in population and spatial organizations; while in health policy, access is regarded as the degree of power and authority of local authorities[88]. It has been asserted that there 'is no gold standard to measure access, and new approaches are constantly being developed to reflect the changes in the delivery of services and an increasing interest in outcome-

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[82] Millman, Michael, *Access to health care in America*: National Academies Press, 1993.

[83] Regmi, Krishna, and Gurch Randhawa, "Access to healthcare: issues of measure and method," *Primary Health Care,* Vol. 3, No. 1, 2013.

[84] Oliver, Adam, and Elias Mossialos, "Equity of access to health care: outlining the foundations for action," *Journal of epidemiology and community health,* Vol. 58, No. 8, 2004, pp. 655-658.

[85] Guagliardo, Mark F, "Spatial accessibility of primary care: concepts, methods and challenges," *International journal of health geographics,* Vol. 3, No. 1, 2004, p. 3.

[86] "Access to health care: bridging the gap between policy and research," *Issue Brief Cent Stud Health Syst Change*, No. 8, Apr, 1997, pp. 1-6.

[87] Regmi and Randhawa, 2013.

[88] Ibid.

based measures of access"[89]. According to the Agency for Healthcare Research and Quality (AHRQ), health care access is measured in several ways, including[90]:

> •Structural measures of the presence or absence of specific resources that facilitate health care, such as having health insurance or a usual source of care.
> •Assessments by patients of how easily they can gain access to health care.
> •Utilization measures of the ultimate outcome of good access to care (i.e., the successful receipt of needed services).

Several studies explored the overall access to primary healthcare services by looking at such factors as availability of medical personnel, convenience to achieve health services, actual use rates, etc[91]. One study looked at access measures at the practice and system levels: the percentage of total primary care visits that are made to the physician with whom the patient is rostered or virtually rostered (practice and system levels) and the percentage of patients who report that they experienced difficulties obtaining required routine or ongoing primary care services from their provider over the past 12 months, for themselves, their children, elderly family members or disabled family members (system level) [92]. This study suggested that measuring access to a regular primary care provider should include measures of the percentage of patients who report that they have a family physician or nurse practitioner (both practice and system levels) and the percentage of practices/organizations that report having arrangements for wheelchair access (system level)[93]. Another study argued that there are two key factors to access to primary healthcare, affordable health insurance and access to a personal healthcare provider[94].

Seminal papers on conceptual framework for access to healthcare

In this subsection, several conceptual frameworks for access to health care models will be reviewed that will be useful in determining how I define access in my dissertation and for developing my conceptual framework.

The majority of studies reviewed indicate the prevalence of perceiving access via availability of services or providers. For instance, an influential study on the concept of access in healthcare perceives access as a set of more specific dimensions – availability, accessibility, accommodation, affordability and acceptability – that depict the fit between the patient and the health care system[95].

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[89] "Access to health care: bridging the gap between policy and research", April 1997.

[90] "Chapter 9: Access to Health Care," in *National Healthcare Quality Report*: Agency for Healthcare Research and Quality. U.S. Department of Helath & Human Services., 2011. .

[91] Shrestha, Jeny, "Evaluation of Access to Primary Healthcare. A Case Study of Yogyakarta, Indonesia," *Master diss., International Institute for Geo-Information Science and Earth Observation*, 2010.

[92] Ontario, Health Quality, "A primary care performance measurement framework for Ontario: report of the Steering Committee for the Ontario primary care performance measurement initiative: phase one," *Toronto: Queen's Printer for Ontario*, 2014.

[93] Ibid.

[94] "Access to Primary Healthcare Services," Washington State Department of Health. 2014. As of December 19, 2015.

[95] Penchansky, Roy, and J William Thomas, "The concept of access: definition and relationship to consumer satisfaction," *Medical care,* Vol. 19, No. 2, 1981, pp. 127-140.

Utilization indicators, such as the frequency of visits to a health care provider or the use of medical procedures, are among the most common ways of identifying if access has been realized[96]. Utilization provides proof of access to services, not just the availability of a facility[97]. One study defines access as a complex concept that involves at least four aspects to assess[98]:

> If services are available and there is an adequate supply of services, then the opportunity to obtain health care exists, and a population may 'have access' to services. The extent to which a population 'gains access' also depends on financial, organisational and social or cultural barriers that limit the utilisation of services. Thus access measured in terms of utilisation is dependent on the affordability, physical accessibility and acceptability of services and not merely adequacy of supply. Services available must be relevant and effective if the population is to 'gain access to satisfactory health outcomes'.

Shrestha argues that objective measures, which usually refer to utilization rates to estimate access, can be measured in different ways, such as, for instance, the simple proportion of people visiting and not visiting a healthcare facility within a certain period of time or the total volume of services provided[99].

One of the prominent studies viewing access via 'Health Policy' perspective was developed in Aday and Andersen's "Framework for the study of access"[100]. In their framework, the concept of access – defined via health policy aspects, such as financing, education, manpower, and organization – affects characteristics of health delivery system and characteristics of population at risk, while the former also affects the latter. Characteristics of health delivery system affect utilization of health services, while the latter is interconnected with consumer satisfaction. Characteristics of population at risk affect both consumer satisfaction and utilization of health services.

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[96] Millman, 1993.

[97] Donabedian, Avedis, "Models for organizing the delivery of personal health services and criteria for evaluating them," *The Milbank Memorial Fund Quarterly,* Vol. 50, No. 4, 1972, pp. 103-154.

[98] Gulliford, Martin, Jose Figueroa-Munoz, Myfanwy Morgan, David Hughes, Barry Gibson, Roger Beech, and Meryl Hudson, "What does 'access to health care' mean?," *Journal of health services research & policy,* Vol. 7, No. 3, 2002, pp. 186-188.

[99] Shrestha, 2010.

[100] Aday, L. A., and R. Andersen, "A Framework for the Study of Access to Medical Care," *Health Serv Res,* Vol. 9, No. 3, Fall, 1974, pp. 208-220.

Another study describes the dimensions of access to medical care and their indicators by categorizing access into potential and realized, as shown in Table 2.1[101]. I explore in detail some of the components of the model, which will be utilized in developing the conceptual framework, presented in Chapter 3.

One could consider that under this model with some modifications, the role of NPs would be

Table 2.1.
Dimensions of Access to Medical Care and Their Indicators

Potential Access		*Realized Access*	
System (County)	*Individual*	*Objective*	*Subjective Satisfaction*
Availability	*Predisposing*	*Use*	*Convenience*
MD/Population	Age 6 or Less	Time Since Exam*	Travel Time
Bed/Population	Age 65 or Over	Preventive Exam	Travel Cost*
Dentist/Population	Sex	MD Visits	Appointment Time*
Community (County) Characteristics	Race	Hospital Admission	Waiting Time
	Education	Dental Visits	Visit Cost
Predisposing	*Enabling*	*Use Relative to Need*	*Provider Behavior*
% 65 or Over	Financing	Symptoms Response	Time with MD*
Enabling	Income	Use Disability	Information*
% below Poverty	Group Insurance*	Dental Want	MD Courtesy*
Region	Major Medical*		RN Courtesy
Rural Residence	Hospital Insurance		Receptionist Courtesy*
Central City Residence	Dental Insurance		MD Concern*
Need	MD Office Insurance*		Quality
Infant Mortality	Visit Cost		Overall*
	Organization		
	Regular Care Source*		
	Particular Provider		
	Specialty of Provider		
	Travel Time		
	Prior Appointment		
	Appointment Time		
	Waiting Time		
	Time with MD		
	Need		
	Perceived Health		
	Worry about Health*		
	Symptoms*		
	Dental Symptoms		
	Disability Days		
	Illness Episode*		

seen as follows: (1) *potential access* – availability – PCP/Population and (2) *realized access* – use – PCP visits, where PCPs incorporate physicians and NPs (PAs are excluded, as they are not allowed to practice independently in any state) in both dimensions of access. Hence, the research questions that my dissertation is to address with regards to access and NPs in primary care seem to fit under this framework; that is, availability of practicing NPs is under *potential access* and patient volume seen by NPs is under *realized access*.

Millman constructed a model of access to personal health care services, such that it included barriers to access, use of services, mediators, and health care outcomes[102]. Under this framework, (un)availability of PCPs (including NPs) is viewed as structural barrier to access and visits to PCPs represent use of services. This model conceptualizes access as a function of *barriers, use of*

[101] Andersen, Ronald M, Allan McCutcheon, Lu Ann Aday, Grace Y Chiu, and Ralph Bell, "Exploring dimensions of access to medical care," *Health services research,* Vol. 18, No. 1, 1983, p. 49.

[102] Millman, 1993.

services, mediators, and *outcomes*. If using this framework to address the research questions my dissertation will try to answer, then supply of NPs (as well as NP SOP that hypothetically might be another barrier) is seen as a *structural barrier*, and number of visits a patient makes to an NP are perceived as *use of services*, i.e., the proxy of how much access is realized under existing barriers and mediators available (quality of providers could be another variable of interest to look at when comparing PCPs – physicians versus NPs). However, when scrutinizing this model of access, this model is difficult to implement, since many of these variables are not easily obtained and some of them are quite subjective.

Shrestha developed a conceptual framework to evaluate access to primary health care, by categorizing access at macro and micro levels[103]. In this model, NP SOP regulations (*policies and processes*) and NPs employed in different health care clinics (*hospitals and private clinics*) could be categorized at macro level of evaluating access to primary health care, which in turn affect access itself, which is defined under this framework as 5As. One of "A"s in the case of NPs could be *availability*, where number of NPs available is considered. The other two "A"s that could be pertinent to access in my dissertation, could be *accessibility* and *acceptability*, where NPs see patients or patient volume (*accessibility*) and NPs accepting different type of patients including Medicare/Medicaid patients (*acceptability*). This conceptual framework seems to be a good paradigm to explain how access to primary healthcare could be assessed, if NPs incorporated into this picture as well. However, some of the variables both at macro and micro level are not easily obtained, such as physical and socio-economic conditions of people, and health planning organizations in each area.

The other study developed a conceptual framework under which there is a linkage between health care market (including physician supply) and health care access[104]. Under this framework, PCP (including NP) supply could be viewed as community characteristics and potential access. However, similar to the first model considered, realized access incorporates doctor's visits. This framework shows that access could be viewed as potential and realized, where the availability of NPs is the *usual source of care* and the number of patients seen by an NP is *NP visits*. Although the community and individual characteristics are not readily available data, health care access and outcomes could be determined and modeled to a certain extent. This conceptual framework seems also a good fit for addressing my dissertation research questions when defining access as potential and realized.

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[103] Shrestha, 2010.

[104] Davidson, Pamela L, Ronald M Andersen, Roberta Wyn, and E Richard Brown, "A framework for evaluating safety-net and other community-level factors on access for low-income populations," *INQUIRY: The Journal of Health Care Organization, Provision, and Financing,* Vol. 41, No. 1, 2004, pp. 21-38.

The model is also presented in Karikari-Martin, Pauline, "Use of healthcare access models to inform the patient protection and affordable care act," *Policy, Politics, & Nursing Practice,* Vol. 11, No. 4, 2010, pp. 286-293.

A more recent conceptual model was developed using behavioral access model that incorporates health services outcomes and uses various access layers and health services outcomes[105]. In this behavioral access model, access layer encompasses availability of health care delivery systems, which in turn includes both distribution (say, number of NPs serving in a certain area) and volume (say, number of patients seen by an NP). Moreover, availability and provider characteristics are viewed under consumer satisfaction as well. So, this might mean that availability of PCPs (including NPs) and PCP characteristics could be viewed as some of the aspects for consumer satisfaction, although availability of PCPs is also enumerated under health care delivery system. This model seems to be convoluted if implemented, as it has many variables that are not readily available on a regular basis and are subjective to a certain extent (consumer satisfaction, characteristics of population at risk, etc.).

Most of the reviewed models are challenging to implement and they perceive access from different perspectives, although the majority of them consider availability of providers (provider supply) and use of services (patient volume seen by a provider) as a close proxy in estimating access to health care.

Summary

A review of the relevant and available literature shows that access may be measured in various ways, depending on a study's objective. For realized access, it is common to use such indicators as patient volume per certain period at a practice level. As pertaining to the NPs in primary care research studies, the available literature measures access as either the number of available providers, appointment availability, or by actual utilization of different services or appointment availability. In my dissertation, I define access to health care via *potential* and *realized*, which will be explained in detail in Chapter 3.

NP SOP

In this section, brief background on NP SOP, how it is defined in this research study, and federal and state regulations for NPs are presented.

What is NP SOP?

Nurse practitioner scope-of-practice (NP SOP) refers to a legal term that states use to define activities that a nurse practitioner can take within their professional abilities to provide health care services. Generally, according to the National Council of State Boards Nursing, “scope of practice

[105] Shaw, Thomas C, "Beyond access: Extending our thinking on health policy," *Social work in public health,* Vol. 27, No. 6, 2012, pp. 554-566.

of a licensed healthcare profession is statutorily defined in each state's laws in the form of a practice act. State legislatures have the authority to adopt or modify practice acts and therefore adopt or modify a particular scope of practice of a healthcare profession"[106]. NP SOP varies by state and incorporates such broad aspects of providing health care services as medical diagnosing, treatment, and prescriptive authority. Certain state NP SOP include specific functions in their definitions pertaining to ability of an NP to diagnose, treat, prescribe, admit to hospital, refer, teach, order tests, perform procedures, remove epidural catheter, assist in surgery, perform palliative care, order durable medical equipment[107], and order restraints[108]. Depending on the state NP SOP, NPs either have full practice authority or so called liberal NP SOP or restricted NP SOP. The latter refers to mandated physician involvement with NP practice. Physician involvement may require either collaboration or supervision. Full practice authority, on the other hand, does not involve any type of involvement of a physician, unless it is outside of the NP SOP.

The definition of Nurse Practitioner Scope-of-Practice in this research

In this research, liberal and restricted NP SOP[109] are the terms used to define state NP SOP. *Liberal NP SOP* refers to full practice authority, defined as independent practice authority and independent whereas *restricted NP SOP* refers to either prescription and/or practice restriction such as collaboration or supervision by a physician. In this study, only two characteristics are used in determining if state NP SOP regulations are liberal or restricted- prescription and practice authority. Table 2.2 presents the definitions of liberal and restricted NP SOP that were used in this dissertation.

Table 2.2.
Liberal vs Restricted NP SOP

NP SOP	Independent	
	Practice	**Prescription**
Liberal	Yes	Yes
Restricted	Yes	No
	No	Yes
	No	No

***Restriction**: Any collaboration or supervision by a physician is required.*

[106] "Changes In Healthcare Professions' Scope of Practice: Legislative Considerations." National Council of State Boards of Nursing. As of December 19, 2015. Page 7.

[107] With the new requirement from the ACA, ordering DME has some restrictive clauses. For further details see Osborne, Jean Marie, "Durable Medical Equipment Ruling: Impact on Nurse Practitioner Role," *The Journal for Nurse Practitioners,* Vol. 10, No. 5, 2014, pp. 344-351.

[108] Buppert, 2015, pp. 41-42.

[109] Note that I use *liberal, expanded broader NP SOP or full practice authority* interchangeably. However, each of these terms refers to liberal NP SOP in this dissertation.

State NP SOP regulations vary by state and year. Over the six years analyzed in this dissertation, the growth of states with liberal NP SOP regulations was observed and in 2013 there were 20 states that have liberal NP SOP.

State Nurse Practitioner Scope-of-Practice Regulations and Federal Law

Depending on the NP practice issue, certain functions of NPs are regulated by state NP SOP regulations and/or federal law. The NP practice issues that come under state regulation are requirements for licensure, scope-of-practice, prescriptive authority, requirement of collaboration or supervision, basis for license suspension, revocation, or nonrenewal, reimbursement under Medicaid, by indemnity insurances, requirements of educational programs, standards of practice[110]. There is also federal regulation of the NP profession and federal law prevails over state law if there is any conflict between state and federal law. Federal regulation entails: care of patients covered by Medicare, Medicaid; billing Medicare; care of hospitalized patients insofar as participation by hospitals in the Medicare program; care of residents in nursing homes; in-office and hospital laboratories, under the Clinical Laboratory Improvement Amendments; self-referral by healthcare providers, under the Stark Acts; prescription of controlled substances under the Drug Enforcement Administration (DEA); reporting of successful malpractice lawsuits against NPs to the National Practitioner Data Bank; confidentiality of information about patients under the Health Insurance Portability and Accountability Act; discrimination in hiring and firing; facility access for disabled people; e-prescribing and electronic medical records[111].

Nurse practitioner scope-of-practice is specified by statute or regulation. In some states, state legislatures enact SOP statutes, and in other states, the board of nursing defines the NP SOP. Regulations and statutes are similarly enforceable[112]. According to the 2016 AANP National Nurse Practitioner Sample Survey, about 75% of NPs accept new Medicare patients and 77.9% of NPs accept new Medicaid patients, 49.9% of NPs hold hospital privileges and 11.3% have long term care privileges[113]. Furthermore, NPs hold prescriptive privileges containing controlled substances in 50 states and D.C., 95.8% of NPs prescribe medications, and “those in full-time practice write an average of 23 prescriptions per day”[114].

Furthermore, states vary in their NP SOP regulations, which could range from being able to have autonomous practice and independent prescribing abilities, order physical therapy, sign death certificate, handicap parking permits, and/or workers' comp claims and be designated as primary care provider, etc. For instance, one study found that NPs surveyed consider "government and

[110] Buppert, 2015, Chapter 3.

[111] Buppert, 2015, Chapter 4.

[112] Buppert, 2015, Chapter 2.

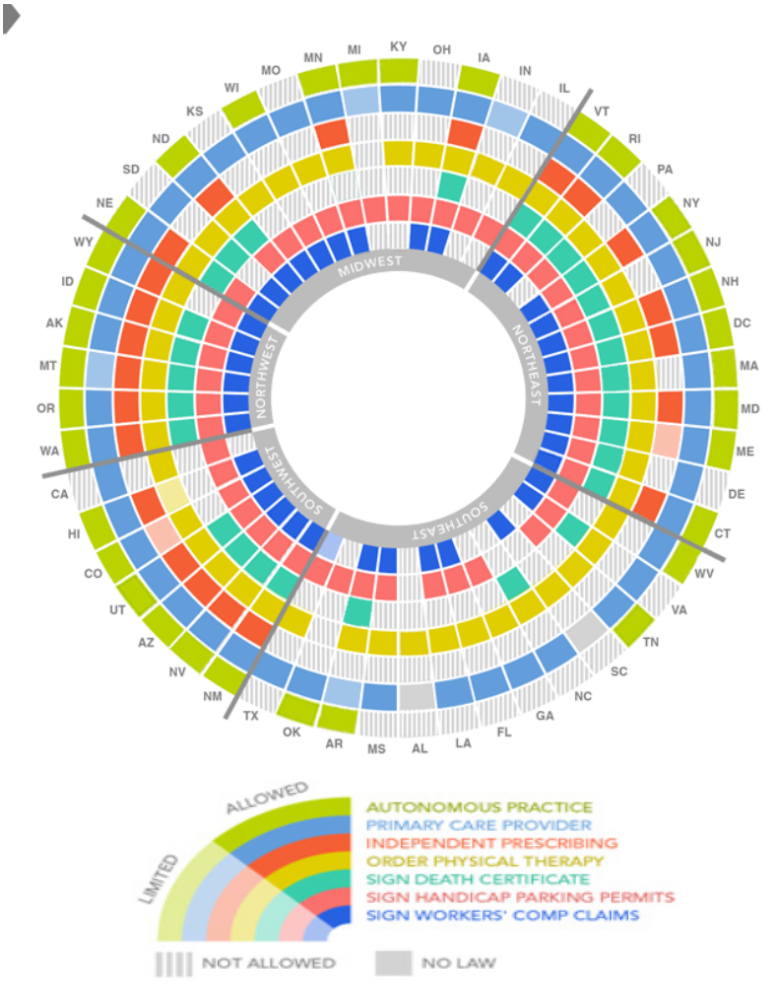
[113] “NP Facts”, 2017.

[114] Ibid.

local regulations as impeding their capacity to admit and round on patients in hospitals and long-term care facilities and write treatment orders without a physician cosignature"[115]. Figure 2.2 shows how states differ in their NP SOP based on the Pearson Report on NPs for 2014, classifying state NP SOP into 8 major categories[116].

States that do not allow NPs to practice independently of physician participation differ in their degree of mandated physician involvement. For instance, some states legally require physician involvement for advanced practice or prescription, which could embrace 'supervision',

Figure 2.2.
States and their NP SOP Permissions



[115] Buerhaus, Peter I, Catherine M DesRoches, Robert Dittus, and Karen Donelan, "Practice characteristics of primary care nurse practitioners and physicians," *Nursing Outlook,* Vol. 63, No. 2, 2015, pp. 144-153. Buerhaus et al., 2015.

[116] "Nurse Practitioner Scope of Practice Laws." Barton Associates. As of November 25, 2015.

'collaboration', 'delegation', 'directing', 'protocols'[117], or 'referral process'. According to the AANP, as of 2017[118], there were 24 states that granted full practice authority to NPs[119].

Also, NP SOP may be further limited by the organization in which NPs work. Some practices would not allow NPs to work up to their full NP SOP. A recent review of the role of NP SOP in delivering health care concluded that states granting NPs greater SOP authority tend to exhibit an increase in the number and growth of NPs, greater care provision by NPs, and expanded health care utilization, especially among rural and vulnerable populations[120].

Comprehensive Primary Care Initiative

In this section, a brief background on CMMI's CPCI will be provided. Thus, background information is essential to understanding how CPCI functions when developing a conceptual framework and policy recommendations[121].

Background

The Comprehensive Primary Care Initiative (CPCI) began under the authority of Section 3021 of the Affordable Care Act[122]. The CPCI was established in collaboration with the Center for Medicare & Medicaid Innovation (CMMI) of the Centers for Medicare & Medicaid Services (CMS) and with public and private health care payers under the "Primary Care Transformation" innovation model in October 2012. CPCI was a four-year initiative with the objective encouraging primary practice redesign along with multi-payer payment models[123]. To improve population health through better care and to lower health care costs, the initiative incorporates specific practice redesign and payment models. CPCI serves as the basis for a more recent initiative in primary care – Comprehensive Primary Care Plus (CPC+)[124], which started in January 2017 and comprises 14 regions, among which 7 regions were in CPCI[125].

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[117] According to Buppert, (2015), a "protocol is a written instrument that guides the NP in collecting data from the patient and recommends specific action based upon the collected data. It consists of mutually agreed upon medical guidelines between the physician and the NP that define their individual and shared responsibilities" (pp. 48-49).

[118] For detailed review on APRNs legislative updates see Phillips, Susanne J, "29th annual APRN legislative update," *The Nurse Practitioner,* Vol. 42, No. 1, 2017, pp. 18-46.

[119] "2017 Nurse Practitioner State Practice Environment." The American Association of Nurse Practitioners. February, 2017.

[120] Xue, Y., Z. Ye, C. Brewer, and J. Spetz, "Impact of state nurse practitioner scope-of-practice regulation on health care delivery: Systematic review," *Nurs Outlook,* Vol. 64, No. 1, Jan-Feb, 2016, pp. 71-85.

[121] Pertinent literature review will be presented in Chapter 6, which addresses Research Question 3, and a more detailed overview of CMMI's CPCI and payment model is presented in Appendix A2.

[122] The CPC initiative was conducted under Section 1115A of the Social Security Act, added by Section 3021 of the Affordable Care Act. For further details see ""FAQ: The CPC initiative and participation in other CMS initiatives". Centers for Medicare and Medicaid Services. As of April 10, 2017.

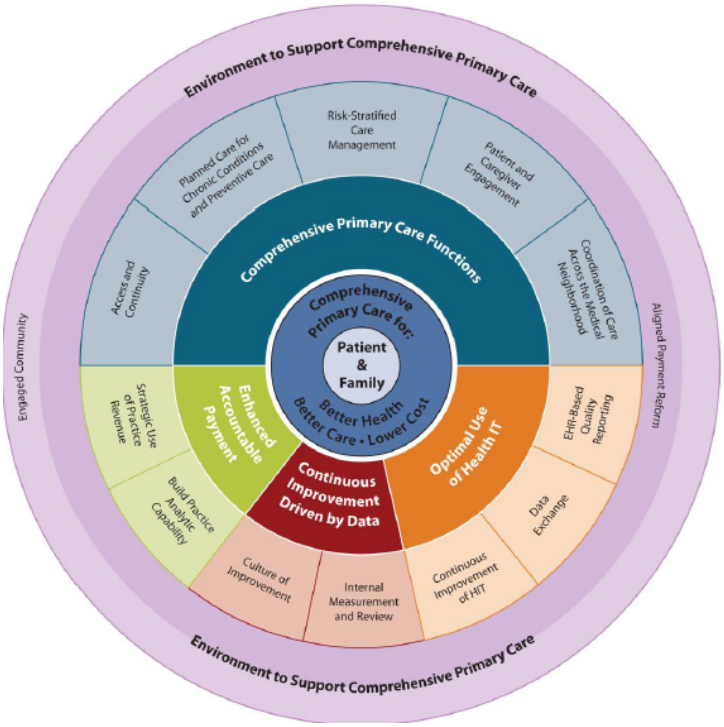
[123] "Comprehensive Primary Care Initiative." American Academy of Family Physicians. As of April 10, 2017.

[124] For further details on CPC+ see "Comprehensive Primary Care Plus". Centers for Medicare and Medicaid Services. As of April 10, 2017.

[125] "Comprehensive Primary Care Initiative ". Centers for Medicare and Medicaid Services. As of April 10, 2017.

As shown in Figure 2.3, the CPCI logic model places "patient and family" in its core objectives, around which providing better health, better care, and lower costs are the next level goals, with the next layer including comprehensive primary care functions, enhanced accountable payment, continuous improvement driven by data, and optimal use of health IT[126].

Figure 2.3.
Logic Model for the CPCI



[126] "CPCI Diagram," 2014. Centers for Medicare and Medicaid Services. As of April 10, 2017.

Figure 2.4 shows the 441 practices in 7 regions participating in the CPCI in 2016[127].

Figure 2.4.
Practices Participating in the CPCI in 2016

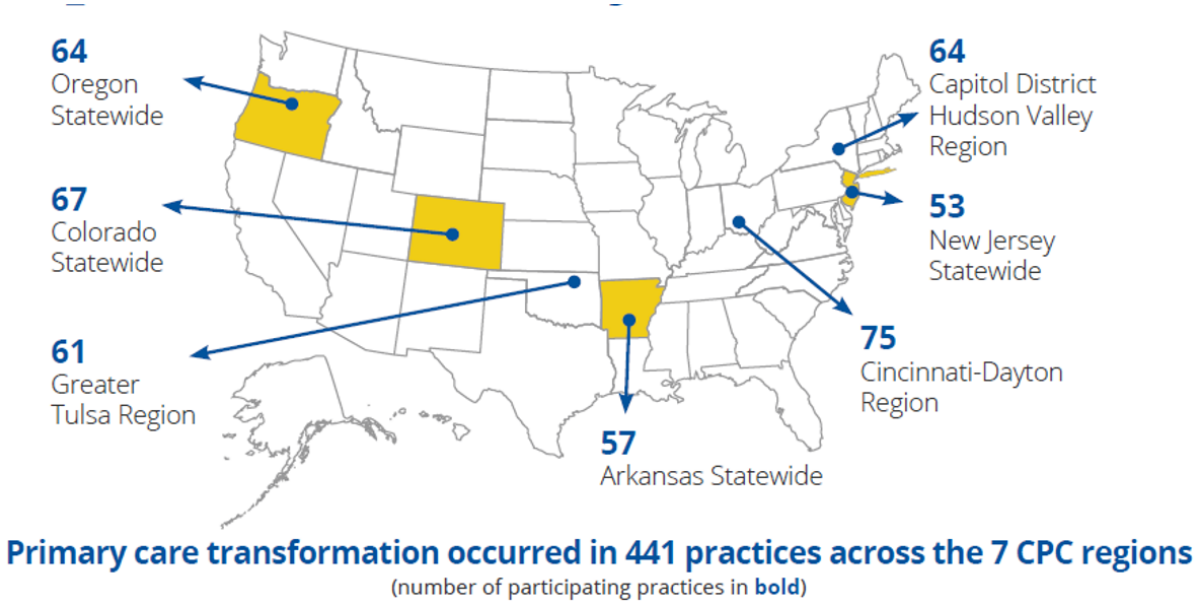


Figure 2.5 enumerates the CPC-attributed beneficiaries, payers, and primary care providers in 2016[128].

Figure 2.5.
The CPC Community

How does CPCI operate?

The objective of CPCI is to achieve improved care, better health for populations, and lower health costs by redesigning primary care. This is done by implementing functions that define *comprehensive* primary care provision (below). The functions would be funded under the multi-

[127] "Comprehensive Primary Care Initiative: Fast Facts." The Centers for Medicare and Medicaid Services. 2016. As of April 10, 2017.
[128] Ibid.

payer payment model, with major emphasis on Medicare beneficiaries which account for a large portion of the care management fees provided by Medicare.

The functions are[129]:

- **Access and Continuity:** Because health care needs and emergencies are not restricted to office operating hours, primary care practices optimize continuity and timely, 24/7 access to care guided by the medical record. Practices track continuity of care by provider or panel.
- **Planned Care for Chronic Conditions and Preventive Care:** Participating primary care practices proactively assess their patients to determine their needs and provide appropriate and timely chronic and preventive care, including medication management and review. Providers develop a personalized plan of care for high-risk patients and use team-based approaches like the integration of behavioral health services into practices to meet patient needs efficiently.
- **Risk-Stratified Care Management:** Patients with serious or multiple medical conditions need extra support to ensure they are getting the medical care and/or medications they need. Participating primary care practices empanel and risk stratify their whole practice population, and implement care management for these patients with high needs.
- **Patients and Caregiver Engagement:** Primary care practices engage patients and their families in decision-making in all aspects of care, including improvements in the system of care. Practices integrate culturally competent self-management support and the use of decision aids for preference sensitive conditions into usual care.
- **Coordination of Care Across the Medical Neighborhood:** Primary care is the first point of contact for many patients, and takes the lead in coordinating care as the center of patients' experiences with medical care. Practices work closely with patients' other health care providers, coordinating and managing care transitions, referrals, and information exchange.

The *payment model* provides participating primary care practices with two forms of financial support on behalf of their fee-for-service (FFS) Medicare beneficiaries[130]: a monthly non-visit based care management fee and the opportunity to share in any net savings to the Medicare program, on top of usual visit-based fee-for-service payments. A CPC participating practice receives a care management fee per-month-per-member (PMPM) for each Medicare fee-for-service (FFS) beneficiary and, in regions where the state Medicaid agency is participating (Arkansas, Colorado, Ohio, and Oregon), for each Medicaid FFS beneficiary. Moreover, practices also receive care management fees from other CPC participating payers. Overall, the fees comprise enhanced payments for practices to use for developing a whole-practice transformation strategy[131].

[129] "Comprehensive Primary Care Initiative." Centers for Medicare and Medicaid Services. As of April 10, 2017.

[130] "Comprehensive Primary Care Initiative." Centers for Medicare and Medicaid Services. As of April 10, 2017.

[131] Ibid.

The opportunity to share net savings, if any, from improved care to attributed Medicare beneficiaries were receivable in 2014-2016 and were to be calculated at a regional level and allocated based on quality metrics of CPC practices' performance. The other CPC participating payers include "public and private payers spanning commercial, Medicare Advantage, Medicaid managed care, and Third Party Administrator/Administrator Services Only lines of business, as well as four state fee-for-service (FFS) Medicaid agencies"[132]. The CMS does not fund these other payers.

What are the incentives for a practice to participate in the CPCI?

A key CPCI goal is to improve primary care delivery. Accounting for changing environment of health care provision, participation in the CPCI "may enhance provider experience"[133]:

> CMMI views CPC as a test of a new model of care delivery for a group of primary care practices that were motivated to transform care and more likely to have attained EHR[134] meaningful use and patient-centered medical home (PCMH) recognition.

Each year of the CPCI, CMS sets milestones that should be met by practices to remain in the program. The milestones are meant to assist practices in their way to achieve the five functions mentioned above.

A practice must be selected to participate in the CPCI. But once selected, the practice may choose whether it will participate. The incentives to participate include multi-payer financial support (such as enhanced payments, which are non-visit-based, and the opportunity to share in any net savings to the Medicare program), data feedback on practice's progress vis-à-vis improving patient outcomes and containing costs, and learning activities along with technical assistance for practices to build necessary capacity for transformation and redesign of providing comprehensive primary care[135]. Practices that choose to participate in the CPCI, after being selected, likely do so because their own objectives in improving quality of care align with those of CPCI, and because of the fees and other support for investing in the transformation and redesign of care along with a comparatively synchronized approach across participating payers[136].

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[132] Ibid.

[133] Taylor, Erin Fries, Stacy Dale, Deborah Peikes, Randall Brown, Arkadipta Ghosh, Jesse Crosson, Grace Anglin, Rosalind Keith, and Rachel Shapiro, "Evaluation of the comprehensive primary care initiative: first annual report," *Princeton: Mathematica Policy Research*, 2015, page 1.

[134] EHR – electronic health records

[135] Taylor, 2015.

[136] Ibid.

Summary

As could be inferred from the descriptive information on the CPCI, it affected primary care practices via the objective of improving primary care in a comprehensive fashion and offering care management fees and support. These fees helped practices acquire IT systems, hire additional staff, and increase the availability of services provided in many cases. Although the role of NPs was not mentioned in the reports directly, it was inferred from the background information that practices hired more staff, which could include NPs.

The CPCI payment model is presented in greater detail in Chapter 6 with the focus on NPs, PAs, and NP SOP. The relationship between NP SOP and CPCI is discussed in the conceptual framework in the next chapter.

3. Theory and Conceptual Framework for Nurse Practitioner Scope-of-Practice

To understand how state NP SOP affects the functioning of NPs in primary care – under what settings NPs are allowed to work, whether they are permitted to prescribe or practice independently, what type of reimbursement schedule they are assigned to – it is necessary to have a conceptual framework showing how NP SOP may affect the employment of NPs in primary care and salient components of primary health care, such as access (as indicated, for example, by patient volume), cost of providing care, and quality of care. In particular, the framework presented in this chapter describes how state NP SOP laws and regulations can affect primary health care at the physician practice level. The conceptual framework is accompanied by a theoretical model with a numerical example showing the impact of an increase in NP productivity at the practice level using Cobb-Douglas production function case. This increase in NP productivity comes from a change in NP SOP that occurs through state law or regulation and is assumed to be exogenous to the physician practice.

The conceptual framework on the state NP SOP in primary health care

In this framework, a *primary care provider* is a primary care physician, nurse practitioner, or physician assistant. Table 3.1 compares the three PCPs and the requirements needed to become one of them.

Table 3.1.
Nurse Practitioner's Education, License, and Certification compared to Other Primary Care Providers

Health Professional	Years of College	Undergraduate Degree	Graduate Degree	License	Continuing Education (Minimum)	Certification (Renewal)
Nurse practitioner	2-4	AA, BS, or RN diploma	Master's degree or doctorate required in 32 states	Yes (RN plus specific area of NP certification)	75 hours / 5 years	Yes, every 5 years
Physician assistant	2-4	BS or certificate	Not required, but the majority of PA programs are master's level programs.	Yes	100 hours / 2 years	Yes, every 6 years
Primary care physician	4	BA/BS	Doctor of medicine or osteopathy required in all states	Yes (MD or DO)	50 hours / year	Optional

ABREVIATIONS: AA, associate of arts degree; BA, bachelor of arts degree; BS, bachelor of science degree; DO - doctor of osteopathic medicine; MD, doctor of medicine; RN, registered nurse.

In most states, NPs are required to have a master's or doctorate degree as well as an RN license and a specific area of NP certification.

Several studies present broad conceptual frameworks of how NP SOP can affect access, cost, and quality of care. For instance, Poghosyan (2016) develops a model for maximizing NP contributions to primary care[137], and Martsolf (2016) utilizes a conceptual framework of how state NP SOP regulations are likely to affect health care delivery[138]. The conceptual framework developed in this dissertation, however, focuses on a specific aspect of health care, which is how NP SOP affects access to primary health care[139]. The framework draws on the model developed by the CDC[140], utilizing process and outcome components of the model. The conceptual model is grounded on the role of NPs in primary care*:*

- NPs work in settings of primary care clinics, clinics, retails clinics, hospitals
- NPs can be complements or substitutes to primary care physicians, depending on the case (patient illness) and the state's NP SOP. For instance, in states with liberal NP SOP and for a patient with disease or condition within NP SOP, an NP could provide similar or on par quality of care compared to that of a physician, with no need for the physician's involvement. In states with restricted NP SOP, regulations might require a physician's involvement, and thus, NPs and physicians could be viewed as complements in patient care. When the patient's illness is out of NP SOP, an NP will need a physician's involvement regardless of whether the state has restricted or liberal SOP.
- NP education provides the knowledge to treat almost all primary care-related diseases and conditions. The NP will refer more difficult cases to physicians with the appropriate specialty; these would typically be patients requiring diagnosis, treatment, or prescription that lie outside NP SOP. Also, the model recognizes that NP reimbursement and education incentives can depend on policy, although again these aspects are not the main focus of this research.

[137] For further details see Figure 1 of Poghosyan, Lusine, Donald R Boyd, and Sean P Clarke, "Optimizing full scope of practice for nurse practitioners in primary care: A proposed conceptual model," *Nursing Outlook,* Vol. 64, No. 2, 2016, pp. 146-155.

[138] For further details see Figure 2.1 of Martsolf, Grant, and Ryan Kandrack, "The Impact of Establishing a Full Scope of Practice for Nurse Practitioners in Michigan," *Santa Monica, CA: RAND Corporation. RR1639*, 2016.

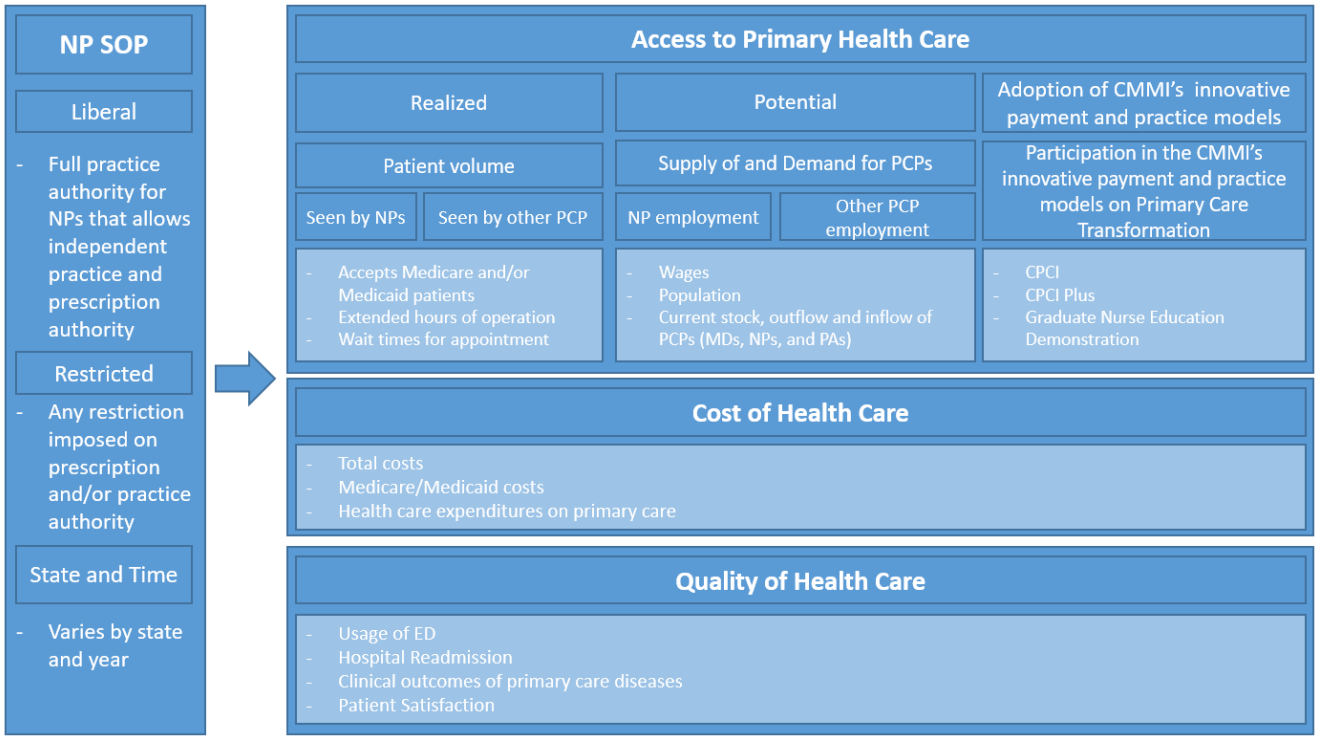
[139] Under the usual Logic Model framework, one has "Resources or Inputs", "Intervention associated activities", "Outputs", and "Outcomes or Effects". In my proposed logic model, I omit "Resources or Inputs", and solely focus on "Activities" and "Outcomes". For instance, Inin Poghosyan (2016 (page, p. 148) study, "Inputs or Resources" are omitted as well. Their proposed model for maximizing NP contributions to primary care shows how SOP regulations directly affect "Institutional Policies", "NP Care and Patient Outcomes", "NP Workforce Outcomes", and "Practice Environment"; with "Institutional Policies" affecting "Practice Environment" and "NP Workforce Outcomes"; whereas "Practice Environment" affects both "NP Workforce Outcomes" and "NP Care and Patient Outcomes"; while "NP Workforce Outcomes" also affects "NP Care and Patient Outcomes". For further details, please see Poghosyan (2016).

[140] "Identifying the Components of a Logic Model." CDC. As of June 30, 2017.

- Payment schedule reforms: NPs in some cases could be reimbursed under the Medicare/Medicaid schedule at a rate of 75 to 100 percent of the physician fee. Under the PPACA, innovative payment reforms would affect how NPs are reimbursed for their services. Assuming that NPs will benefit from these reforms, access to primary care may rise because of an increase in the employment of NPs and in the number of patients seen by NPs.
- PPACA reforms include education loans to become NPs, the opening of patient-centered medical homes (PCMH), and a focus on preventive care. These reforms might affect the NP workforce: RNs might seek an NP degree under favorable financial support for continuing education. In addition, the appearance of PCMH and similar primary care organizations that are willing to hire NPs will likely increase the demand for NPs.

Given the above basis, the conceptual framework for the effect of state NP SOP on primary health care is presented in Figure 3.1. The framework categorizes NP SOP either as *liberal* or *restricted* and indicates that NP SOP can affect access to primary care, cost of care, and quality of care. Liberal NP SOP refers to full practice authority, which is independent authority to practice and prescribe, whereas restricted NP SOP refers to any restriction on prescription and/or practice authority, including written, collaborative, and supervision agreements. The framework takes NP SOP as given, i.e., as a determinant of access, cost, and quality, and assumes that there is no feedback at the practice level from access, cost, and quality to NP SOP. The potential impact of

Figure 3.1.
Conceptual Framework for State NP SOP in Primary Health Care



NP SOP on access, cost, and quality is consistent with broad frameworks of health care assessment, e.g., Donabedian (1988)[141].

Access to PHC may be divided into two categories, *realized* and *potential*. Realized access in this dissertation refers to the number of visits or patients seen by a primary care provider, or patient volume for short. Thus, patient volume may be divided into patient visits involving an NP (including an NP alone or an NP along with a physician) and visits not involving an NP (including a physician alone or a physician and a physician assistant). All PCPs (including NPs) are affected by their practice's decision on whether to accept Medicare/Medicaid patients, whether they operate on the extended hours schedule, and wait times needed to get an appointment. Potential access in this dissertation refers to reduced form of supply of and demand for PCPs, which includes NP employment and other PCP employment. NP employment refers to the number of NPs practicing at a particular moment in a particular state; similarly, other PCP employment would be defined accordingly. This is viewed as potential access because the capacity of a practice to treat patients depends on the number of physicians, NPs, and PAs on its staff.

Factors that determine PCP employment include PCP wages, local population size, and the current stock of PCPs, which in turn depends on the inflow and outflow of PCPs. For instance, the number of licensed NPs may not accurately indicate potential access, at least in the short run, because many licensed NPs are not employed by primary care practices. A more accurate indicator of potential access is the number of NPs employed in medical practice. The supply of practicing NPs will depend on the current stock of NPs at a particular moment and the inflow of NPs (graduating from NP programs and entering medical practice, or transitioning to medical practice from a non-medical job or being out of the labor force) and outflow of practicing NPs (retirement and/or migrating to another state or switching to another field of specialization instead of practicing in primary care as an NP).

Access to primary health care can also be affected by policy interventions such as CMMI's innovative payment and practice models. The goal of these models is to transform health care, and specifically the model for Primary Care Transformation is geared toward increasing access to health care while improving quality of care and reducing health care costs. Research in this dissertation estimates whether NP SOP is a determinant of practice participation in the comprehensive primary care initiative (CPCI).

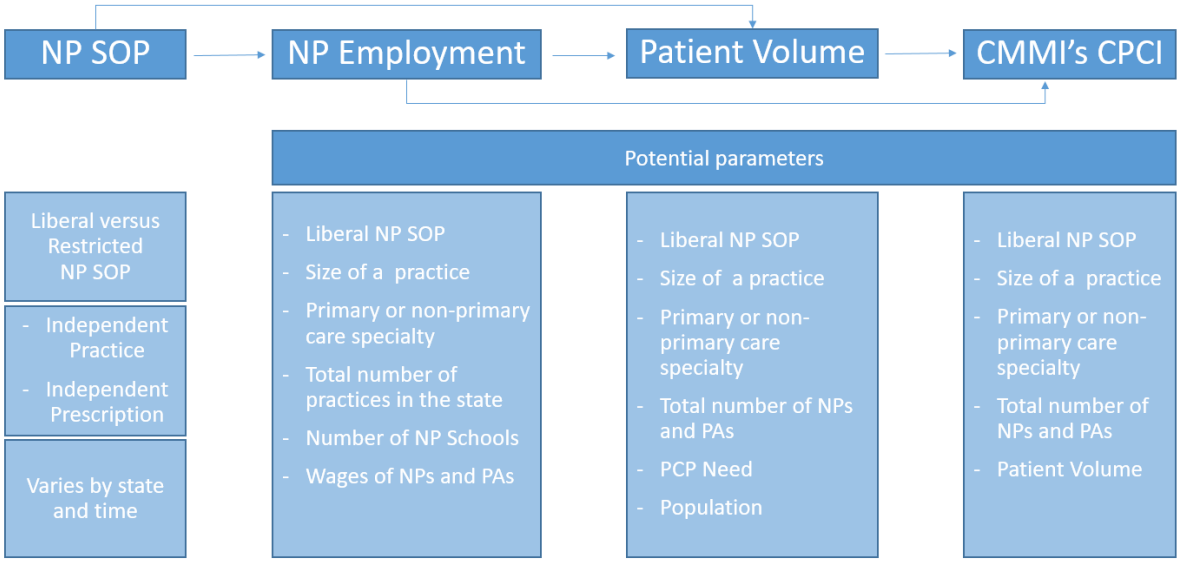
*Cost*s *of Health Care* refers to total costs – which will also include wages of NPs and costs associated with care provided by an NP among other health care costs, Medicare and Medicaid costs – which could vary due to 'incident to billing' clause for NPs, and health care expenditures in primary health care.

[141] Donabedian, Avedis, "The quality of care: how can it be assessed?," *Jama,* Vol. 260, No. 12, 1988, pp. 1743-1748.

Quality of Health Care is perceived in terms of usage of ED, hospital readmission rates, clinical outcomes, and patient satisfaction when comparing health care provided by NPs to MDs. What is the relationship between the quality of care and NP SOP? Given that NPs are taught in nursing schools which use a patient-centered model, in states with liberal NP SOP one would expect NPs to have more independence in treating and prescribing. Although not studied in this dissertation, if NPs are knowledgeable and well trained, the quality of care they provide within their SOP should be on par with that of physicians. Quality of care might improve if, for example, NPs are more effective than physicians in communicating the importance of taking the full course of prescribed medications or of taking actions to prevent diseases or conditions. This might result in a higher (or on par) level of patient satisfaction, and perhaps the same (or lower) rates of ED utilization and hospital readmissions.

Given the above framework, a reduced form of the conceptual framework is relevant to the empirical analysis in this dissertation. The reduced form is shown in Figure 3.2. The relationship among *NP Employment*, *Patient Volume*, and *CMMI's CPCI* is based on the variables that will be utilized in empirical analyses presented in Chapters 4-6. The diagram shows which potential parameters could be used to estimate the impact of state NP SOP regulations on NP employment, patient volume, and CPCI. The above diagram also suggests that there is a relationship between *CMMI's CPCI* and *NP Employment*, *CMMI's CPCI* and *Patient Volume*, along with *NP SOP* that indirectly affects whether a practice participates in the CPCI.

Figure 3.2.
Reduced Form Conceptual Framework of the Impact of NP SOP in Primary Health Care



Numerical example of the theoretical model on NP SOP

Effect of an Increase in NP Productivity on the Practice's Output and Demands for NP and PA: Cobb-Douglas Case

In this section, the theoretical model is presented, using *Mathematica 11.0* software to run calculations and graphs. The goal is to illustrate how NP SOP, viewed as affecting the productivity of NPs, in turn affects a practice's output and demand for NPs and PAs, given the size of the practice, which is measured by the number of physicians employed. This section presents a Cobb-Douglas production function for the production of health care services as a function of inputs, nurse practitioners and physician assistants (or all other support staff, treated collectively). The analysis shows that, with the practice as a price-taker in output and input markets, an increase in the productivity of NPs decreases the demand for NPs and PAs, given the level of output. However, when NPs are more productive the practice can handle more cases – produce more health care services – and this causes the practice's supply curve to shift out. Assuming the practice is a price taker in the health care services market, the outward shift means that the practice will increase its level of output. This in turn, will increase its demand for NPs and PAs. The model assumes practice size is constant, though in the long run an increasing supply of NPs could affect the market structure of practices, possibly resulting in larger practices and greater use of NPs especially where NP SOP was broad.

The context for the model is as follows. These points are also relevant to Chapters 4 and 5:

(1) The practice's production technology is Cobb Douglas, and the focus is only on NP and PA as inputs. Other factors such as practice size, office space, equipment, and the number of non-NP/PA staff members could change in response to liberal NP SOP but such changes are not analyzed.
(2) The analysis assumes that a change to liberal NP SOP increases the productivity of NP. By definition, liberal NP SOP allows the NP to provide a wider range of patient care. This is seen through an increase in a, the Cobb Douglas exponent for NP. Assuming the practice is a price-taker and profit-maximizer, the analysis shows how the increase in a (or alpha in Chapter 5) affects the level of output, which in the empirical analysis will be measured by patient volume (patients per day). In particular, the increase in a increases the practice's demand for NP and increases its profit-maximizing level of output. The increase in demand for NP is consistent with the findings in Chapter 4.
(3) As mentioned in Chapter 4, a change to liberal NP SOP can also affect NP supply. NP supply would increase if prospective students expected the NP wage to increase, expected higher on-the-job utility from having an expanded scope of practice, or expected the number of available positions to increase. Similarly, already-trained and licensed NP's not currently working at a practice might seek work in a practice.
(4) Thus, a change to liberal NP can be expected to shift out the demand curve for NP and might shift out the supply curve for NP. Depending on the increase in demand for and supply of NP, the NP wage might increase, decrease, or remain the same. Assuming the practice is a price-taker, the practice is too small to affect the wage for NP. But given the possibility of both a demand and supply response to a change to liberal NP SOP, the analysis first shows the effect of a change to liberal NP SOP on the practice's demand for NP and

the practice's output holding the NP wage constant, and then uses the demand expression to show how the demand effects could be affected by a change in NP wage that resulted from a supply curve shift driven by the change to liberal NP SOP. If the NP wage increased, the increase in demand for NP and patient volume would be less than otherwise. If the NP wage decreased, they would be greater than otherwise.

(5) Because the shift to liberal NP SOP could cause both a demand-side and supply-side response, the estimated models are discussed as reduced form models.

Notation

A profit-maximizing practice has a Cobb-Douglas production function for producing health care services with two variable factors, labor provided by NPs and PAs. The practice chooses the number of NPs and PAs to use in producing it output, y, of health care services. The wages of NPs and PAs are exogenous and given by w_1 and w_2, respectively. Furthermore, assume that productivity factor, A, is a constant for a practice, though A can differ for practices of different size.

Cobb-Douglas Production

Consider a Cobb-Douglas health services production function, where the physician (or physician group) uses inputs of NPs (x_1) and PAs (x_2)[142].

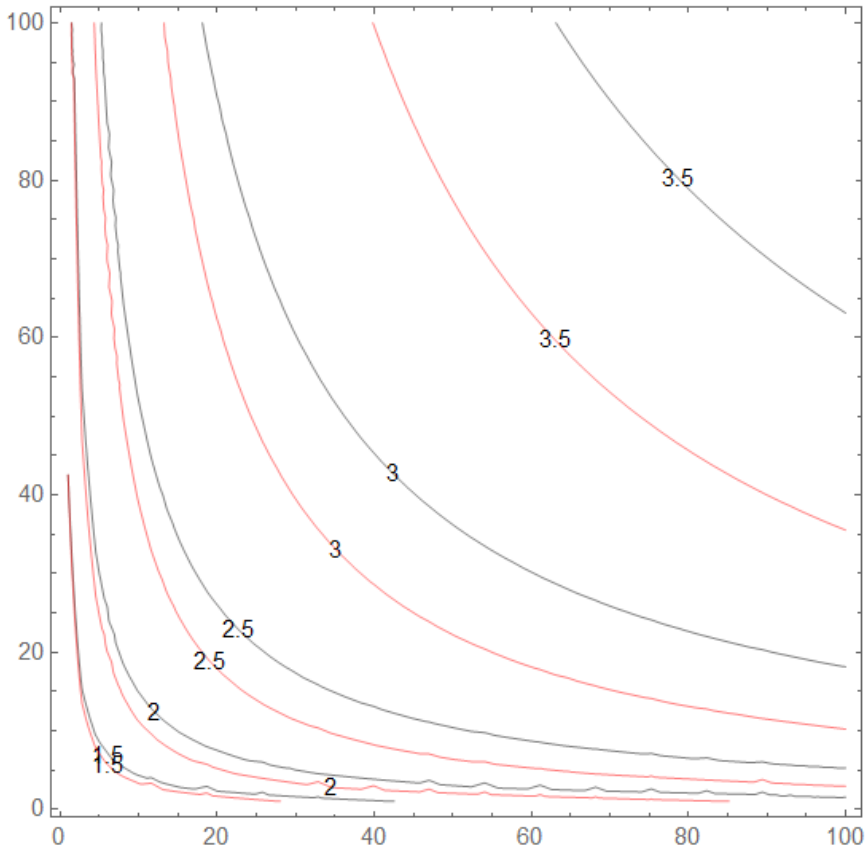
Let $y = f(x_1, x_2)$ be a Cobb-Douglas production function, $y = Ax_1^a x_2^b$, and A, a, b are positive constants. The Cobb-Douglas technology is monotonic with positive marginal products , $MP_1 = \frac{\partial y}{\partial x_1} > 0$ and $MP_2 = \frac{\partial y}{\partial x_2} > 0$, and convex with technical rate of substitution equal to $TRS = \frac{MP_1}{MP_2} = \frac{ax_1}{bx_2}$ and decreasing as x_1 rises and x_2 falls. Decreasing returns to scale are assumed with $a + b < 1$.

[142] The work below uses equations derived by Gervais, Antoine "Cobb-Douglas Production Functions." As of February 15, 2017.

The isoquant is defined as $u(x_1, x_2) = a \log(x_1) + b \log(x_2)$. Figure 3.3 contains graphics of isoquants, showing a shift in when *a* is increased.

Recall that isoquants show various bundles of x_1 and x_2 while holding y fixed. As shown above,

Figure 3.3.
Isoquant 1 and 2 Combined (Isoquant 1 and Isoquant 2)



the increase in *a* – or say change of NP SOP from restricted to liberal, results in smaller x_1 and x_2 for a given output, such that a practice employs less number of NPs and PAs per each fixed number of services.

Cost Minimization: Conditional Input Demand

The next step is to explore conditional input demand. The cost minimizing input demands conditional on output are used in building the practice's health care services supply function, which is given further below. The conditional input demands are:

$$x_1 = x_{NP} = A^{-\frac{1}{(a+b)}} a^{\frac{b}{(a+b)}} b^{-\frac{b}{(a+b)}} w_1^{-\frac{b}{(a+b)}} w_2^{\frac{b}{(a+b)}} y^{\frac{1}{(a+b)}} \qquad (1)$$

$$x_2 = x_{PA} = A^{-\frac{1}{(a+b)}} a^{-\frac{a}{(a+b)}} b^{\frac{a}{(a+b)}} w_1^{\frac{a}{(a+b)}} w_2^{-\frac{a}{(a+b)}} y^{\frac{1}{(a+b)}} \qquad (2)$$

The first question to ask is how an increase in *a* affects the demand for x_1, nurse practitioners, holding input prices w_1 and w_2 and output *y* constant. Since an increase in *a* means that NPs are more productive, we can expect that when *a* is higher, less x_1 is needed to produce a given level of output. The derivative of $\log(x_1)$ with respect to *a* is taken, and then, the result is multiplied by *a* to obtain the percentage change in x_1 with respect to a one-percent increase in *a* $(dlog(x_1)/(\frac{da}{a}) = (dx_1/x_1)/ (\frac{da}{a}))$:

$$\frac{1}{a(a+b)^2}\ [ab + b^2 - \text{ablog(a)} + \text{alog(A)} + \text{ablog(b)} + \text{ablog}(w_1) - \text{ablog}(w_2) - \text{alog(y)}]$$

Collecting terms:

$$\frac{1}{a(a+b)^2}\left(ab + b^2 + a\log(A) + ab\log\left(\frac{bw_1}{aw_2}\right) - a\log(y)\right)$$

So, multiplying this by *a*, the percent change in x_1 with respect to a one-percent change in *a* is obtained:

$$\frac{1}{(a+b)^2}\left(ab + b^2 + a\log(A) + ab\log\left(\frac{bw_1}{aw_2}\right) - a\log(y)\right)$$

Next, factoring out *a* to get:

$$\frac{a}{(a+b)^2}\left(b\left(\frac{a+b}{a}\right) + \log(A) + b\log\left(\frac{bw_1}{aw_2}\right) - \log(y)\right)$$

The term *-log(y)* is negative, assuming $y > 1$, so a higher marginal product for x_1 (through a higher value of *a*) tends to decrease the demand for x_1 needed to produce output at level *y*. Also, the demand for x_1 will rise or fall depending on whether $\frac{bw_1}{aw_2}$ is greater or less than 1. It is known from the first order condition that $\frac{x_2}{x_1} = \frac{bw_1}{aw_2}$. Hence, if at the production point $x_2 > x_1$, the demand for x_1 will increase because of input substitution. However, if $x_1 < x_2$, the demand for x_1 will decrease. The latter case might reflect a doctor's office with one NP and two PAs.

Next question arises, how does the demand for x_2 change when *a* is higher? Similarly, derivative of $\log(x_2)$ with respect to *a* is taken and then the result is multiplied by *a* to obtain the percentage change in x_2 with respect to a one-percent in *a* $(dlog(x_2)/(\frac{da}{a}) = (dx_2/x_2)/ (\frac{da}{a}))$:

$$-\frac{1}{(a+b)^2}\ [a + b + \text{blog(a)} - \text{log(A)} - \text{blog(b)} - \text{blog}(w_1) + \text{blog}(w_2) + \text{log(y)}]$$

Collecting terms, it is seen that the result in parentheses is the same with the exception of the term *–(a + b)*, which is negative:

$$\frac{1}{(a+b)^2}\left(-(a+\ b)+\ \log(A)+b\log\left(\frac{bw_1}{aw_2}\right)-\log(y)\right)$$

Multiplying by *a* to obtain the percentage change in the demand for x_2 with respect to a one-percent increase in *a*:

$$\frac{a}{(a+b)^2}\left(-(a+\ b)+\ \log(A)+b\log\left(\frac{bw_1}{aw_2}\right)-\log(y)\right)$$

Similar interpretation follows for the demand for x_2, given the increase in *a*.

As a side point, the difference in the percentage changes in the demand for x_1 and x_2 is calculated:

$$\frac{a}{(a+b)^2}\left(b\left(\frac{a+b}{a}\right)+\log(A)+b\log\left(\frac{bw_1}{aw_2}\right)-\log(y)\right)-\frac{a}{(a+b)^2}\left(-(a+\ b)+\ \log(A)+ b\log\left(\frac{bw_1}{aw_2}\right)-\log(y)\right)=$$

$$\frac{a}{(a+b)^2}b\left(\frac{a+b}{a}\right)-\frac{a}{(a+b)^2}\left(-(a+b)\right)=\frac{b}{a+b}+\frac{a}{a+b}=1$$

The difference is equal to 1, implying that the percentage change in the demand for x_1 is one percent greater than the percentage change in the demand for x_2, in response to a one-percent increase in *a*. Thus, as *a* increases, we expect the demand for the inputs to decrease, however, the demand for x_1 increases relative to the demand for x_2.

Cost Function

The next question arises on how does an increase in the parameter *a* affect the cost function? It is expected that the cost of producing a given level of output to decrease, given a change from restricted NP SOP to liberal NP SOP (or an increase in *a*). The total cost of producing *y* units in the cheapest possible ways is:

$$C(w_1, w_2, y) = w_1x_1 + w_2x_2 = A^{-\frac{1}{a+b}}\left[\left(\frac{a}{b}\right)^{\frac{b}{a+b}} + \left(\frac{b}{a}\right)^{\frac{a}{a+b}}\right] w_1^{\frac{a}{a+b}} w_2^{\frac{b}{a+b}} y^{\frac{1}{a+b}} \quad (3)$$

Taking derivative of (3) with respect to *a* and then simplifying the result, we get:

$$\frac{C[w_1,w_2,y]}{(a+b)^2}\left(2b + \log[A] + b\log\left[\frac{bw_1}{aw_2}\right] - \log[y]\right) \quad (4)$$

Again, the term *-log(y)* means that cost will be lower the higher the level of output produced, if this effect dominates the other terms in parentheses. If in equilibrium there are more PAs (x_2) than NPs (x_1), $\log\left(\frac{x_2}{x_1}\right) > 0$. Otherwise, $\log\left(\frac{x_2}{x_1}\right) < 0$. The other terms are greater than zero, though *A* can be normalized to 1, in which case log(A) = 0. Overall, for "large" values of *y* it is reasonable to expect it to be lower for higher *a*.

Profit-Maximizing Output

The next question to explore is to determine how the practice's supply changes when *a* increases, i.e., when NP SOP changes from restricted to liberal. The perfectly competitive firm's supply curve for output *y* is:

$$A^{1/(1-a-b)}a^{a/(1-a-b)}b^{b/(1-a-b)}w_1{}^{-a/(1-a-b)}w_2{}^{-b/(1-a-b)}p^{(a+b)/(1-a-b)} \quad (5)$$

where *p* is price for health care services. Recall that the curve is defined for production with less than constant returns to scale, $a + b < 1$. So, taking derivative of (5) with respect to *a*:

$$\frac{1}{(1-a-b)^2}\left(1 - a - b + \log[a] + \log[A] + b\log\left[\frac{bw_1}{aw_2}\right] + \log[p] - \log[w_1]\right)$$

The effect of higher *a* on the supply curve is positively related to price and negatively related to the cost of a unit of NP services, w_1. It is expected that $p > w_1$, because otherwise it would not be profitable to produce the first unit of health care services, hence, log(p) > log (w_1). The numerical example with plots is presented below.

As a side point, the practice's profit equals the price times its supply curve evaluated at the market price. How does the firm's profit change when *a* increases? The perfectly competitive firm's profit function is *p* times the firm's supply curve:

$$A^{1/(1-a-b)}a^{a/(1-a-b)}b^{b/(1-a-b)}w_1{}^{-a/(1-a-b)}w_2{}^{-b/(1-a-b)}p^{(1+a+b)/(1-a-b)} \quad (6)$$

Taking the derivative of (6) with respect to *a*:

$$\frac{1}{(1-a-b)^2}\left(1-a-b+\log[a]+\log[A]+b\log\left[\frac{bw_1}{aw_2}\right]+2\log[p]-\log[w_1]\right)$$

That is the same as the effect on the supply curve except that now it is 2log(p) instead of log(p).

Plots of the Practice's Supply Curve

To plot the supply curve in the usual way, with output on the x-axis and price on the y-axis, the supply curve needs to be inverted:

$$y = A^{1/(1-a-b)}a^{a/(1-a-b)}b^{b/(1-a-b)}{w_1}^{-a/(1-a-b)}{w_2}^{-b/(1-a-b)}p^{(a+b)/(1-a-b)} \quad (7)$$

$$y^{1-a-b}A^{-1}a^{-a}b^{-b}{w_1}^{a}{w_2}^{b} = p^{a+b}$$

$$p = y^{\frac{1-a-b}{a+b}}A^{\frac{-1}{a+b}}a^{\frac{-a}{a+b}}b^{\frac{-b}{a+b}}{w_1}^{\frac{a}{a+b}}{w_2}^{\frac{b}{a+b}}$$

For the plots for Supply 1, I choose A = 1, a = 0.34, b = 0.5, $w_1 = 1.02$, $w_2 = 1$ and for Supply 2 – A = 1, a = 0.35, b = 0.5, $w_1 = 1.02$, $w_2 = 1$, where increase in *a* represents change from restricted to liberal NP SOP, or an increase in productivity. To make more realistic assumptions, on w_1 and w_2, I chose these values while using mean hourly wages of May 2016[143] for NPs and PAs:

NP hourly mean wages $50.30
PA hourly mean wages $49.08

I normalize wages, using PAs as my base wage, such that PA wages = 1, and thus, NP wages = $50.30/$49.08 ≈ 1.02.

As for the concern of *a* and *b*, I chose them based on decreasing returns to scale criteria, so that x_1, x_2, and *y* equations are aligned with the theory and data[144], and examining by how much patient volume changes if PAs or NPs are employed in the practice by practice size (aggregated across six years), using SK&A data. Table 3.2 shows these results.

[143] Current wages for PAs were accessed at "29-1071 Physician Assistants," March 31, 2017. Bureau of Labor Statistics. As of June 1, 2017
Current wages for NPs were accessed at "29-1171 Nurse Practitioners," March 31, 2017. Bureau of Labor Statistics. As of June 1, 2017.

[144] See notes developed by Gervais on "Cobb-Douglas Production Functions" for further details on decreasing returns to scale criteria, a + b < 1.

As seen from Tables 3.2 and 3.3, for most of the practice size categories it seems like adding a PA generates a higher patient volume than adding an NP, holding all else constant. Therefore, the hypothetical numbers chosen for *a* and *b* are such that *b* is larger than *a*.

The line for price will be used to show the market price of health care series, here price is assumed to be 4. The reason p is chosen to be equal to 4 is based on the price estimates for primary care physician visits which may be in the range of $160 to $200[145] for uninsured individuals. Again, if choosing PA wages as a base, then p is approximately equal to 4. Figure 3.4 shows the plot of price and two supply curves with varying *a*.

Table 3.2.
Means, Standard Deviations, and Frequencies of Average Daily Number of Patient Visits, Categorized by NP Employment and Practice Size across 2008-2013

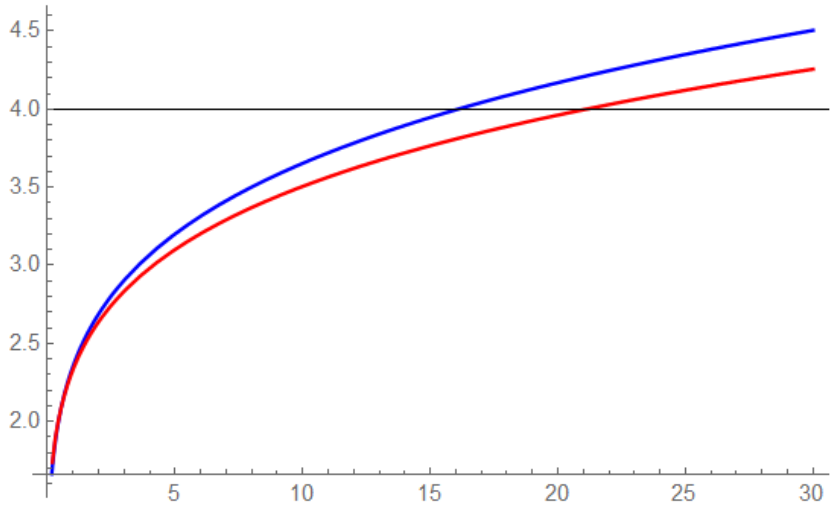
PA indicator	Solo: 1MD	Small: 2-4 MDs	Medium: 5-9 MDs	Large: 10-20 MDs	Very large: 21+MDs
	26	46	81	123	203
No PA	19	33	57	107	225
	55967	328369	87974	22431	4975
	36	59	96	144	267
One or more PAs	23	38	62	119	231
	73451	88506	44434	15935	4872

Table 3.3.
Means, Standard Deviations, and Frequencies of Average Daily Number of Patient Visits, Categorized by PA Employment and Practice Size across 2008-2013

PA indicator	Solo: 1MD	Small: 2-4 MDs	Medium: 5-9 MDs	Large: 10-20 MDs	Very large: 21+MDs
	26	46	81	123	212
No PA	19	33	58	108	230
	580294	350364	100775	26341	6018
	38	61	98	151	270
One or more PAs	24	40	62	119	226
	52834	66511	31633	12025	3829

[145] "Primary Care Visits Available to Most Uninsured But at a High Price," May 5, 2015, 2015. John Hopkins Bloomberg School of Public Health. As of May 1, 2017.

Figure 3.4.
Price, Supply 1 and Supply 2 Combined



Using the supply function, the level of outputs at the two values of *a* is found:

```
A^(1/(1-a-b)) a^(a/(1-a-b)) b^(b/(1-a-b)) w1^(-a/(1-a-b)) w2^(-b/(1-a-b)) p^((a+b)/(1-a-b)) /. {A → 1, a → .34, b → .5, w1 → 1.02, w2 → 1, p → 4}
```

```
16.0773
```

```
A^(1/(1-a-b)) a^(a/(1-a-b)) b^(b/(1-a-b)) w1^(-a/(1-a-b)) w2^(-b/(1-a-b)) p^((a+b)/(1-a-b)) /. {A → 1, a → .35, b → .5, w1 → 1.02, w2 → 1, p → 4}
```

```
21.1024
```

Under this scenario and using the assumed values for *p*, w_1, w_2, *a*, and *b*, the practice's equilibrium level of output has increased from about 16.1 to 21.1.

Change in Input Demand

Before the increase in *a*, output was 16.0773 and the parameter values were {A = 1, a = 0.34, b = 0.5, w_1 = 1.02, w_2 = 1, p = 4}. The input demands were therefore:

```
x1 = A^(-1/(a+b)) a^(b/(a+b)) b^(-b/(a+b)) w1^(-b/(a+b)) w2^(b/(a+b)) y^(1/(a+b)) /. {A → 1, a → .34, b → .5, w1 → 1.02, w2 → 1, y → 16.0773}
x2 = A^(-1/(a+b)) a^(-a/(a+b)) b^(a/(a+b)) w1^(a/(a+b)) w2^(-a/(a+b)) y^(1/(a+b)) /. {A → 1, a → .34, b → .5, w1 → 1.02, w2 → 1, y → 16.0773}
```

```
21.4364
```

```
32.1546
```

The input ratio of x_1 to x_2, $\frac{x_1}{x_2}$, was 0.666667.

After the increase in *a* and the increase in output to 21.1024, the input demands increased:

```
x1 = A^(-1/(a+b)) a^(b/(a+b)) b^(-b/(a+b)) w1^(-b/(a+b)) w2^(b/(a+b)) y^(1/(a+b)) /. {A → 1, a → .35, b → .5, w1 → 1.02, w2 → 1, y → 21.1024}
x2 = A^(-1/(a+b)) a^(-a/(a+b)) b^(a/(a+b)) w1^(a/(a+b)) w2^(-a/(a+b)) y^(1/(a+b)) /. {A → 1, a → .35, b → .5, w1 → 1.02, w2 → 1, y → 21.1024}
```

```
28.9641
```

```
42.2048
```

Now, the ratio of x_1 to x_2, $\frac{x_1}{x_2}$, also increased and is equal to 0.686275.

Summarizing the results of this numerical example by using theoretical model with Cobb-Douglas production function, one may see that NP SOP has an impact on NP, PA employment, and services produced by a practice. The subsequent chapters will show this result and estimate the impact of NP SOP empirically.

4. The Impact of Nurse Practitioner Scope-of-Practice on Nurse Practitioner Employment

The demand for primary care is expected to increase[146] and the supply of primary care physicians is growing slower than the demand for primary care physicians, resulting in projected shortage of primary care providers between 14,900 to 35,6000 by 2025[147] in the United States. Viewed as potential access to care, the supply of primary care practitioners needs to be sufficient to meet the rising demand. Primary care practitioners generally include physicians, nurse practitioners, and to some extent physician assistants. The latter usually are not able to practice independently, and therefore are viewed as assistants to physicians. However, NPs, depending on state NP scope-of-practice, may practice without need of physician supervision. Hence, the availability of NPs may affect access to primary care in a direct way.

This chapter focuses on the effect of liberal NP SOP on the number of NPs employed. In particular, the key research question in this chapter is to identify how the number of NPs practicing in a certain state or practice in a particular year is affected by NP SOP regulations. Two types of empirical analysis are done: an analysis of state-level data using the synthetic control method, and an analysis of practice-level data using both fixed-effect and random-effect specifications. The analyses are preceded by a brief review of findings in the literature and descriptive information about the data used in the two analyses. Results from the synthetic control method indicate that the introduction of liberal NP SOP caused an increase in NP employment. This result is also found in the practice-level data. Because the practice-level data set has a large number of observations, it was possible to estimate specifications allowing for interaction of the NP SOP indicator with practice size (number of physicians) and whether the practice was primary or non-primary care. The results show that liberal NP SOP leads to an increase in NP employment, which increases with practice size. The results suggest that liberal NP SOP has contributed to the capability of care providers to provide care and the capacity of the health care system to provide care. Further increase in NP employment and extending liberal NP SOP to all states could be expected to help alleviate the projected shortage of care providers.

[146] "Projecting the Supply and Demand for Primary Care Practitioners Through 2020," 2013.

[147] "The Complexities of Physician Supply and Demand: Projections from 2014 to 2025," 2016.

Background and Literature Review

Literature review: studies measuring NP supply or employment in primary health care

Several studies examine the supply or employment of NPs and, accounting for the limitations of each study, the evidence in these studies supports the hypothesis that broader NP SOP increases the supply of NPs. For instance, one study examined how NP SOP affected NP employment and found that licensed "NPs in states with full practice and prescriptive authority were about 5 percentage points more likely to work in patient care than NPs in states with restricted practice and prescribing"[148]. Stange found that expanded NP supply has had a small effect on the office-based health care market – access, use of health care services, and prices – although utilization has been "modestly more responsive to supply increases" in states that allow for more autonomy in scope-of-practice regulations: "the number of primary care visits is more responsive to NP supply in states that permit NPs greater autonomy than those with restrictive environments" [149]. Sekscenski examined the effect of NP SOP – defined in terms of legal status, reimbursement services, and prescription authority using practice environment score – on supply of NPs and found that there were more NPs per capita in states with less restrictive SOP regulations and there was a positive correlation between the supply of generalist physicians and NPs, suggesting that a greater number of NPs did not lead to a reduction in the number of physicians[150]. Lin examined the relationship between distribution of NPs in the country and independent practice, and found that NPs "were more likely to locate in a county where state laws allowed independent practice" as well as concluded that states with favorable practice environment – independent practice and direct third-party reimbursement – will "likely have greater availability and a larger supply of nurse practitioners in rural counties"[151]. A cross-sectional study found that NPs "had 13% higher odds of working in primary care in states with full scope of practice"[152], whereas another study concluded that NPs were 3.4 percentage points more likely to practice in primary care in states with full practice and prescriptive authority[153].

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[148] *Impact of State Scope of Practice Laws and Other Factors on the Practice and Supply of Primary Care Nurse Practitioners.*, Washington, DC: Office of the Assistant Secretary for Planning and Evaluation, 2015.

[149] For further details see (Table 4) of Stange, Kevin, "How does provider supply and regulation influence health care markets? Evidence from nurse practitioners and physician assistants," *Journal of Health Economics,* Vol. 33, 2014, pp. 1-27.

[150] Sekscenski, Edward S, Stephanie Sansom, Carol Bazell, Marla E Salmon, and Fitzhugh Mullan, "State practice environments and the supply of physician assistants, nurse practitioners, and certified nurse-midwives," *New England Journal of Medicine,* Vol. 331, No. 19, 1994, pp. 1266-1271.

[151] Lin, Ge, Patricia A. Burns, and Thomas H. Nochajski, "The Geographic Distribution of Nurse Practitioners in the United States," *Appled Geographic Studies,* Vol. 1, No. 4, 1997, pp. 287-301.

[152] Barnes, Hilary, Claudia B Maier, Danielle Altares Sarik, Hayley Drew Germack, Linda H Aiken, and Matthew D McHugh, "Effects of regulation and payment policies on nurse practitioners' clinical practices," *Medical Care Research and Review*, 2016, p. 1077558716649109.

[153] "Impact of State Scope of Practice Laws and Other Factors on the Practice and Supply of Primary Care Nurse Practitioners"*, 2015.*

Reagan and Salsberry compared the number of NPs per capita in 2001 and 2008 using ARF data developed by HRSA and found that the number of NPs decreased by approximately 10 per 100,000 and the NP growth rate decreased by 25% in states with restrictive SOP regulations when compared to states with least restrictive SOP regulations[154]. Kalist and Spurr estimated the supply of NPs indirectly by looking at the impact of scope-of-practice regulations on the decision of Advanced Practice Nurses (APNs), including NPs, certified nurse midwives (CNMs), certified registered nurse anesthetists (CRNAs), and clinical nurse specialists (CNSs), to enter an Advanced Practice Nursing graduate school and found that the enrollment into specialized graduate APN programs was 30 percent higher in states with less restrictive SOP regulations[155].

Perry examined the impact of NP SOP on earnings of NPs and physicians and identified that if NPs have greater practice authority, defined in the study as NPs having controlled substance prescription authority and/or NPs having reimbursement authority, their earnings increase, while physician earnings decrease[156]. Another study examined the impact of NP SOP, defined in terms of NPs having controlled substance prescriptive authority, on moving to another state that has expanded NP SOP, and found that NPs in states granting expanded NP SOP "are less likely to move from the state than nurse practitioners in states that have not granted" expanded NP SOP[157]. In particular, the findings, given the study's sample, indicate "a state authorizing expanded authority to NPs leads to a reduction in the probability of moving of around 46%"[158]. Graves examined relationship between states with more or less restrictive SOP laws and geographic accessibility to primary care clinicians and found that although a "similar share of the population resided in low accessibility areas across state scope-of-practice categorizations, full-practice states overall had more geographically accessible" NPs and PAs in primary care[159]. Ku examined the effect of NP SOP on use of various types of practitioners and found that centers in states with full practice authority used "slightly fewer physicians and slightly more advanced-practice staff", where advanced-practice staff included NPs, PAs, and CNMs[160]. Spetz examined the impact of NP SOP in rural settings and identified that rural NPs "more often reported they were fully using

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[154] Note that the study was focusing on two separate periods 2001 and 2008 for comparing the impact of NP SOP. For further details see Reagan, Patricia B, and Pamela J Salsberry, "The effects of state-level scope-of-practice regulations on the number and growth of nurse practitioners," *Nursing Outlook,* Vol. 61, No. 6, 2013, pp. 392-399.

[155] Note that in this study, the dependent variable – enrollment – is defined as log of enrollment or log of per capita enrollments. For further details see page 278 of Kalist, David E, and Stephen J Spurr, "The effect of state laws on the supply of advanced practice nurses," *International Journal of Health Care Finance and Economics,* Vol. 4, No. 4, 2004, pp. 271-281.

[156] Perry, John J, "The rise and impact of nurse practitioners and physician assistants on their own and cross-occupation incomes.," *Contemporary Economic Policy,* Vol. 27, No. 4, 2009, pp. 491-511.

[157] Perry, John J, "State-granted practice authority: Do nurse practitioners vote with their feet?," *Nursing research and practice,* Vol. 2012, 2012.

[158] Ibid.

[159] Graves, John A, Pranita Mishra, Robert S Dittus, Ravi Parikh, Jennifer Perloff, and Peter I Buerhaus, "Role of geography and nurse practitioner scope-of-practice in efforts to expand primary care system capacity: Health reform and the primary care workforce," *Medical care,* Vol. 54, No. 1, 2016, pp. 81-89.

[160] Ku, Leighton, Bianca K Frogner, Erika Steinmetz, and Patricia Pittman, "Community health centers employ diverse staffing patterns, which can provide productivity lessons for medical practices," *Health Affairs,* Vol. 34, No. 1, 2015, pp. 95-103.

their NP skills, practicing to the fullest extent of the legal scope of practice, satisfied with their work, and planning to stay in their jobs"[161]. Further, a systematic review concludes that states with greater NP SOP authority demonstrate an increase in the number and growth of NPs[162]. Another study examined the relationship between growth of retail clinics, where NPs are largely employed, and NP SOP, and found that in three states studied – Pennsylvania, Maryland, and New Jersey – the growth of "retail clinics may in part be related to regulatory environments that support NP practice"[163].

Facts available on the number of NPs in the country

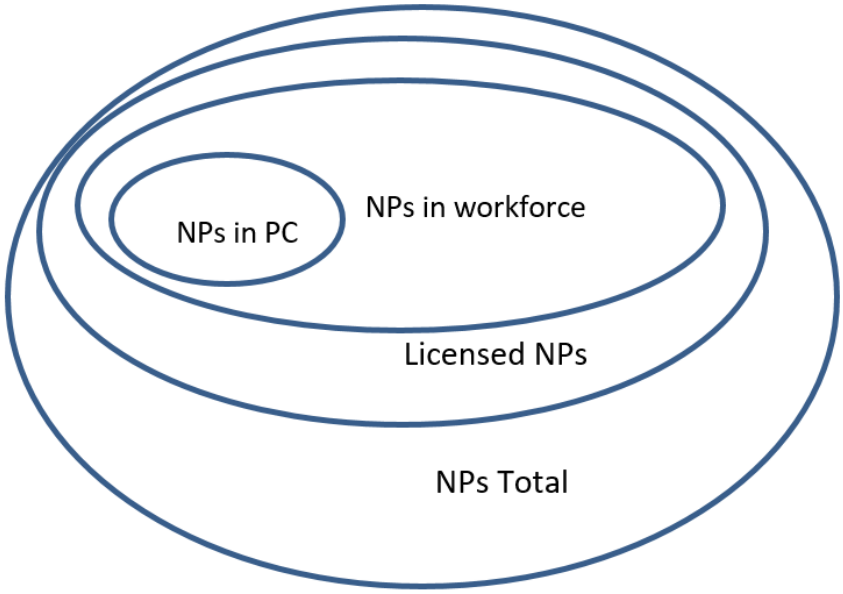
Several data sources have been used to estimate number of NPs in the United States. However, the datasets available count number of NPs differently. Given that NPs in some states are also titled as APNs, some data sources count NPs and APNs either combined or separately. Another issue related to historical data available on the counts of NPs is that each source estimates it disparately: either by the number of issued licenses or by the number of practicing NPs at the provider level. Moreover, not every source considers NPs by specialty, i.e., there are some datasets that count all NPs available in a particular state. This becomes an issue when trying to estimate number of NPs in primary care. Besides, there is a difference between number of NPs that obtained licenses and/or trained only for practicing in primary care versus those NPs who actually practice in primary care. Therefore, number of NPs that practice in primary care is a subset of NPs that have licenses to practice in primary care, and the latter is a subset of total number of NPs licensed in the states that includes NPs practicing in primary care and/or outside of primary care, as illustrated in Figure 4.1.

[161] Spetz, J., S. M. Skillman, and C. H. Andrilla, "Nurse Practitioner Autonomy and Satisfaction in Rural Settings," *Med Care Res Rev*, Jan 29, 2016.

[162] Xue et al., 2016.

[163] Brooks Carthon, J. M., T. Sammarco, D. Pancir, J. Chittams, and K. Wiltse Nicely, "Growth in retail-based clinics after nurse practitioner scope of practice reform," *Nurs Outlook,* Vol. 65, No. 2, Mar - Apr, 2017, pp. 195-201.

Figure 4.1.
NPs in Primary Care



NPs in PC – total number of NPs practicing in Primary Care only
NPs in Workforce – total number of practicing NPs
Licensed NPs – total number of NPs that are licensed and/or educated for practicing in Primary Care
NPs Total – total number of NPs licensed in all of the fields, including Primary Care; might also include counts of APNs, such as CNMs, CNSs, and CRNAs.

Data sources available on NP counts

The following sources contain data on the number of NPs:

- Kaiser Family Foundation started to track the total number of NPs by state since 2015, based on data from *Redi-Data, Inc*[164]*;*
- National Sample Survey of Nurse Practitioners (NSSNP) estimated the number of NPs in 2012 and 2016;
- Bureau of Labor Statistics started to track occupational data related to NPs since 2012;
- Kevin Stange and Deborah Sampson, researchers at Gerald R. Ford School of Public Policy at University of Michigan and at the Boston College School of Nursing, respectively, assembled a dataset with the number of licensed NPs at the county level by year for 1990-2008[165];
- Linda Pearson's NP Report tracks the number of NPs[166] by state for selected years;

[164] "Total Number of Nurse Practitioners, by Gender." Kaiser Family Foundation. As of December 27, 2015.

[165] Stange, 2014.

[166] The number of NPs reported from every state's Boards of Nursing (BON). It is most likely that this number comprises all licensed NPs and not necessarily practicing ones. See Linda Pearson reports on NPs for further details on how number of NPs was counted.

- SK&A data tracks the number of NPs working at the practice level[167].

Some of these datasets are based on the number of individual licenses issued in a state and/or national provider identifiers (NPIs). For instance, Linda Pearson's NP report estimates the number of providers by calculating the number of NPs reported from every state's Board of Nursing (usually as of May each year); the report for 2014 uses data from May 2013[168]. Further, Kaiser Family Foundation recently started to track the number of NPs and estimated a total number of 174,943 NPs as of October 2015, which includes currently professionally active NPs as calculated by *Redi-Data, Inc*. on active state licensed nurse practitioners[169]. Of these, 58,839 were in primary care[170]. Table 4.1 compares the number of NPs as reported by different sources.

The Agency for Healthcare Research and Quality has reported the number of NPs in primary care based on data from the Robert Graham Center, which calculated the total number of NPs by using the NPI dataset to explore the practice partners of each NP. Unlike the Pearson Report and the National Sample Survey of Nurse Practitioners (see below), which place the total number of licensed NPs around 150,000, the NPI data show 106,073 NPs. The difference in these estimates may reflect the possibility that nearly a third of licensed NPs are not practicing; the NPI focuses on NPs who are providers, which is likely a subset of licensed NPs. The NPI estimate is that about 56,000 NPs practiced in primary care in 2010, as shown in Table 4.2[171].

A similar estimate comes from NSSNP data, which found 60,407 NPs practicing in primary care in 2012[172]. More broadly, this survey found 154,057 licensed NPs, of whom 132,368 were in the NP workforce. Most of these, 127,210, were providing patient care (note that this is a higher number than the 106,073 in the NPI data), and about half of those, 60,407, were working in primary care. Figure 4.2 shows the NSSNP estimates[173].

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[167] SK&A: permitted perpetual and unlimited use at RAND for data years 2003-2013. First SK&A obtains data from various directories, state licensure data, DEA data, NPI, and claims data. Then, a staff of over 100 researchers verifies the information by calling offices to update the data every 6 months. There is annual audit and data quality team.

[168] 2014 Pearson Report on NPs. "Components of the 2014 Pearson Report", page ix.

[169] "Total Number of Nurse Practitioners, by Gender."

[170] Data received from Redi-Data via personal communication. Piretra, Judy, "Counts of NPs within primary care," Email, January 4, 2016.

[171] "The Number of Nurse Practitioners and Physician Assistants Practicing Primary Care in the United States: Primary Care Workforce Facts and Stats No. 2," October 2014, 2012. As of December 2015.

[172] "Highlights From the 2012 National Sample Survey of Nurse Practitioners," 2014. Health Resources and Resources Services. As of December 28, 2015.

[173] Ibid.

Table 4.1.
Number of NPs by Different Sources

Year	Source of Data					
	SK&A	BLS	Pearson Report	Stange and Sampson	NSSNP	Redi Data
2008	49255	—	137178	15862	—	—
2009	50956	—	147295	—	—	—
2010	54607	—	167857	—	—	—
2011	59887	—	167857	—	—	—
2012	64284	62520	147295	—	60407	—
2013	68185	67410	—	—	—	—
2014	—	122050*	202615	—	—	—
2015	—	136060*	Not available	—	—	58839

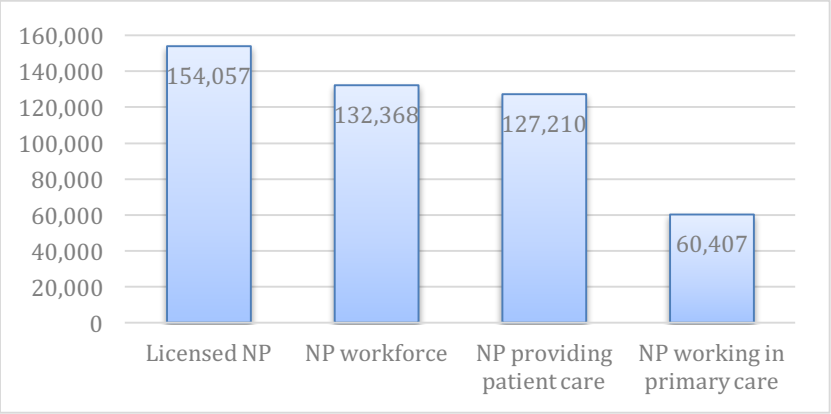
NOTES: "—" indicates no data; * total employed (not only in primary care).

Table 4.2.
Estimated Number of NPs and PAs Practicing Primary Care in the USA, 2010

Provider type	Total	Percent primary care	Practicing primary care
NPs	106,073	52.0%	55,625
PAs	70,383	43.4%	30,402

Source: AHRQ

Figure 4.2.
The Estimated NP Supply, 2012

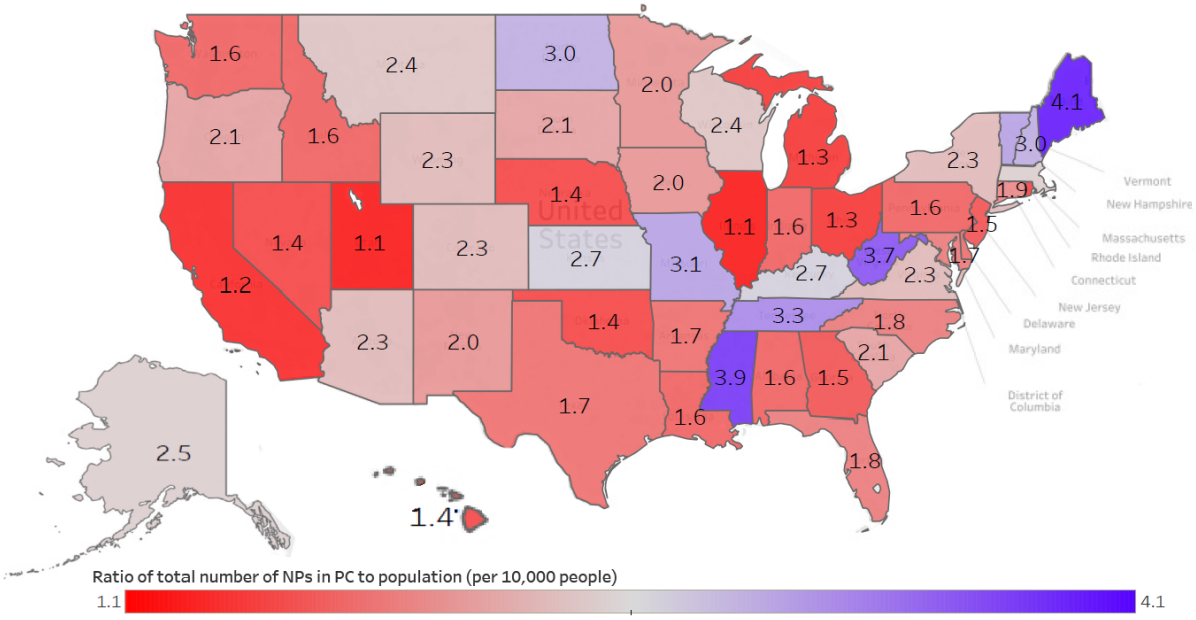


Source: NSSNP

Figure 4.3 is a map representing the ratio of the total number of NPs in primary care to the population across the country[174], demonstrating that the ratio of NPs in primary care to population varies across the US and some states have a lower ratio than others, ranging from 1.1 to 4.1. The map in Figure 4.4 shows the ratio of the total number of NPs employed by population (per 10,000) across states categorized by liberal and restricted NP SOP[175], indicating that ratio varies from state to state, ranging from 1.0 to 4.5.

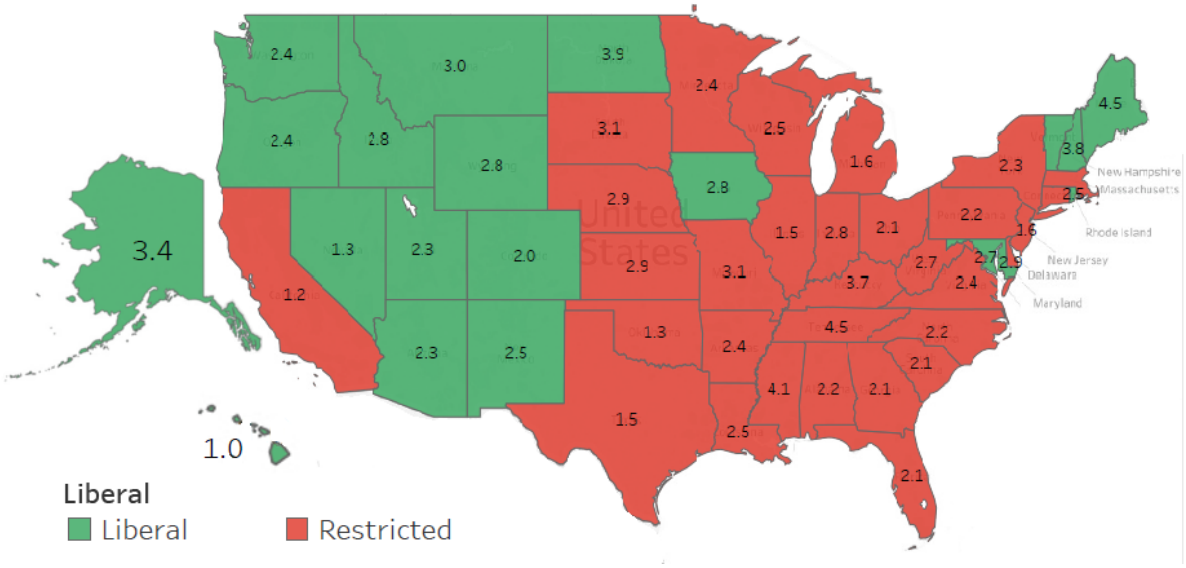
[174] The sources used for generating map were United States Census Bureau and Redi-data for 2015.
[175] The sources used for generating map were United States Census Bureau and SK&A data for 2013.

Figure 4.3.
Map of NPs in Primary Care vs. US Population



Map based on Longitude (generated) and Latitude (generated). Color shows sum of Ratio of total number of NPs in PC to population (per 10,000 people). Details are shown for State. The view is filtered on State, which excludes no members.

Figure 4.4.
Map of NPs Employed by Population in Liberal vs. Restricted States



Map based on Longitude (generated) and Latitude (generated). Color shows details about Liberal. The marks are labeled by sum of ratio of total number of NPs by population. Details are shown for State.

Education and Licensure for becoming an NP

Nurse practitioners are required to have at least master's degree and advanced clinical training in addition to their initial registered nurse preparation. In compliance with state laws, a master's degree is mandatory in 34 states[176]. NPs have to take and pass a national certification exam in 45 states; to sit for the certification exam, one is required to have a master's education[177]. So, NPs have at least 6 years of post-secondary education (4 years of college plus 2 years of master's degree study) and must obtain continuing education, which varies depending on the certifying body. Moreover, they need to have an RN and NP license to practice and renew their certification as NP through the American Nurses Credentialing Center, Pediatric Nursing Certification Board, or National Certification Corporation[178]. The majority of NPs attend didactic and clinical courses that provide NPs with specialized knowledge to practice in primary, acute, and long-term health care settings[179]. According to the American Association of Nurse Practitioners, NPs not only undergo rigorous national certification, but also periodic peer review, clinical outcome evaluations, and adhere to a code of ethical practice[180].

Services and settings under which NPs operate

NPs are qualified to meet the majority of patients' health care needs and have a comprehensive approach to treatment by emphasizing the overall health of their patients[181]. Depending on state NP SOP regulations, NPs can work independently and/or collaboratively in a health care team. NPs provide "high-quality care in rural, urban and suburban communities, in many types of settings including clinics, hospitals, emergency rooms, urgent care sites, private physician or NP practices, nursing homes, schools, colleges, and public health departments"[182]. NPs may provide services allowed by a state's nurse practice act, which could include obtaining medical histories and performing physical examinations, diagnosing and treating health problems, ordering and interpreting laboratory tests and X-rays, prescribing medications and other treatments, providing prenatal care and family planning services, providing well-child care and immunizations, providing gynecologic examinations and Pap smears, providing education about health risks, illness prevention, and health maintenance, providing counseling regarding the need for compliance with a diagnostic and/or treatment plan, course of illness, side effects of treatment,

[176] Buppert, 2015, Chapter 1.
[177] Ibid.
[178] Ibid.
[179] "What's an NP." The American Association of Nurse Practitioners. As of November 25, 2015.
[180] Ibid.
[181] "Nurse Practitioner." Mayo School of Health Sciences. Nurse Practitioner. As of November 25, 2015.
[182] "What's an NP".

and/or prognosis, coordinating care and case management[183]. Specialty areas of care may include acute care, adult health, family health, gerontology health, neonatal health, pediatric/child health, psychiatric/mental health, women's health, and oncology. Sub-specialty areas might involve allergy and immunology, cardiovascular, dermatology, emergency, endocrinology, gastroenterology, hematology and oncology, neurology, occupational health, orthopedics, pulmonology & respiratory, sports medicine, and urology[184].

Theoretical Discussion

NP Supply and Demand

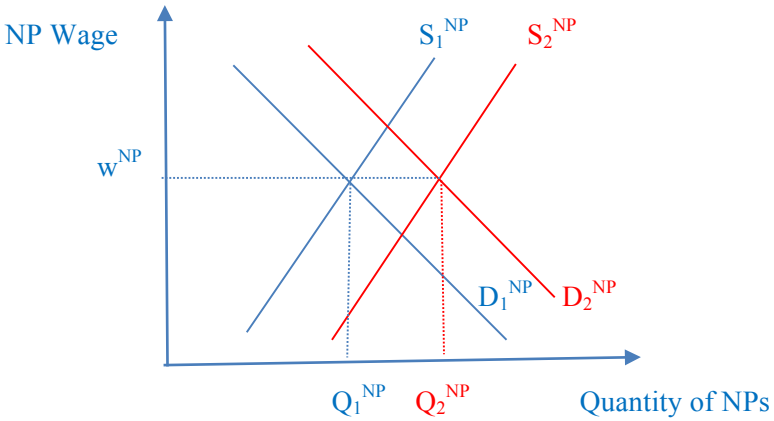
Nurse practitioners are more productive when their SOP is broader, and as a result the practice can produce the same level of output at lower cost. Stated differently, the practice's supply curve shifts out. Assuming the practice is a price-taker, the practice will increase its output level and, to do so, will employ more hours of NPs as its demand for NPs shifts out. Since PAs are also used in production, the practice's employment of PAs might also increase.

The increase in demand for NPs could increase the NP wage depending on the supply elasticity. As mentioned earlier, there are many licensed NPs not currently holding jobs in health care, and they might re-enter the NP health care labor market. Also, there may be an inflow of newly educated or newly licensed NPs, i.e., graduates of bachelor of science and master of science training programs and former RNs who transitioned to become NPs, as well as an inflow of 'migrated' NPs from neighboring states. Depending on these sources, the NP supply might be quite elastic in response to broader NP SOP; this would allow NP employment to increase with little increase in NP wage. But if supply is inelastic, a shift out in demand for NPs will cause an increase in NP wage. Overall, broader NP SOP are expected to cause an increase in practices' employment of NPs.

Considering a case of supply and demand side effects, the analysis in Figure 4.5 at the state and practice levels views the regressions as supply and demand reduced forms.

[183] Buppert, 2015, pp. 3-6.
[184] "What's an NP".

Figure 4.5.
NP Wage vs. Quantity of NP



The above diagram suggests that liberal NP SOP can affect the NP supply, both in the short run and in the long run. If practice's demand for NP shifts out and, at the same time, supply of NP shifts out, the practice may be able to increase its employment of NP without having to pay a higher salary. Similarly, at the state level, liberal NP SOP would allow NPs to practice to their full competency and result in the increase in demand for NPs, which in turn may induce more NPs to start practicing as an NP or enter NP schools, so the supply of NPs will shift to the right in the longer run as a response for a higher demand. These shifts of demand for NPs and supply of NPs may result in no changes in the NP wage, as illustrated above. However, there could be other two scenarios where shifts in supply or demand are higher such that the wage could be lower or higher, depending on the magnitude of curves' shifts. Hence, the shift of practice's demand for NPs due to change in NP SOP can help to identify the NP supply curve. Further, one might ask what happens to NP wage. If a change in the NP employment is accompanied by a rise in NP wage, then NP supply curve is upward sloping.

Based on this reasoning, labor supply could be affected by such factors as availability of PAs (substitutes), wages for NPs and wages for PAs, number of NP schools available (a proxy for inflow – graduating NPs and entering each year NP workforce), NP SOP regulations, practice size, and total number of practices available in the state. These are the major variables that could affect the NP supply.

The empirical analysis focuses on the employment of NPs rather than attempting to identify the supply and demand curves and shifts. NP counts at the state level designate the total number of NPs employed[185] in a state and a particular year, whereas number of NPs at the practice level – is the total number of NPs employed at a particular practice, state, and year.

[185] In the SK&A data, I calculate NP counts as a sum of total number of NPs working in a practice across a state for each year between 2008 and 2013: $\sum_{s=1}^{51} \sum_{p=1}^{k} \sum_{i=1}^{n} NP_{ipsy}$, where i – individual i, p - practice p, s – state s, y – year y.

The regression model for NP employment at the state levels is:

State level: $\text{Number of NPs}_{\text{ in year y and state s}} = \alpha + \beta\text{*NP SOP}_{\text{ in year y and state s}} + \delta\text{*wage of NPs}_{\text{ in year y and state s}} + \theta\text{*wage of PAs}_{\text{ in year y and state s}} + \zeta\text{*Number of schools granting NP degrees}_{\text{ in year y and state s}} + \psi\text{*number of practices}_{\text{ in year y and state s}} + \varepsilon_{\text{ in year y and state s}}$

The NP wage is expected to have a positive effect on NP supply and a negative effect on NP demand. In the reduced form, the NP wage coefficient may be of either sign. Wage variation derives from market wage differences across the geographic locales where practices are located, and from wage changes within a market over time. The data times series is not long, and most wage variation is cross sectional. A negative wage coefficient is consistent with the demand effect dominating the supply effect, i.e., in markets where the NP wage is higher the employments of NPs is lower, other things equal, and vice versa for a positive coefficient. With respect to the PA wage, it should have a positive effect on NP employment assuming NPs and PAs are substitutes in production.

The number of schools in the area reflects the inflow of NPs each year, that is, it is assumed that the more schools are available, the greater the number of NPs are enrolled and graduate each year in a state. The number of practices in a state is included in the model due to the idea that states with a large number of practices have a large demand for the services provided by NPs and/or PAs, and this induces more NPs to actually work for a practice. In 2012, there were about 154,057 NPs, but only about 60,407 of them worked for a practice[186]. Moreover, perhaps in states with a large number of practices the employment opportunities for NPs are good and relatively many NPs work for practices instead of working somewhere else or dropping out of the labor force. The regulation on NP SOP is expected to have an impact on the employment of NPs and the objective of this analysis is to identify what effect it has on NP employment in states with various NP SOP.

Similarly, the regression model for NP employment at the practice level is:

Practice Model: $\text{Number of NPs}_{\text{ at practice p in year y and state s}} = \alpha + \beta\text{*Regulation NP SOP}_{\text{ in year y and state s}} + \delta\text{*Wage of NPs}_{\text{ in year y and state s}} + \theta\text{*Wages of PA}_{\text{ in year y and state s}} + \psi\text{*number of practices}_{\text{ in year y and state s}} + \gamma\text{*number of MDs}_{\text{ at practice p in year y and state s}} + \zeta\text{*number of NP schools}_{\text{ in year y and state s}} + \sigma\text{*Primary care practice}_{\text{ in year y and state s}} + \varepsilon_{\text{ at practice p in year y and state s}}$

Again, the demand for NPs should increase with the size of the practice. In addition, assuming more schools create a greater supply of NPs in the state, this should lead to a lower NP wage, *ceteris paribus*. Therefore, the number of schools can be viewed as a shifter in NP supply hence in the NP wage: more schools lead to lower NP wage, and thus, more NPs employed by a practice. The type of practice also has an impact on the demand for NPs. In practices where the care provided by NPs is especially valuable to the practice's specialization, the demand for NPs should

[186] "Highlights From the 2012 National Sample Survey of Nurse Practitioners," 2014.

be little affected by the NP wage, i.e., the demand should be inelastic. However, if the care provided by NPs can be provided equally well by PAs, then the NP wage coefficient on NP labor demand might be large. In this case, the demand for NPs would be elastic. For the practice level model, other specifications, such as a specification including interaction term liberal NP SOP * Primary care practice *Number of MDs, were run as well.

NPs and PAs vis-à-vis MDs: substitutes or complements

When comparing NPs to PAs as well as NPs and PAs to MDs, one needs to examine the difference in these PCPs by looking at the practice's decision on hiring a particular practitioner. Physicians can treat patients without supervision, but NPs and PAs may need to be supervised by a physician under scope-of-practice regulations. Here, we briefly consider whether PAs and NPs are 'strategic' complements or substitutes with respect to physicians. This concept concerns the organization of a practice, i.e., the workforce mix, and differs from the narrower use of substitute-in-production, meaning a positive cross-price effect (an increase in the price of input two increases the demand for input one, holding output constant).

In some cases, NPs, PAs, and MDs may be substitutes, and in others complements. Since in every state PAs may not practice independently of physicians, PAs are viewed more as complements to MDs. However, NPs, depending on NP SOP and a patient's case, could be either complements or substitutes to MDs.

Given a state's NP SOP, there is a subset of patient care tasks that PAs and NPs can both perform, as can physicians. In this narrow sense, one can imagine that all three, PAs, NPs, and MDs, are substitutes in production for these tasks. But because of comparative advantage, the physician would want to delegate such tasks to PAs and NPs. PAs are not allowed to practice independently of the physician, but an NP may have authority to diagnose, treat, and prescribe without physician supervision. Thus, when NP SOP is broader, NP capabilities are closer to those of a physician and PA capabilities are more limited when compared to an NP's.

NPs and PAs also differ in their orientation toward care. NPs follow a patient centered model where they not only diagnose and treat diseases, but also emphasize prevention of diseases and educating a patient. PAs follow a disease-centered model, whereas they not only assist in diagnosing and treating diseases, but also focus on the biologic and pathologic parts of health. So, NPs and MDs could be viewed as strategic complements, as one could use patient-centered model and the other (physician) a disease-centered model. PAs and MDs could be viewed as strategic substitutes (even with MDs supervision). Since PAs are similar to MDs in the way they treat patients, if an MD wants to complement his/her skills, he/she could hire an NP rather than a PA.

Both PAs and NPs can reduce time that an MD needs to spend with a patient:

> By functioning as a 'one-man shop,' NPs offer benefits that extend beyond those of PAs and can be a stronger fit for primary care practices. Their

> nursing background and education equips them with the ability to connect with and educate patients, leading them to rate highly in achieving patient compliance. This results in fewer follow-up visits and lower hospitalization rates, which translates to reduced healthcare costs[187].

The pay of NPs and PAs is the same. According to the Bureau of Labor Statistics (BLS)[188], as of 2013, NPs earned $45.71 per hour and PAs earned $45.36 per hour. Therefore, in states with liberal NP SOP, a practice would want to hire an NP rather than PA, as an NP may not need much assistance or oversight from a physician. Another important aspect in deciding to hire an NP could be their work experience: "Nurse practitioners have, on average, over 10 years of nursing experience before they go into their practitionership"[189].

Methodology and data sources

Data sources

The data sources used in this chapter come from four main sources for the period of 2008-2013: SK&A, BLS, Linda Pearson Report, and United States Census Bureau. Specifically, SK&A provides data on NP counts and PA counts at the state and practice level, practice type at the state level, size of a practice/number of MDs employed at the practice, patient volume at the practice level, total number of practices in the state; BLS – Occupational Employment Statistics on wages for RNs and PAs at state level; Pearson Report – NP SOP regulations, i.e., whether an NP has prescription and practice authority and number of NP schools at the state level; United States Census Bureau – population by state. For estimating NP wage, 90th percentile of hourly or annual wage of RNs was utilized as a proxy, as BLS started to track wages of NPs in 2012 and the NP wages from 2008-2011 by state were not readily available from any other sources searched. It should be noted that Linda Pearson's NP Report for a particular year, say 2012, would be based on the NP SOP regulations in the beginning of 2012, and therefore, if a regulation passed, after the beginning of the year, these regulation changes were incorporated only for the following year[190]. Also, there is no Linda Pearson Report for 2013[191], and therefore, the numbers for schools and changes on regulation were based on comparing 2012 and 2014 Linda Pearson Report and

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[187] Loria, Gaby, "Nurse Practitioners and Physician Assistants: Why You Should Hire One (or the Other)," 2013. *Software Advice*. As of January 15, 2016.

[188] "Occupational Employment and Wages, May 2013: 29-1071 Physician Assistants," 2013. Bureau of Labor Statistics.

"Occupational Employment and Wages, May 2013: 29-1171 Nurse Practitioners," 2013. Bureau of Labor Statistics.

[189] "Nurse Practitioner vs. Physician Assistant," January 9, 2011, 2011. The Washington Post. As of January 15, 2016.

[190] Pearson, Linda "Details on Pearson Report," E-mail correspondence with Linda Pearson., January 6, 2016.

[191] Ibid.

examining any changes in these two years to obtain either an average for the number of schools or checking the NP SOP changes via official Board of Nursing websites.

Other additional data sources that were used for conducting synthetic control method included: health care expenditures per capita by state of residence in actual U.S. dollars from Kaiser Family Foundation[192] (data was available only for 2008-2009 and these two years were only used to calculate predictor means for constructing synthetic cohort) and per capita personal income[193] in actual U.S. dollars was (available for 2008-2013) by state from the Bureau of Economic Analysis.

Briefly about SK&A data and how NP counts are measured in SK&A data

SK&A is among the leading U.S. providers of healthcare information solutions and research that collects health care related data. It maintains contact profiles for more than 2.1 million health care providers and decision makers from 492,000-plus healthcare facilities across the country and ships more than 35 million data records on average every month[194]. SK&A collects data on health professionals under such settings as physician offices, home health agencies, dentists, and so on.

SK&A claims to have the most accurate and comprehensive list of nurse practitioner (NP) prescribers. However, there are other data sources available such as Bureau of Labor Statistics' Occupational Employment Statistics on NPs, Redi Data, National Sample Survey of Nurse Practitioners, and Linda Pearson's NP report. SK&A pursues prescribers that are involved in all aspects of patient care and verifies records via phone for 88,600 NPs at business addresses[195]. The NP list from SK&A is updated twice a year. SK&A defines NPs as "registered nurses in advanced practice positions who prescribe medicine, perform physician exams, development assessment, treat common illnesses and coordinate patient healthcare needs"[196]. SK&A targets NP prescribers by practice specialty, number of doctors in the practice, patient volume, medical group, health system, and hospital affiliation.

Methods

The study design involved a literature review on supply of NPs and NP SOP and quantitative analyses addressing the research question regarding the impact of NP SOP on employment of NPs. The quantitative analyses involved using STATA 12 software to run synthetic cohort method and

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[192] "Health Care Expenditures per Capita by State of Residence," Centers for Medicare & Medicaid Services: Kaiser Family Foundations, April 30, 2016.

[193] "Total personal income divided by total midyear population," *Bureau of Economic Analysis: U.S. Department of Commerce*, As of May 25, 2016.

[194] "Healthcare Marketing Leads and Medical Marketing Resources." SK&A. As of December 26, 2015.

[195] "The most accurate and comprehensive list of NP and PA prescribers." SK&A. As of December 26, 2015.

[196] "Nurse Practitioners & Physician Assistants." SK&A. As of December 26, 2015.

GLS with fixed and random effects. To generate maps (Figures 4.3 and 4.4) Tableau 10.3 was used.

The literature review included studies that looked into NP SOP regulations and their effect on supply of NPs. It reviewed studies with projections of the trend of primary care, in particular, the number of NPs and/or PCPs needed. The literature review also focused on studies to identify how existing studies define supply of NPs. Moreover, factors affecting the supply of NPs (such as salary, years of training required, licensing, etc.) and the demand for PCPs, along with the methodologies used to estimate these parameters were reviewed as well.

The quantitative analysis involved using generalized least squares regression with fixed and random effects and robust standard errors specification to test the effect of NP SOP on employment of NPs in primary care. Here, liberal NP SOP refers to no supervision for prescription and practice. Some states might allow independent practice authority, but not prescription authority, and vice-versa. In case if there is any restriction, either supervision or collaboration agreement with a physician is required, the NP SOP is defined as restricted in this study. The model will assume that the indicator for liberal NP SOP is exogenous to unobserved factors (in the error term) affecting the number of NPs. Further, SOP reforms were adopted at different times in different states: Colorado (2010), Hawaii (2011), Maryland (2010), Nevada (2013), North Dakota (2011), Rhode Island (2009), and Vermont (2011). For instance, in Arizona, NPs had independent prescriptive authority in 1984, but started to have independent practice authority in 2000. Similarly, in Oregon NPs had prescriptive authority in 1979, but practice authority in 1987. Interestingly, Wisconsin allows NPs to have independent prescriptive authority, but not independent practice authority. The difference-in-difference (DiD) approach was not used as, with only 7 states changing SOP during 2008-2013 data window there was not enough variation to perform DiD at the state level. Also, at the practice level the models include an indicator for NP SOP as well as practice-level fixed effects (in the fixed effect models) and this is essentially a DiD specification. Moreover, instead of using the difference-in-difference method, a comparative case study was used, *viz*., synthetic control approach was applied to examine the effect of changing NP SOP regulations in certain states on the number of NPs. The synthetic control method (SCM) implies utilizing a weighted average of the available control units that allows explicitly to estimate the relative contribution of each control unit to the counterfactual of interest and differences/similarities between the intervention (in this case passing expanded NP SOP), and the synthetic control[197].

[197] Alberto Abadie, Alberto, Alexis Diamond, and & Jens Hainmueller, "Synthetic control methods for comparative case studies: Estimating the effect of California's tobacco control program," *Journal of the American statistical Association,* Vol. 105, No. 490, (2010), pp. 493-505.

Model

Access to primary care depends on the availability of primary care providers in a certain geographic area and a particular time (in this case, *year*). There are several factors that have a direct impact on supply of primary care practitioners. The models at the state and practice levels are presented under "NP Supply and Demand" subsection.

Number of NPs refers to total counts of NPs in SK&A data and is not restricted to any specific health care field (such as primary care, as the data have some inconsistency of not coding NPs by their field of specialization in 2008-2009 years and would not be aligned properly when restricting to one field). Given the data limitations, and having survey estimates[198], as of 2017, there have been more than 234,000 of NPs practicing in the USA and 89.2% of which are certified in primary care, therefore, the use of total counts of NPs by state from SK&A data could not pose a significant bias.

Null hypothesis, Ho: States with liberal NP SOP (or full practice authority that allows for independent prescription and practice authority) have higher number of NPs providing health care.

Stated differently, the hypothesis is that state NP SOP regulations have a positive impact on number of NPs practicing in primary care in states allowing independent practice and prescription authority, while accounting for such state specifics as number of NP schools available, NP wages, and number of practices available in the state in each particular year.

Under this hypothesis, the coefficient on NP SOP, β, has a causal effect on employment of NPs. So, it is expected that β will have a positive sign, implying that number of practicing NPs should be higher in states with liberal NP SOP compared to states with restricted NP SOP.

At the state level, a log specification is run. Exploratory analysis found that log specification performed better than a specification where the variables are not in logs. Log-log transformation is used when the relationship between the dependent and independent variables is expected to be nonlinear. One of the ways to check the relationship between Y and X_i is to examine plots. The plots of each X_i with respect to Y will show if there is linear or non-linear relationship (the plots are presented in "Results" section).

Since one cannot compare R-squares of log-log and linear regressions, another way to see which model seems to have a better explanatory power is to take a look at statistical significance of all of the independent variables. Given the results (presented in the "Results" section), the log-log specification is preferable, as most of the independent variables are statistically significant. For the practice level, a log specification is not used, as there are zeroes in the dependent variable.

[198] "NP Facts", 2017.

Fixed effects versus Random effects at the State and Practice level

As was mentioned previously, GLS models with random and, alternatively, with fixed effects at the state and practice level are run. Also, logarithmic transformation is applied to the model at the state level, as it closely traces the non-linear relationship among the dependent and independent variables, and eases the interpretation of the results.

Nurse practitioner scope-of-practice is assumed to be exogenous. This is defensible at the practice level analysis as an individual practice is unlikely to affect whether liberal NP SOP law or regulations are enacted. The assumption may be less defensible at the state level, as conceivably NP and MD lobbyists might have influence the emergence of liberal NP SOP. Yet this is not clear, as lobbying might have gone against, not for, liberalizing NP SOP. This question may deserve future analysis. The empirical results here from both the state- and practice-level models, under the exogeneity assumption, suggest a potential benefit from liberal NP SOP, which might encourage passage of liberal NP SOP in more states.

State-level fixed effects versus random effects models

When state-level fixed effects are included, the variation in the explanatory variables is within-state variation. If there is little change in an explanatory variable in the window of observation, which is six years, then the variable will have little effect on the dependent variable. The number of NP schools is likely to increase during this window. However, the two other variables, liberal NP SOP and NP wages, probably do not change much. In the fixed effects specification, the coefficients on these variables are virtually zero. Therefore, in the results section, graphs are presented to identify how much these variables change. This is why the random effects specification performs better — more of the explanatory variables are significant (as will be shown in the "Results" section). However, given the fixed effects results, the significance of liberal NP SOP and NP wages in the random effects model apparently comes from variation across states, not variation within state.

Practice-level fixed effects versus random effects Models

At the practice-level, the fixed effects model performs better than random effects model, as expected. There are numerous practices within a state, hence more opportunities to observe the effect on practice-level NP employment and patient volume of introducing liberal NP SOP within the state. The practice-level fixed effect controls for a variety of practice-level environmental factors such as location, patient mix, physician experience, age of practice, and so forth. These factors are not controlled (held constant) in the random effects model but are inherent in the error term. The assumption of the random effects model is that such factors are statistically independent of the included variables. However, if such factors co-vary with the included variables, the

inclusion of a fixed effect controls for them and prevents a possible omitted-variable bias in the estimated coefficients. In a sense, the fixed effects model is like a difference-in-difference specification where the treatment, introducing liberal NP SOP, affects the treated relative to their behavior before treatment and compared to the untreated. As the results below indicate, the hypothesized model at the practice level performs better than at the state level.

Synthetic control method

To test the effect of changing NP SOP laws at the state level, the synthetic control method is applied. It estimates the impact of changing NP SOP for a particular state under consideration, by comparing it to the synthetic cohort that is constructed under certain resembling characteristics to the state that modified its NP SOP.

Overview of the synthetic control method (SCM)

The aim of the SCM, introduced by Abadie and Gardeazabal[199] (2003), is to examine the impact of an intervention, implemented at aggregate level and influencing a small number of large units, on a certain outcome under consideration. The advantage of using the SCM is that unlike the difference-in-differences (DiD) method it does not assume parallel trend, which infers to the assumption of having outcomes for the treated and control groups to follow parallel trajectories if intervention had not taken place. The SCM allows for the effects of observed and unobserved predictors to change over time and the outcomes from the synthetic cohort (control) units are weighted such that the counterfactual outcome for the treated in the absence of the treatment is constructed. Hence, the SCM could be suitable to evaluate health policy evaluations "when the validity of the parallel trends assumption is questionable"[200].

Notation and set up in the SCM

Before describing SCM set up, the terms will be defined under the framework of NP SOP and its impact on NP employment. Let the following terms refer to:

Event/Intervention/Treatment: NP SOP changes in one state in a particular year
Treated Unit: State
Treatment period: year when NP SOP is enacted in a particular state of interest
Control units (*donor pool* or *synthetic cohort*): states that have similar characteristics to a treated state and utilized as a comparison group when running comparative analysis
Outcome: Number of NPs in a certain state and year

[199] Abadie, Alberto, and Javier Gardeazabal, "The economic costs of conflict: A case study of the Basque Country," *The American Economic Review,* Vol. 93, No. 1, 2003, pp. 113-132.

[200] Kreif, Noémi, Richard Grieve, Dominik Hangartner, Alex James Turner, Silviya Nikolova, and Matt Sutton, "Examination of the synthetic control method for evaluating health policies with multiple treated units," *Health economics*, 2015.

Predictor variables: variables that are used as characteristics for choosing the weighted combination of control units

Let[201] there be J+1 units (states) and the first unit is exposed to changing its NP SOP, such that J units are potentially viewed as controls or donor pool. Also, let there be T total time periods and the NP SOP change starts in T_{0+1}. So, Y_{jt}, the observed outcome can be viewed as:

$$Y_{jt} = Y_{jt}^{N} + a_{jt}D_{jt} \quad (1)$$
$$Y_{jt}^{N} = \delta_t + \lambda_t\mu_j + \theta_t Z_j + \varepsilon_{jt} \quad (2)$$
$$Y_{jt} = \delta_t + \lambda_t\mu_j + \theta_t Z_j + a_{jt}D_{jt} + \varepsilon_{jt} \quad (3)$$

where

Y_{jt}^{N} – the outcome observed for state j in time t in the absence of treatment
a_{jt} - the effect of the treatment for unit j at time t
D_{jt} – indicator that takes value of one if unit j is treated after T_0 and 0 otherwise
δ_t – time fixed effect
λ_t – a vector of time-varying unobserved coefficients
μ_j – a vector of time-invariant unknown predictor variables
θ_t – a vector with time-varying coefficients
Z_j – a vector of time-invariant measured predictors
ε_{jt} – unobserved transitory shocks at the unit level with zero mean

Note that in the DiD method, Equation 3 becomes: $Y_{jt} = \delta_t + \lambda\mu_j + \theta_t Z_j + a_{jt}D_{jt} + \varepsilon_{jt}$, so that the effect, λ, of the unknown predictor variables, μ_j, does not change over time.

Before the NP SOP is enacted (pre-treatment period), $Y_{jt}^{N} = Y_{jt}$. However, after the treatment takes place – NP SOP is implemented – the counterfactual for the treated unit is not observed. Therefore, synthetic cohort is generated to estimate the unobserved Y_{1t}^{N} after the treatment is in effect. Synthetic control[202] or also called synthetic cohort or donor pool is a weighted grouping of potential control units (states) that are similar in characteristics to a treated unit (or state that passed NP SOP). The weights for control units are chosen such that they characterize the treated unit the best. Let $W = \left(w_{1,\dots}, w_{J+1}\right)'$ be the vector of weights and each w_j is assigned non-negative weight with all the weights summing up to one: $w_j \geq 0$ and $\sum_{j=2}^{J+1} w_j = 1$. Then the estimator of the counterfactual is $\hat{Y}_{1t}^{N} = \sum_{j=2}^{J+1} w_j Y_{jt}$ and the estimated treatment effect after the treatment period T_0 is $\hat{a}_{1t} = Y_{1t} - \hat{Y}_{1t}^{N}$ (such that $\hat{a}_{1t}$ is an unbiased estimator of a_{1t}, if $\sum_{j=2}^{J+1} w_j Z_j = Z_1$ and $\sum_{j=2}^{J+1} w_j Y_{jt} = Y_{1t}$ for t = 1, …, T_0 and the

[201] The notations are adopted from these two sources:
Abadie et al., 2010.
Kreif et al., 2015.

[202] According to Abadie et al. (2010), synthetic controls "can provide useful estimates in more general contexts than the factor model…" (p.495).

outcome is a linear function of potential observed and unobserved confounders). To measure the discrepancy between the treated and synthetic control units, the distance metric is employed such that W* is chosen to minimize:

$$\arg\min_{W} \sqrt{(X_1 - X_0 W)' V (X_1 - X_0 W)}$$

Where

W – Jx1 vector of weights for choosing a synthetic control

X_1 – kx1 vector with k covariates and pre-treatment outcomes for the treated state

X_0 – kxJ matrix of the control units (states)

V – kxk matrix with assigned weights according to the relative importance of the covariates and pre-intervention outcomes (if used)

Optimally, V "assigns weights to linear combinations of the variables X_0 and X_1 to minimize the mean square error of the synthetic control estimator"[203]. Note that the synthetic weight, W, is a weight assigned to a state by the SCM such that it minimizes the distance between the treated and synthetic control trajectories. Another important assumption for applying the SCM is that the sample used should be balanced panel[204].

NP SOP and SCM

Since there were 6[205] states (Colorado, Hawaii, Maryland, North Dakota, Rhode Island, and Vermont) changing their NP SOP regulations in the observation study period of 2008-2013, the SCM is applied to each state and analyzed separately.

The donor pool included states that had restricted NP SOP. Specifically, the synthetic cohort excluded states that already had liberal NP SOP prior to the intervention and states that adopted liberal NP SOP either at the same year or later were not included as well. The predictor variables were chosen by identifying variables that have an impact on outcome of interest, employment of NPs, from the regressions run earlier as well as choosing variables that could best describe the characteristics of a state at a macroeconomic level (such as population, health expenditures per capita, income per capita, etc.).

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[203] Abadie et al., 2010.

[204] Abadie, Alberto, Alexis Diamond, and Jens Hainmueller, "Comparative politics and the synthetic control method," *American Journal of Political Science,* Vol. 59, No. 2, 2015, pp. 495-510.

[205] *Nevada* changed its NP SOP in July 2013 and it is not analyzed in the SCM as there is no at least one full period after the treatment occurred. Note that in this study, one period is measured as one year.

Since the SCM is applied to each state separately (single treated unit versus multiple treated units[206]), even for the states that had their NP SOP enacted in the same year, the best fitting model was chosen based on the pre-treatment fit of treated and synthetic control units, determined by the outcome trajectory followed by the treated and synthetic units. The preference was given to fits that closely followed the trend or matched the trends before the treatment, i.e., synthetic controls and treated unit overlay each other's trajectories before the NP SOP changed[207], with weights assigned to at least two or more states, such that comparisons with one state only models were excluded.

Results

The SCM was applied to the six out of seven states listed in Table 4.3, which represents the years in which each state enacted liberal NP SOP (or so-called full practice authority).

To examine if there are any spikes after the passage of liberal NP SOP, growth rate of NPs is analyzed in the graphs in Figure 4.6. As shown, each state had a different trajectory – either upward or downward – during this six-year period. However, it is seen that Hawaii, Rhode Island, and Maryland had spikes in the years when NP SOP was implemented and went into effect. Other states had relatively downward sloping trend in their NP growth rates over the six-year period.

For comparison reasons, it is important to examine NP growth rates and trends in the ratio of number of NPs to population ratio per 100,000 persons in states with liberal and restricted NP SOP and identify if there is any common trend that states experienced during 2008-2013, shown in Figures 4.7 and 4.8.

[206] One study develops the Generalized Synthetic Control Method where it uses approach of estimating the impact of an intervention for multiple units by combining the interactive fixed effects model and synthetic control method. The GSCM uses average treatment effect and it may seem improper to utilize it for estimating the impact of changing NP SOP, given the assumptions and requirements that the GSCM requires a large number of pre- and post-treatment number of observations for the treated units under consideration (for more details see Xu, Yiqing, "Generalized synthetic control method for causal inference with time-series cross-sectional data," *Massachusetts Institute of Technology Political Science Department Working Paper*, No. 2015-1, 2015.)

[207] Based on the approach from Abadie et al. (2015): "Once it has been established that the unit representing the case of interest and the synthetic control unit have similar behavior over extended periods of time prior to the intervention, a discrepancy in the outcome variable following the intervention is interpreted as produced by the intervention itself" (p. 498).

Table 4.3.
States Granting Liberal NP SOP (2008-2013)

State	Year implemented	Independent practice	Independent prescription	Liberal NP SOP
Colorado	2009	Yes	No	0
Colorado	2010	Yes	Yes	1
Hawaii	2011	Yes	No	0
Hawaii	2012	Yes	Yes	1
Maryland	2010	No	No	0
Maryland	2011	Yes	Yes	1
Nevada	2012	No	No	0
Nevada	2013[208]	Yes	Yes	1
North Dakota	2011	Yes	No	0
North Dakota	2012	Yes	Yes	1
Rhode Island	2008	Yes	No	0
Rhode Island	2009	Yes	Yes	1
Vermont	2010	No	No	0
Vermont	2011	Yes	Yes	1

[208] The bill went into effect on July 1, 2013 and was coded as "Liberal NP SOP". However, the SCM for Nevada was not conducted as 6 months data to analyze the impact of NP SOP deemed to be insufficient to perform the analysis.

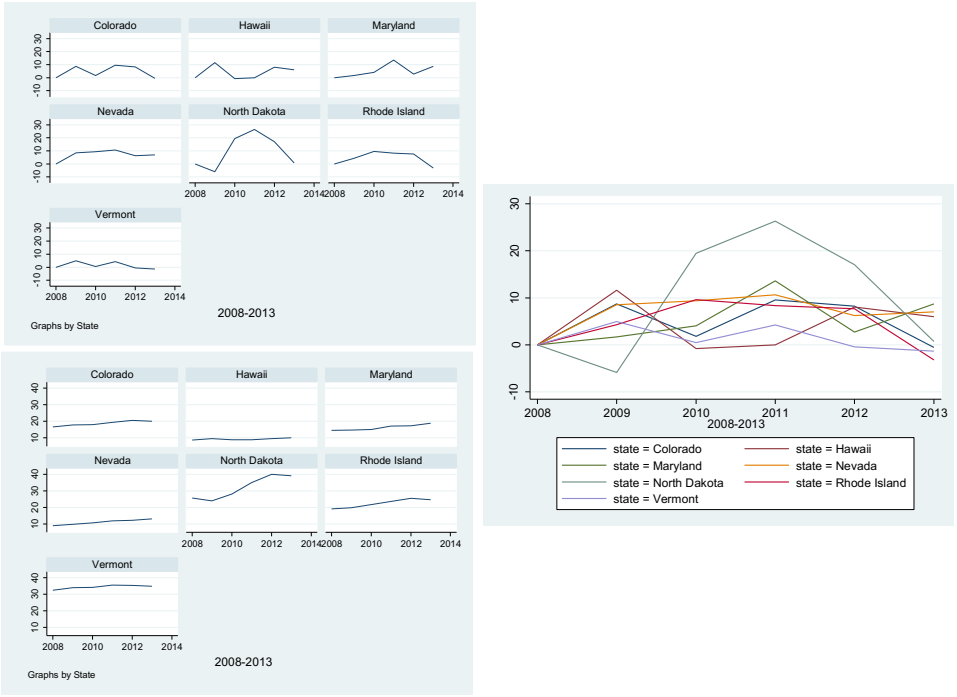
The trends — either downward, upward, or having almost constant slope — varied from one state to another, indicating that there is no common trend for these states. However, many states with restricted NP SOP had an upward sloping trend, which could be explained by the relative increase of NP counts that has been taken place in the whole country. Therefore, it is important to differentiate between the impact of NP SOP and existent upward trend in the growth rate of NPs. The SCM may be suitable in this case to trace the effect of NP SOP, while taking into account increasing growth rate of NPs.

As mentioned previously, for each of the six states that changed their NP SOP, the SCM was applied. Only one state was chosen to be presented in this section, as the other five states did not seem to be a good fit for using the SCM to examine the impact of NP SOP on NP employment, as they did not meet the needed criteria.

North Dakota is not analyzed, as it does not perform well under the SCM, since the control unit is only a single unit – Delaware – and the predictor balance does not closely track the pre-treatment trajectory.

Vermont is not analyzed as well, since the predictor balance does not closely match the treated unit and the fit does not track pre-treatment period in a way to make any inferences about the applicability of the SCM.

Figure 4.6.
Growth Rate of NPs in Percentages and Trends for NPs to Population Ratio per 100,000 Persons for States that Changed Their NP SOP



Similarly, the SCM is not performed for *Colorado, Hawaii,* or *Rhode Island*, as the predictor balance is not sufficiently close, and therefore, the fit does not track the trajectory for pre-treatment period of synthetic control units to the treated unit. It is important to note that these states did not perform well under the SCM, and therefore, were eliminated from the SCM analysis due to such aspects as the number of pre-treatment versus post-treatment observations and unique cases attributable to specifics of a state under consideration, when finding proper weights for synthetic controls becomes not feasible[209]. The applicability of the SCM requires "a sizable number of

Figure 4.7.
Growth Rate of NPs in Percentages and NPs to Population Ratio per 100,000 Persons in States with Liberal NP SOP

preintervention periods" and "a sizable number of postintervention periods may also be required in cases when the effect of the intervention emerges gradually after the intervention or changes over time"[210].

[209] The contextual requirements under which the SCM is appropriate to use include such conditions as availability of pertinent control group, no anticipation, no interference, convex hull condition, proper time horizon, and sufficient size of the effect and low volatility of the outcome. For more details see Abadie, Alberto, "Using Synthetic Controls to Evaluate an International Strategic Positioning Program in Uruguay: Feasibility, Data Requirements, and Methodological Aspects," Draft, 2011.)

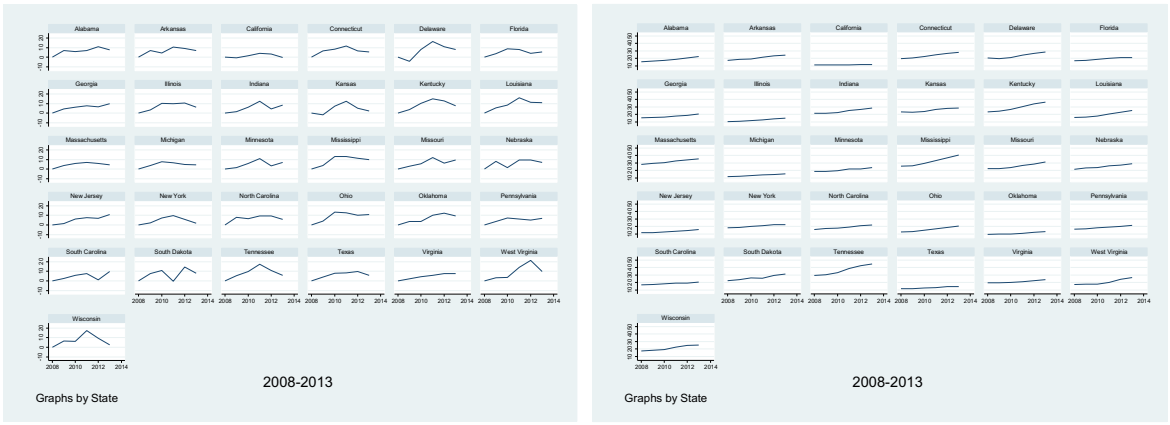
[210] Abadie, Alberto, Alexis Diamond, and Jens Hainmueller, "Comparative politics and the synthetic control method," *American Journal of Political Science,* Vol. 59, No. 2, 2015, pp. 495-510.

The synthetic control method: the effect of NP SOP in Maryland

In 2010 Maryland changed its NP SOP from restricted to liberal NP SOP and enacted it in 2011[211]. Before running the SCM, it is necessary to examine the trends for Maryland in Figure 4.9 and compare them to the cohort of states with restricted NP SOP.

There is a spike in 2011, when Maryland adopted liberal NP SOP. Although the states with restricted NP SOP also had an upward trend in the number and growth rate of NPs, it is clear that there is a sharper increase in these metrics for Maryland in 2011, which could possibly be attributable to the enactment of full practice authority granted for NPs.

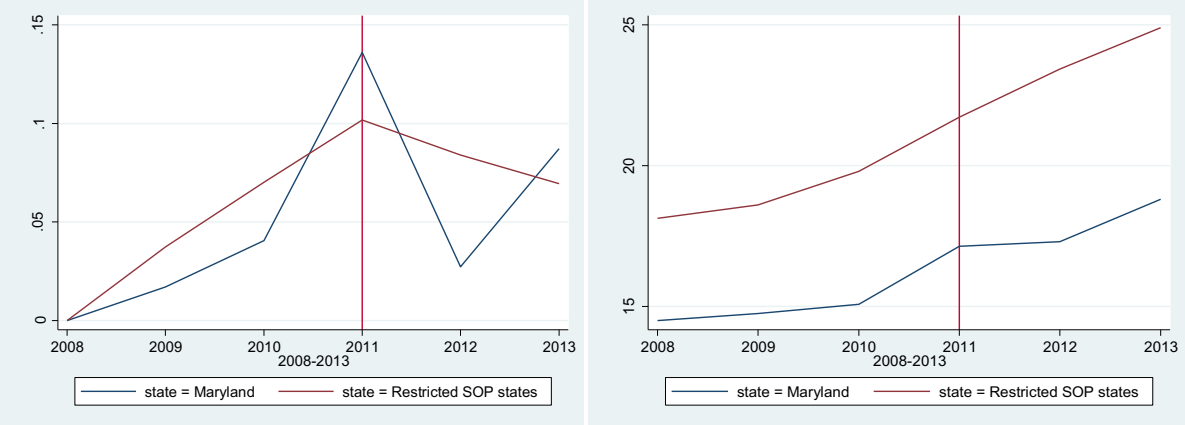
Figure 4.8.
Growth Rate of NPs in Percentages and NPs to Population Ratio per 100,000 Persons in States with Restricted NP SOP



[211] Note that the coding of year when the policy went into effect might differ from the year when the full practice authority regulation passed. One of the reasons is that Linda Pearson's Report is based on the initial months of the year for the year it codes the regulations. Therefore, if the bill passed later in the year, it is most likely that the state will be coded as liberal only the next year after its passage. This coding difference does not cause any discrepancy as the time period is year and for the full effect to be seen, one might safely code regulations according to the Linda Pearson's Report timeline.

The case of Maryland was chosen as it had the appropriate fit and met the criteria for the SCM to be used. The pre-treatment period included 3 years and post-treatment period – 3 years too. The donor pool for analyzing the counterfactual for the treated state consisted of states that have restricted NP SOP in place and the other 6 states that switched to liberal NP SOP were excluded from the donor pool to avoid a spillover effect. Two specifications are run – one that includes pre-intervention outcome of interest for one period earlier than the treatment period (Number of NPs in 2010) and the other specification is without it[212]. Also, *nested* specification with *allopt* option is chosen to get the robust fit. The nested specification in the SCM method utilizes a data-driven regression method to identify the variable weights in V-matrix and best fitting W-weights conditional on the regression based V-matrix, by using a constrained quadratic programming. The *allopt* option that is used in conjunction with nested specification when conducting the SCM in STATA, allows for fully robust results as it runs the nested optimization 3 times using three various starting points[213].

Figure 4.9.
NP Growth Rate and NPs to Population Ratio in MD, 2008-2013



As mentioned earlier, the synthetic Maryland is constructed as the convex combination of states in the control units (or donor pool) that have similar predictor values prior to Maryland's passage of liberal NP SOP. From Figure 4.9, it could also be concluded that average number of NPs in the restricted NP SOP states were higher than in Maryland. However, it should be noted that these values include all of the 31 control states that may have zero weight when the SCM is conducted.

[212] This specification was based on the findings of a study that found that using the entire pre-treatment path of the outcome variable as separate predictors yields irrelevance of all other covariates. For more details see Kaul, Ashok, Stefan Klößner, Gregor Pfeifer, and Manuel Schieler, "Synthetic control methods: Never use all pre-intervention outcomes as economic predictors," *Unpublished.* As of June 5, 2016.

[213] For further details on "nested" and "allopt", access STATA and use the "help synth" command.

Table 4.4 demonstrates the values and their proximity to a treated unit (Maryland) and synthetic controls (donor pool with assigned weights, W – weights assigned to the states from the donor pool and V – weights assigned to predictor variables and are chosen to minimize the mean squared prediction error of Number of NPs before the treatment period[214], before 2011) as well as average of 31 control states that were included in the study.

Table 4.5 shows the weights of each control state in the synthetic Maryland, and these weights represent trends in Number of NPs) in Maryland before it enacted liberal NP SOP in 2011. As could be observed from the table below, Maryland is represented by positive weights assigned to California, Connecticut, Delaware, and Oklahoma. All other states in the donor pool are assigned zero W-weights and states with liberal NP SOP (L and *), as mentioned prior, are excluded from the donor pool.

Table 4.4.
Number of NPs Predictor Means

	Maryland		Average of 31
Variables	Real	Synthetic	control states
Population	5733333	5863082	8351590
Number of NP schools	6	6.005667	9.655914
Number of practices in a state	999.6667	994.879	1514.591
Wage of NPs (90th percentile of RN's wage)	104463.3	90883.53	84534.41
Health Expenditures per capita (2008-2009)	7348.5	7863.462	6856.242
Income per capita	49243	45210.25	39151.91
Number of NPs a year prior to intervention (2010)	875	877.118	1462.29

[214] Mean square prediction errors (MSPE) are minimized for periods 2008 – 2010 and root mean squared prediction error (RMSPE) is 1.148412.

Table 4.5.
State Weights in the Synthetic Maryland

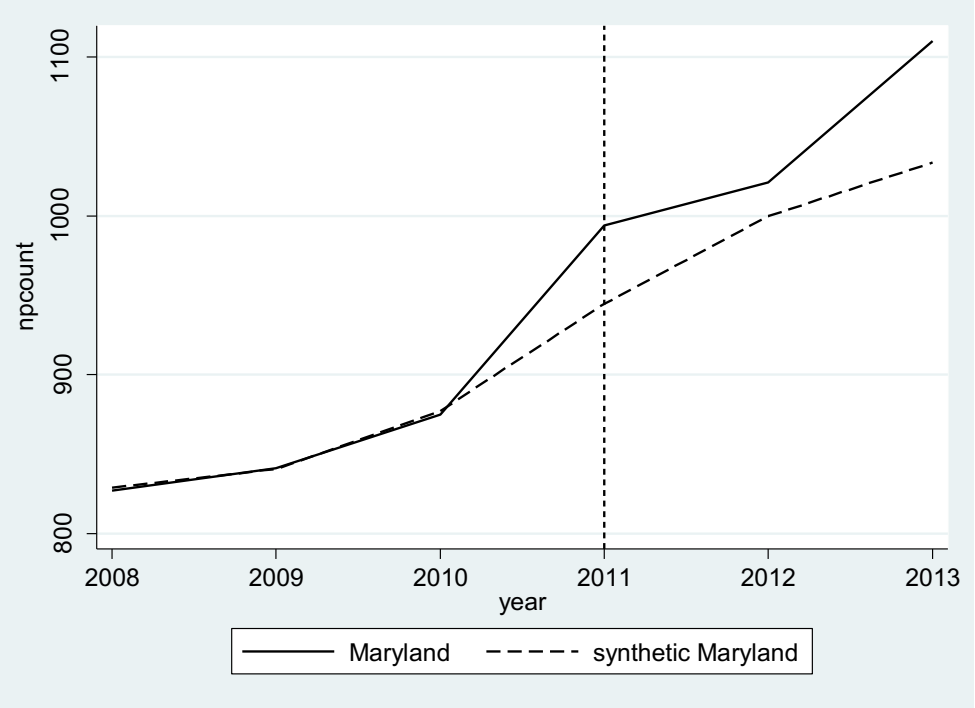
State	Weight	State	Weight
Alabama	0	Montana	L
Alaska	L	Nebraska	0
Arizona	L	Nevada	*
Arkansas	0	New Hampshire	L
California	0.097	New Jersey	0
Colorado	*	New Mexico	L
Connecticut	0.242	New York	0
Delaware	0.433	North Carolina	0
District of Columbia	L	North Dakota	*
Florida	0	Ohio	0
Georgia	0	Oklahoma	0.166
Hawaii	*	Oregon	L
Idaho	L	Pennsylvania	0
Illinois	0	Rhode Island	*
Indiana	0	South Carolina	0
Iowa	L	South Dakota	0
Kansas	0	Tennessee	0
Kentucky	0	Texas	0
Louisiana	0	Utah	L
Maine	L	Vermont	*
Massachusetts	0.062	Virginia	0
Michigan	0	Washington	L
Minnesota	0	West Virginia	0
Mississippi	0	Wisconsin	0
Missouri	0	Wyoming	L

Note: L - liberal NP SOP prior to the intervention and earlier than 2008; * - states that changed their NP SOP during 2008-2013 period, either before or after Maryland changed its NP SOP.

Figure 4.10 depicts the number of NPs in Maryland and its synthetic cohort during 2008-2013. As displayed in Figure 4.10, the synthetic Maryland quite closely traces the trajectory of number of NPs in Maryland for the pre-intervention period of 2008-2010, suggesting that the synthetic cohort constructed under the SCM is a "sensible approximation"[215] to the number of NPs that would have been available in Maryland if it had not passed liberal NP SOP.

[215] Abadie et al., 2010, p. 500.

Figure 4.10.
NP SOP Change and Synthetic Maryland with One-Period Lagged Outcome



The difference between the synthetic Maryland and Maryland after it acquired full practice authority could be viewed as the estimated effect of switching to liberal NP SOP. Further, it is seen that the effect increases in the last period of observation, 2013, which may not be surprising, as Maryland when passing the bill in 2010 had an agreement to modify it and grant further autonomy to NPs in 2015, which would remove the requirement from an NP to sign an attestation, a document containing the name and license number of a Maryland physician and also allow NPs to open their own practice[216].

For comparison reasons and to assess the robustness of the above results, the lagged outcome variable is removed as a predictor variable, and a secondary SCM is run. As could be seen from the below results, the weights changed slightly[217] as well as Maryland and the synthetic Maryland closely track the trajectory of the number of NPs.

[216] Maryland adopted a modified NP SOP in 2015 successfully: "Governor Hogan signed the bill (HB 999/SB 723) into law on May 12th, making Maryland the 21st full-practice authority state, and the seventh state to right-size regulations affecting nurse practitioner patients in the last four years. The move closely follows actions undertaken in Nebraska, which similarly eased nurse practitioner restrictions in March." For further details see "AANP Applauds Maryland for Right-Sizing Nurse Practitioner Regulations," 2015. As of June 8, 2016.

[217] However, RMSPE slightly increased and with the new model is 1.454702.

Table 4.6.
Number of NPs Predictor Means

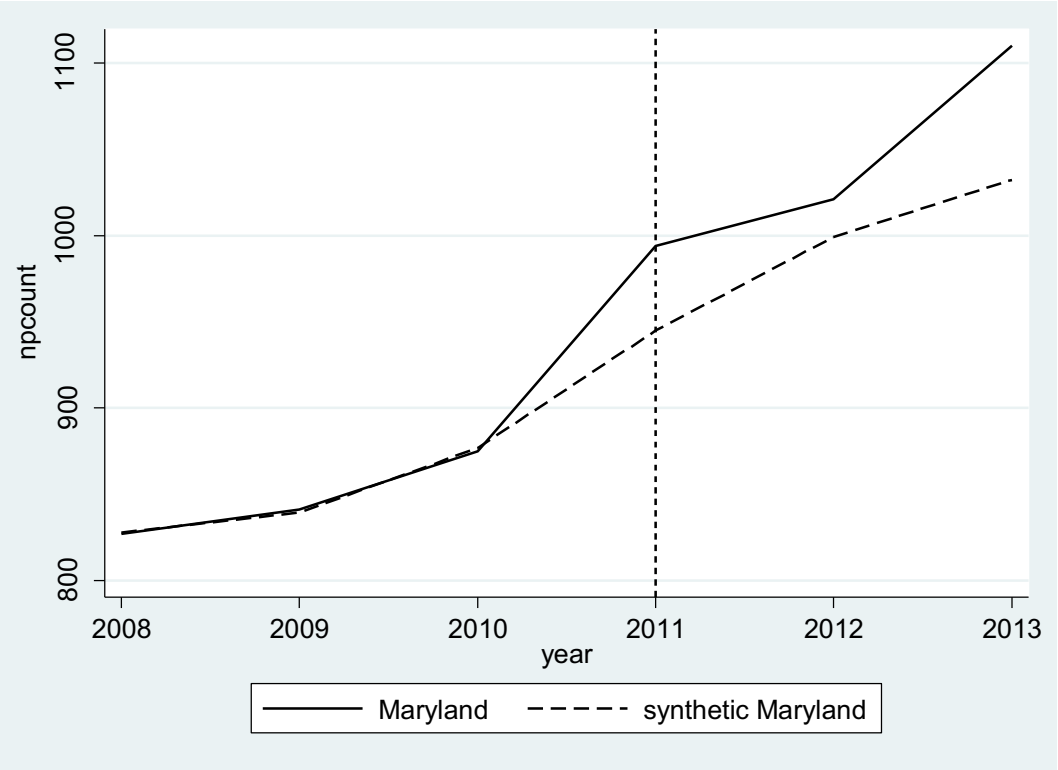
Variables	Maryland		Average of 31 control states
	Real	Synthetic	
Population	5733333	5725062	8351590
Number of NP schools	6	6.093667	9.655914
Number of practices in a state	999.6667	979.446	1514.591
Wage of NPs (90th percentile of RN's wage)	104463.3	92022.07	84534.41
Health Expenditures per capita (2008-2009)	7348.5	7973.405	6856.242
Income per capita	49243	45767.28	39151.91

Table 4.7.
State Weights in the Synthetic Maryland

State	Weight	State	Weight
Alabama	0	Montana	L
Alaska	L	Nebraska	0
Arizona	L	Nevada	*
Arkansas	0	New Hampshire	L
California	0.096	New Jersey	0
Colorado	*	New Mexico	L
Connecticut	0.256	New York	0
Delaware	0.472	North Carolina	0
District of Columbia	L	North Dakota	*
Florida	0	Ohio	0
Georgia	0	Oklahoma	0.111
Hawaii	*	Oregon	L
Idaho	L	Pennsylvania	0
Illinois	0	Rhode Island	*
Indiana	0	South Carolina	0
Iowa	L	South Dakota	0
Kansas	0	Tennessee	0
Kentucky	0	Texas	0
Louisiana	0	Utah	L
Maine	L	Vermont	*
Massachusetts	0.065	Virginia	0
Michigan	0	Washington	L
Minnesota	0	West Virginia	0
Mississippi	0	Wisconsin	0
Missouri	0	Wyoming	L

Note: L - liberal NP SOP prior to intervention; * - states that changed their NP SOP either before or after Maryland changed its NP SOP

Figure 4.11.
NP SOP Change and Synthetic Maryland



A comparison of the two models indicates that there is an impact of NP SOP on number of NPs in Maryland after it changed its NP SOP to liberal. The difference that could be examined between the synthetic Maryland and the treated unit indicates the estimate of the effect of Maryland's modification of its NP SOP to full practice authority.

Nurse practitioner count growth rate was also examined but did not yield good results, as the synthetic control and treated unit did not match the pre-treatment period trajectory. Therefore, the results of the SCM for the growth rate are not presented here. This SCM study did not involve the placebo studies – iterative application of the SCM to every other state in the donor pool – to assess the significance of the results above by examining the gaps in the outcome variable between Maryland and the donor states, as the major rationale for performing the SCM was to illustrate the impact of NP SOP on one of the states that passed the liberal NP SOP in the period of study (2008-2013). Another rationale behind running the SCM was to identify if the SCM could be applied in assessing the impact of NP SOP, since so far there was no study that has attempted to evaluate the impact of NP SOP on NP employment in Maryland (or any other state). It should be noted that there is no study (to my best knowledge) so far that used the SCM for analyzing the impact of NP SOP, including the case of Maryland that utilizes SK&A data.

Results

Descriptive statistics

This section covers descriptive statistics regarding NPs and other primary care providers using SK&A data. The pertinent tables and charts are provided in Appendix A3.

There is an increasing trend in the number of NPs and PAs employed in the practice each year (Table A3.2). The top 3 primary specialties for NPs were family practitioner, pediatrician, and internist (Figure A3.2), whereas the top 3 primary specialties for PAs were family practitioner, orthopedic surgeon, and internist (Figure A3.3). The percentage of practices employing at least one NP ranges from about 16.8% to 19.9% (Table A3.3), whereas the percentage of practices employing at least one PA is in the range of about 12.7% and 14.1% throughout 2008-2013 years (Table A3.4).

The top three (in terms of absolute numbers) site specialties of practices at which NPs were employed are family practice, multi-specialty, and obstetrics/gynecology (Table A3.6); while family practice, multi-specialty, and orthopedic surgery are the top three practice specialties that employ PAs across 2008-2013 (Table A3.6)[218]. However, in terms of percentages, practices that specialize in multispecialty, oncology/hematology, and obstetrics/gynecology employ NPs the most compared to other practice specialties. Practices that specialize in obstetrics/gynecology, multi-specialty, and general practice are the top three practice specialties that employ PAs in terms of percentages.

Figure 4.12[219] represents percentages of practices by NP and/or PA employment, practice specialty, and NP SOP. It shows that non-primary care practices employ more PAs when the state has liberal NP SOP. They also employ more NPs when the state has liberal NP SOP, though typically in addition to PAs. Primary care practices employ more PAs when the state has liberal NP SOP, but these practices also employ considerably more NPs, often only employing NPs but at times along with PAs. The added NP employment is greater when the state has liberal NP SOP.

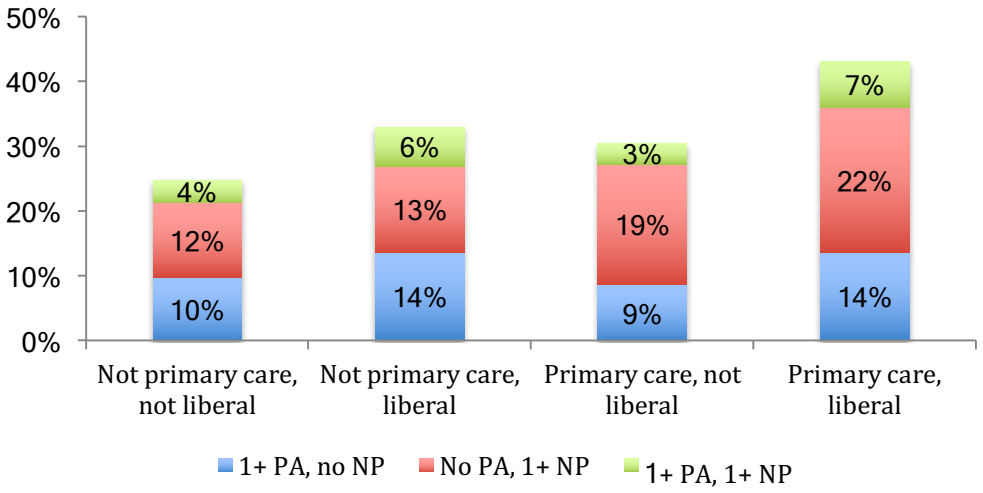
The proportion of practices that hire more NPs not only depends on NP SOP and practice's specialty, but also on practice's size – number of MDs employed (Table A3.7). When comparing practices of various size categories, there is a trend of employing NPs in higher proportion in

[218] Interestingly, a study identified a higher use of PAs or NPs in primary care practices, which was associated with "favorable PA scope-of-practice laws, but not with NP scope-of-practice laws". For further details see Hing, Esther, and Chun-Ju Hsiao, "In which states are physician assistants or nurse practitioners more likely to work in primary care?," *Journal of the American Academy of Physician Assistants,* Vol. 28, No. 9, 2015, pp. 46-53.E.

[219] Table A3.5 presents the same data, but in terms of number of practices by NP and/or PA employment, practice specialty, and NP SOP.

practices with liberal NP SOP than restricted NP SOP and within primary care specializing

Figure 4.12.
Percentages of Practices Employing NPs and PAs by NP SOP, and Practice Specialty, Aggregated Across 2008-2013



practices than non-primary care practices (except for 'very large' practices category).

Before presenting summary statistics and the results of state and practice level regressions, it is important to investigate how certain explanatory variables vary in 2008-2013. As mentioned previously, when state-level fixed effects are included, the variation in the explanatory variables is within-state variation. If there is little change in an explanatory variable in the window of observation, then the variable will have little effect on the dependent variable. Therefore, the next step is to explore how much explanatory variables change over six years of observation.

The graphs of the number of NP schools by regions in Figure 4.13[220] demonstrates that most states follow a constant trend, as the number of NP schools virtually stays the same except for a few cases that had either an increasing or decreasing trend. This is not surprising, as opening a new program (or school) is a process requiring time for accreditation, etc.

As for the concern of NP wages, which are estimated as a 90th percentile of RN's wage, it is observed that most of the states have an increasing trend in NP wages, as shown in Figure 4.14. These wages are in absolute values, and therefore, are not adjusted for inflation.

Figure 4.15 demonstrates that the number of practices available in a state by year reveals either increasing or constant trends. Among the variables analyzed, NP wages were more fluctuating over time compared to the other explanatory variables.

[220] States are categorized by regions – Northeast, Midwest, South, and West. The categorization is based on "Census Regions and Divisions of the United States," Prepared by the Geography Division: U.S. Department of Commerce Economics and Statistics Administration U.S. Census Bureau. As of May 5, 2017.

Figure 4.13.
Number of NP Schools by State and Year

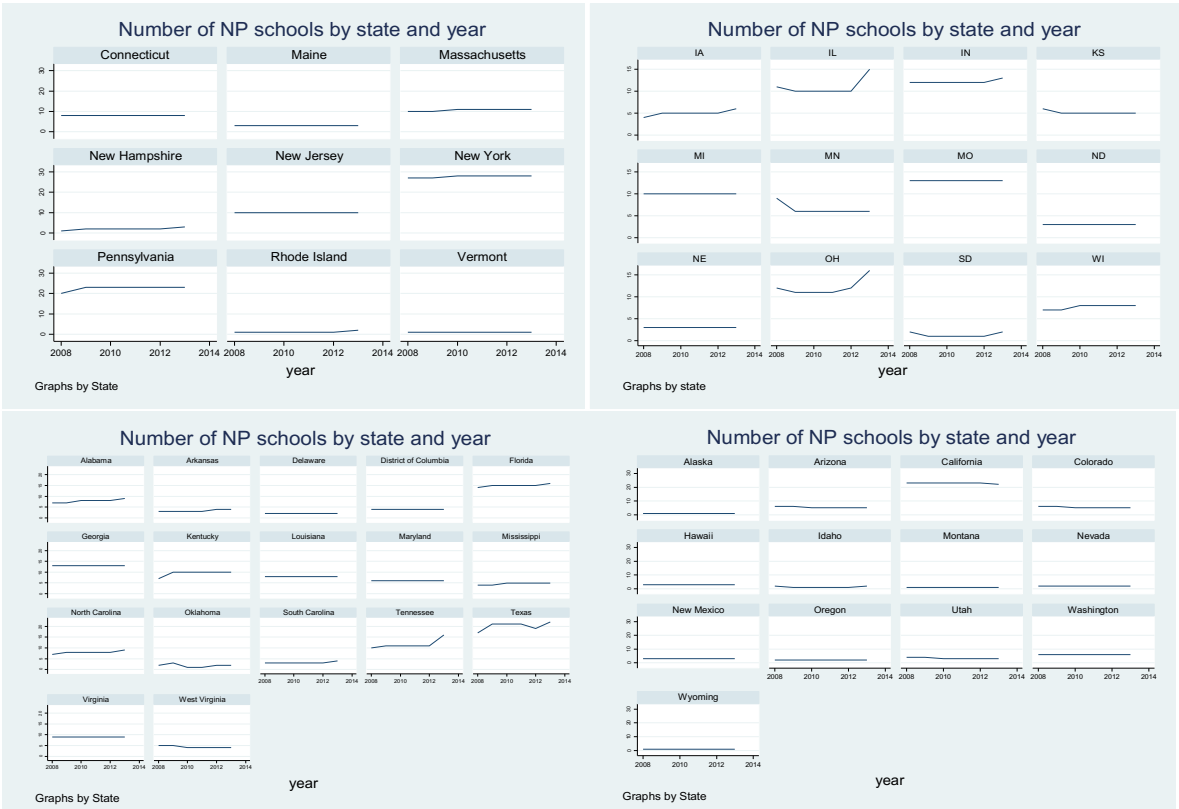


Figure 4.14.
NP Wage by State and Year

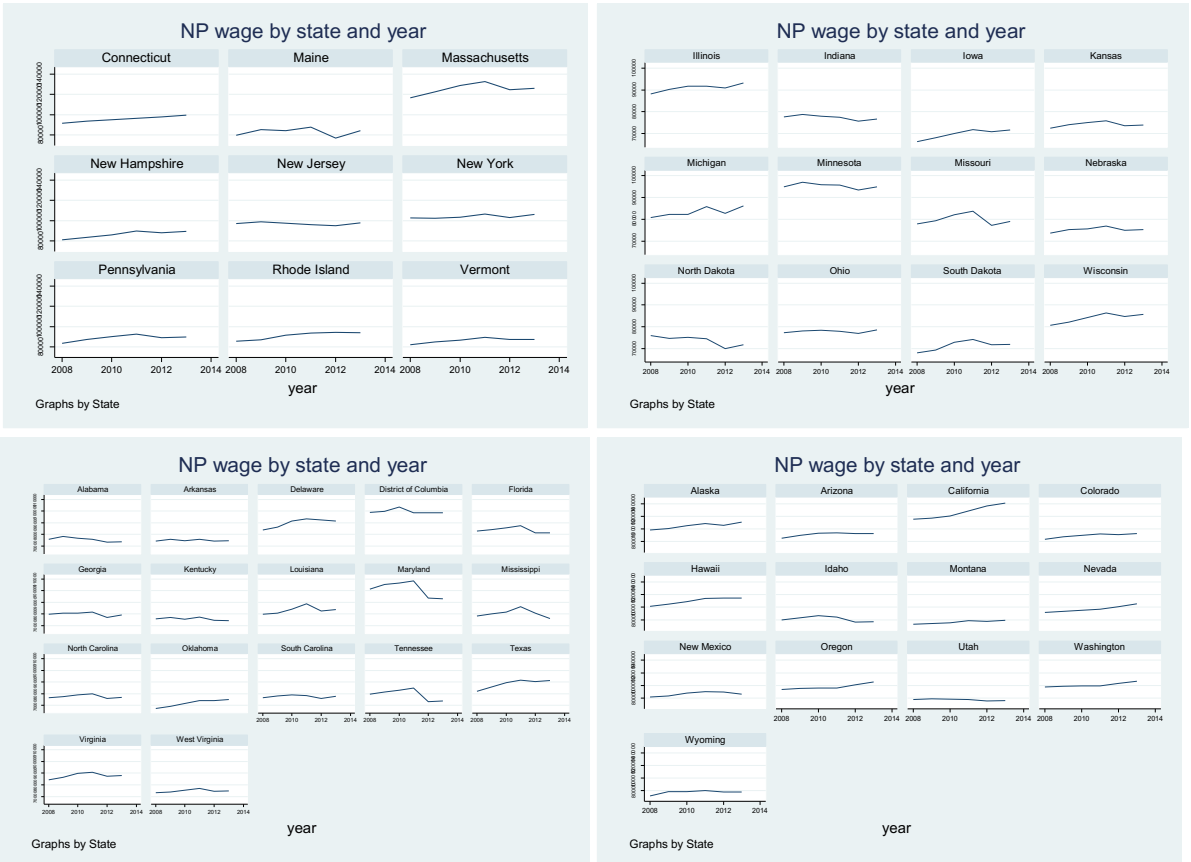
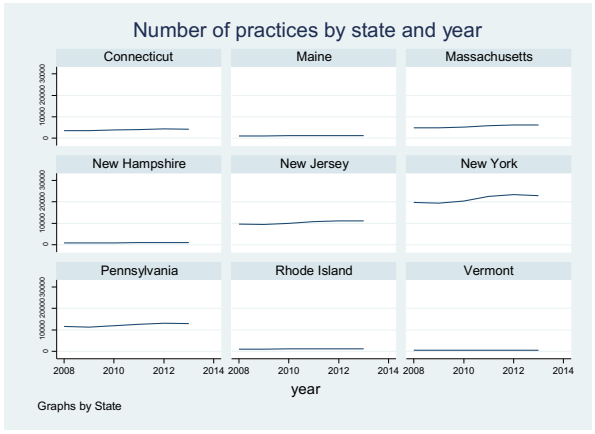
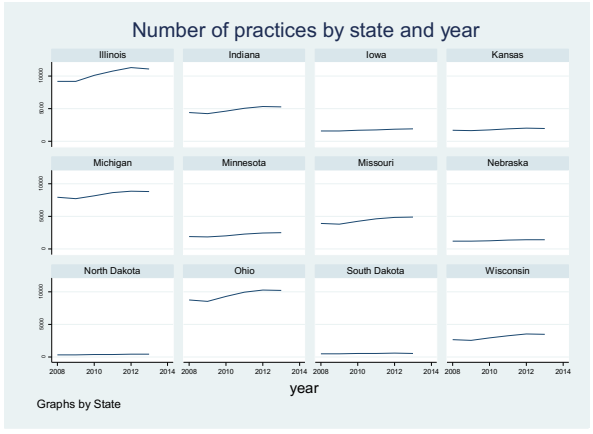
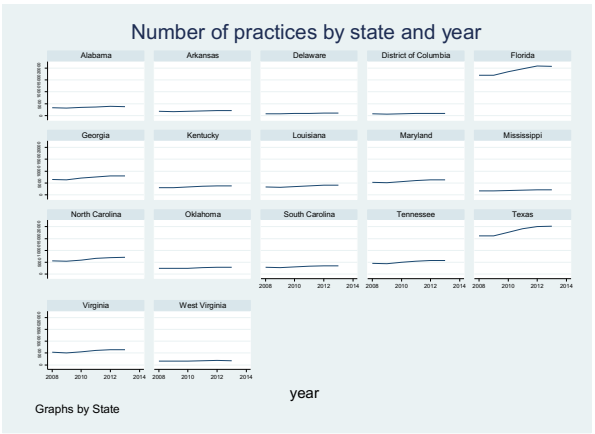
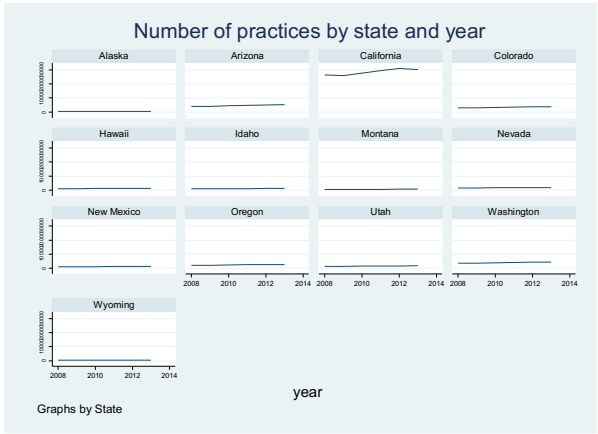


Figure 4.15.
Number of Practices by State and Year









Regressions

In this section, state and practice level analyses are conducted. In particular, summary statistics and GLS with random and fixed effects are run and compared. Table 4.8 describes each variable used in regressions.

Table 4.8.
Description of the Variables in the Regressions

Name	Description
npcount	Total number of NPs by year and state
lnpcount	Logarithm of total number of NPs by year and state
totnp	Total number of NPs employed at the practice (by year, state, practice)
totpa	Total number of PAs employed at the practice (by year, state, practice)
liberal	Dummy variable for NP SOP (liberal = 1, restricted = 0)
np_indicator	Dummy variable for a practice to employ (or not) an NP (1 or more NP = 1, 0 = otherwise)
pa_indicator	Dummy variable for a practice to employ (or not) a PA (1 or more PA = 1, 0 = otherwise)
size	Total number of physicians (MDs) employed at the practice (by year, state, practice)
nsize	Categorical variable to designate a practice type by size: (1) *Solo* – 1 MD practicing in a practice, (2) *Small* – 2-4 MDs practicing in a practice, (3) *Medium* – 5-9 MDs practicing in a practice, (4) *Large* – 10-20 MDs practicing in a practice, (5) *Very large* – 21 and more MDs practicing in a practice.
primcare	Dummy variable to designate a practice either as specializing in primary care or not (if yes = 1, 0 = otherwise)
nonprimcare	Dummy variable to designate a practice either specializing in nonprimary care or not (if yes = 1, 0 = otherwise); nonprimcare = 1 - primcare
liberal#c.size	Interaction term between liberal NP SOP and size (number of MDs employed at the practice; continuous variable)
liberal#nonprimcare#c.size	Interaction term among liberal NP SOP, nonprimcare and size (number of MDs employed at the practice; continuous variable)
nonprimcare#c.size	Interaction term between nonprimcare and size (number of MDs employed at the practice; continuous variable)
school	Number of NP schools by year and state
lschool	Logarithm of number of NP schools by year and state
totpracticest	Total number of practices by year and state
ltotpracticest	Logarithm of total number of practices by year and state
a_npwage	Annual NP wage – 90^{th} percentile or RN's wages by year and state
la90np	Logarithm of annual NP wage – 90^{th} percentile of RN's wages by year and state
h_npwage	Hourly NP wage – 90^{th} percentile of RN's wages by year and state
a_pawagemean	Annual mean PA wages by year and state
lapawagemean	Logarithm of annual mean of PA wages by year and state
h_pawagemean	Hourly mean PA wages by year and state

State level analysis

Table 4.9 presents summary statistics of variables used in the GLS models at the state level. The panel data is balanced and includes all of the 306 observations for each variable utilized, as there are 6 periods for 50 states and D.C.

Before running regressions, I check the relationship between the dependent and independent variables to identify if there is a linear or non-linear relationship. The plots are examined to determine the relationship between Y and X_i.

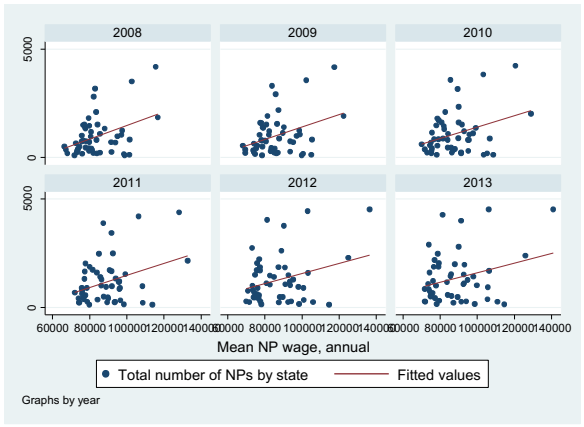
The plot of wages and NP counts in Figure 4.16 exhibits a non-linear relationship, and therefore, logarithmic form could be a better fit. Similarly, the plot of PA wages and NP counts in Figure 4.17 exhibits a non-linear relationship and a logarithmic transformation might be a better fit.

The plot of *school* and NP counts in Figure 4.18 exhibits a somewhat linear relationship. Therefore there is no clear need to transform the number of NP schools variable to logarithmic form. However, the decision on whether to use log or linear form for the *school* variable might be based on the overall regression results that would indicate which model (with log transformation or linear form for *school*) is preferred.

Table 4.9.
GLS Model Summary Statistics: State Level

Variable	Obs	Mean	Std. Dev.	Min	Max
Number of NPs	306	1134.546	1017.563	95	4529
Number of practices	306	4858.673	5827.727	290	30964
Number of NP schools	306	7.150327	6.134312	1	28
NP wage, annual	306	86840.36	12918.89	66340	141030
Mean PA wage, annual	306	86478.27	10380.34	48190	112250
Liberal NP SOP	306	0.320261	0.467341	0	1

Figure 4.16.
Plot of NP Counts and NP Wages



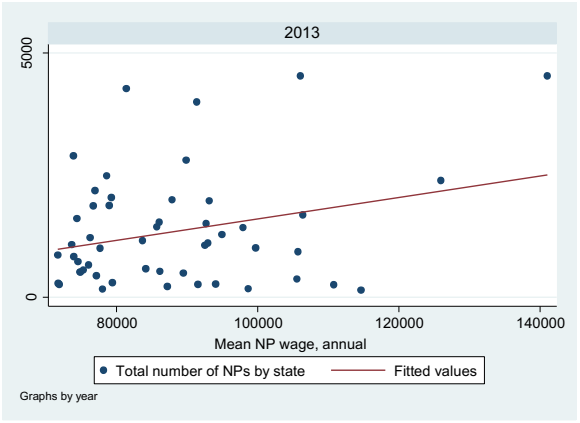
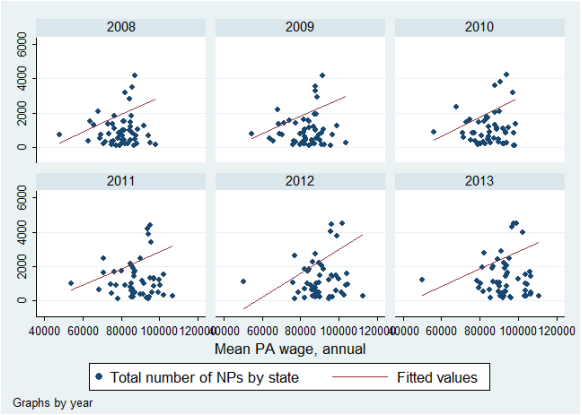


Figure 4.17.
Plot of NP Counts and PA Wages



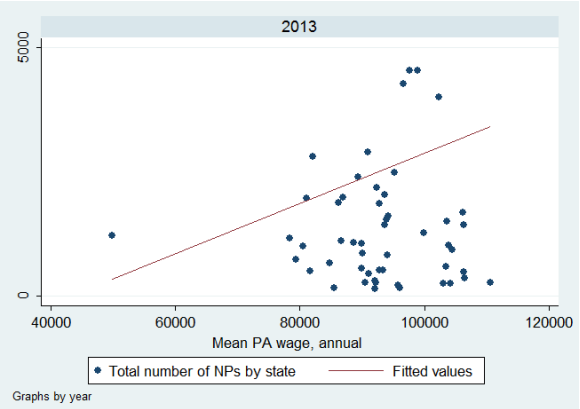
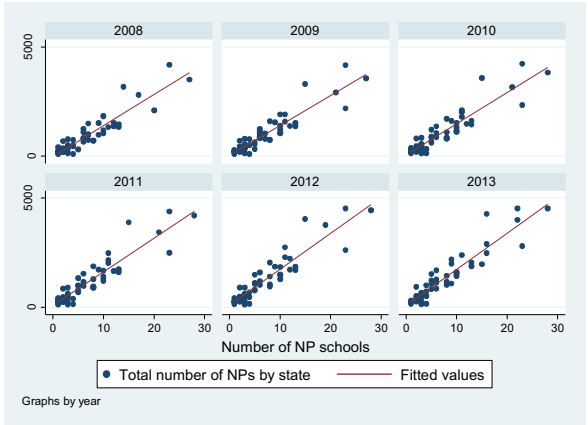
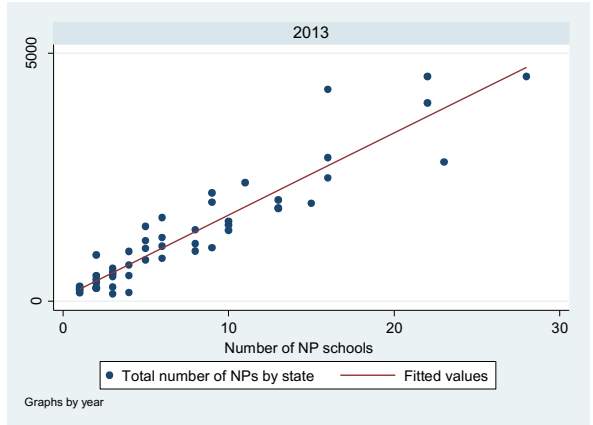


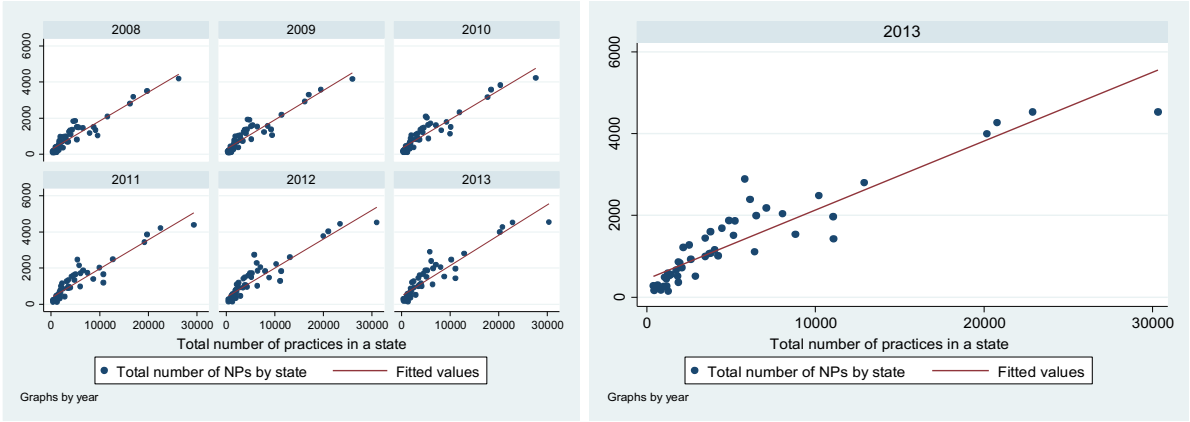
Figure 4.18.
Plot of NP Counts and NP Schools





The plot of total number of practices in the state and NP counts in Figure 4.19 exhibits a somewhat linear relationship. Similarly, there is no clear need to transform the number of total practices variable to logarithmic form. However, the decision on whether to use log or linear form for *totpracticest* variable might be based on the overall regression results that would indicate which model is preferred.

Figure 4.19.
Plot of NP Counts and Total Number of Practices in a State



After running several specifications, log-log transformation is identified as a better performing model when compared to other specifications. The next step is to run GLS with log-log transformation for all of the variables in the model.

Initially, I run GLS with robust standard errors[221] with fixed and random effects and not including control variables to examine the impact of liberal NP SOP. Table 4.10 shows the results of this model.

As can be seen from the regression results for Model 1.1 and Model 1.2 in Table 4.10, the coefficient on *liberal* is statistically significant at the 1% significance level (p-value = 0.001, or 0.1% significance level) and positive in sign in both specifications. The results of this regression suggest that if a state has liberal NP SOP, one may expect either about 20% (with fixed effects specification) or 16% (with random effects specification) increase in the number of NPs employed

[221] I run clustered robust standard errors, as the number of clusters (51) is sufficient to consider as large sample. If following Wooldridge, then when using robust standard errors, the t-statistics obtained would have distributions which are similar to the exact t-distributions if the sample size is *large*. It is shown that "50 clusters (with roughly equal cluster sizes) is often close enough to infinity for accurate inference, and further that, even in the absence of clustering, there is little to no cost of using the CRSE estimator, as long as the number of clusters is large. With a small number of clusters *(M << 50),* or very unbalanced cluster sizes, the cure can be worse than the disease, i.e. inference using the cluster-robust estimator may be incorrect" (for further details see Nichols, Austin, "Clustered Errors in Stata," edited by Schaffer, Mark. STATA, September 10, 2007. page 7; Jeffrey, M Wooldridge, "Introductory Econometrics: A modern approach," *Canada: South-Western Cengage Learning*, 2009. page 268. Also, for further details see Kezdi, Gabor, "Robust Standard Error Estimation in Fixed-Effects Panel Models," *Hungarian Statistical Review,* Vol. Special, No. 9, 2004, pp. 96-116.).

in a state, which supports the hypothesis of a positive relationship between NP counts and NP SOP regulations.

After running several other specifications, 3 pairs of models are chosen and presented in Table 4.10. Models 1.3-1.8 are run using linear GLS with fixed and random effects and robust standard errors specifications.

In all the models the sign on *liberal* coefficient is positive, suggesting a positive relationship between liberal NP SOP and number of NPs employed in a state, all else holding constant. Across these 6 models, the coefficient on *liberal* ranges from about 0.02 to 0.18, depending on the specification. In Model 1.6, the coefficient on *liberal* is 0.07 and statistically significant at the 5% significance level, indicating that states with liberal NP SOP have about 7% more NPs practicing, *ceteris paribus*. It should be noted that comparing random and fixed effects specification, random effects specification yields the results aligned with the hypothesis in regards to a positive effect of liberal NP SOP on the number of NPs practicing in the state.

The coefficient on *lschool*, logarithm of NP schools in the state, is positive and statistically significant at least at the 5% significance level in almost all models except Models 1.6-1.8. Aligned with the hypothesis, the results indicate that there is a positive relationship between number of NP schools and number of NPs practicing in the state. The coefficient on *lschool* ranges from about

Table 4.10.
Model 1: GLS with Robust Standard Errors and Logarithmically Transformed Variables

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
VARIABLES	Model 1.1	Model 1.2	Model 1.3	Model 1.4	Model 1.5	Model 1.6	Model 1.7	Model 1.8
1.liberal	0.197***	0.155***	0.177***	0.122*	0.0230	0.0696**	0.0185	0.0421*
	(0.0441)	(0.0465)	(0.0634)	(0.0665)	(0.0295)	(0.0309)	(0.0263)	(0.0240)
lschool			0.194**	0.533***	0.0670**	0.00940	0.0570*	0.0177
			(0.0725)	(0.0976)	(0.0299)	(0.0297)	(0.0299)	(0.0300)
la90np			0.951***	0.896***	-0.0133	0.0193	-0.124	-0.234
			(0.343)	(0.326)	(0.139)	(0.168)	(0.146)	(0.161)
ltotpracticest					1.424***	1.140***	1.312***	1.022***
					(0.0601)	(0.0507)	(0.0849)	(0.0684)
lapawagemean							0.243**	0.500***
							(0.0930)	(0.0991)
Constant	6.568***	6.582***	-4.537	-4.436	-4.608***	-2.655	-5.216***	-4.535***
	(0.0141)	(0.140)	(3.863)	(3.635)	(1.586)	(1.859)	(1.552)	(1.741)
Effects	Fixed	Random	Fixed	Random	Fixed	Random	Fixed	Random
Observations	306	306	306	306	306	306	306	306
R-squared (overall)	0.1944	0.1944	0.3909	0.7087	0.8641	0.8640	0.8640	0.8602
Number of fips (states)	51	51	51	51	51	51	51	51

Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1

0.009 to 0.53 depending on the specification across Model 1.3 – 1.8. For instance, in Model 1.5, the coefficient on *lschool* suggests that 1% increase in availability of NP schools results in about 7% increase in the number of NPs practicing in the state, all else holding constant.

Depending on the model specification, the sign on *la90np* varies either to be positive or negative, and in models where it is negative it is not statistically significant at the 10% significance level. In Models 1.3 to 1.8, the coefficient ranges from about -0.23 to 0.95, holding all else constant. Recalling that reduced supply and demand model is used, the results are not surprising that the effect of NP wage may vary depending on the model.

Both *ltotpracticest* and *lapawagemean* are positive in sign and statistically significant at least at the 5% significance level in the pertinent models. The results are aligned with the hypothesis that the larger the number of practices in the state, the more NPs would be practicing, and similarly, the higher the PA wage, the more NPs would be practicing (employed), all else holding constant.

Focusing on the results of the Model 1.6, there is a positive relationship among explanatory variables and total number of NPs employed in a state, as expected. The coefficient on the key variable of interest, liberal NP SOP, suggests that there is an increase of about 7% in the number of NPs practicing in a state if the state has liberal NP SOP, *ceteris paribus*. The coefficient on log of NP schools is positive, as expected, but not statistically significant, and suggests, that 1% increase in the number of NP schools leads to about 0.9% increase in NP employment in a state, all else holding constant. Note that I use number of NP schools instead of the number of graduates from NP programs, since there is no available data for the period of 2008-2013, and therefore, the impact of availability of NP schools may be overestimated. As to concern of NP wage coefficient, which is also not statistically significant, it has a positive effect on the number of NPs practicing in the state, holding all else constant. The number of practices in the state is positive and statistically significant at the 1% significance level, suggesting that 1% increase in the number of practices available in the state leads to about 114% increase in the number of NPs practicing in a state, all else holding constant. These results are expected and in line with the prior suggested hypothesis.

As previously seen from the graphs on variation of explanatory variables over time, only NP wages had relative variation compared to other explanatory variables used in the model. Since there is not much variation in explanatory variables in six years, therefore, the impact of certain variables on the dependent variable is not observed. Also, the NP SOP regulations changed only in 7 states from 2008 to 2013 and it may be reasonable to deem that the fixed effects model is not best to use for identifying the effect of liberal NP SOP. So, the random effects specification performs better given the rationale above, and thus, we observe a larger effect of liberal NP SOP on NP counts. Although the random effects model performs better than the fixed effects model with respect to identifying the impact of liberal NP SOP, it is inconclusive whether the random effects results are reliable. Thus, state-level analysis provides limited information on the impact of NP SOP on NP employment and the practice-level analysis holds more potential. When comparing Model 1.5 and Model 1.6 results, the significance of liberal NP SOP and NP schools (*lschool*)

comes from variation across states and not variation within states. Hence, fixed effects model is not reliable for identifying the effect of a change to liberal NP SOP.

Although the fixed effects model results show little statistical significance, this is probably because of little within-state variation in the explanatory variables, most likely due to the data being inadequate. Fixed effect models, which will subsequently be shown, produce better results when regressions are run at the practice level. This does not mean that the random effects model is reliable for identifying the effect of a change to liberal NP SOP, despite the coefficients being statistically significant. The problem is one of co-determination by a third, unobserved factor: that factor might cause states to employ more NP SOP and enact liberal NP SOP. For instance, some medical practices might both prefer to employ NPs and lobby the state to pass liberal NP SOP. This issue may be less of a concern in regressions at the practice level. A practice might exert little effect to secure passage of liberal NP SOP, and NP SOP, whether liberal or not, might be exogenous to the practice. If so, practice-level regressions offer a better opportunity to learn whether liberal NP SOP causes higher employment of NPs.

Practice level regressions

Table 4.11 shows summary statistics of the variables used in the GLS models at the practice level. The dependent variable, number of NPs, represents counts of total number of NPs at the practice in a certain state and year. For the models below, I use hourly wages for NPs and PAs, as practices (physicians) hiring NPs and PAs may consider hourly wage rate rather than annual wages/salary.

Table 4.11.
GLS Model Summary Statistics: Practice Level

Variable	Obs	Mean	Std. Dev.	Min	Max
Number of NPs in a practice	1230624	0.2904567	0.8054868	0	43
Number of PAs in a practice	1230624	0.2185469	0.7389483	0	41
Total number of practices in a state	1230624	11813.52	8832.947	290	30964
Liberal NP SOP	1230624	0.1126307	0.3161409	0	1
Number of physicians employed in a practice	1230624	2.793843	4.82771	1	406
Hourly mean PA wage	1230624	42.3573	4.580088	23.17	53.97
Hourly NP wage	1230624	44.62723	7.917143	31.89	67.8
Number of NP schools	1230624	13.63308	7.753354	1	28
Primary care specialty	1230624	0.4046362	0.4908217	0	1

Since there are zeroes in the dependent variable – number of NPs at the practice – I do not use log transformations for my models.

The advantage of running the analysis at the practice model is that it has more separate clusters (284206) than state level model (51 clusters) and the standard errors are clustered around practices. In addition, the fixed effects specification will be a good fit in this case, as the fixed effects are going to be for a practice rather than a state.

First, I run GLS with clustered robust standard errors (CRSE) without full controls to identify the impact of liberal NP SOP. The results of the initial regressions with no controls in Table 4.12, Model 2.1 and Model 2.2, suggest that the effect of *liberal* NP SOP is positive and statistically significant at the 1% significance level both with fixed and random effects specification. Given the results above, one may deem that the NP SOP regulations have a positive impact on the number of NPs employed by a practice.

For the subsequent models, including Model 2.3 and Model 2.4, fixed effects specification is used, as the Hausman test indicates that fixed effects specification is a better fit than random effects for these models. Moreover, the fixed effect controls for state level factors that might affect both the number of NPs and the presence of liberal NP SOP. The random effect model assumes the random effect is independent of the included variables, which may be questionable. As mentioned, there may be unobserved factors that affect both NP employment and liberal SOP.

Model 2.3 includes *nonprimcare* – if a practice specializes in non-primary care – independent variable, along with other control variables. Model 2.4 includes categories for different sizes of practices, depending on the number of MDs employed in a practice, along with *nonprimcare* and other control variables.

Table 4.12.
Model 2: GLS with CRSE at Practice Level

VARIABLES	(1) Model 2.1	(2) Model 2.2	(3) Model 2.3	(4) Model 2.4
1.liberal	0.0362***	0.0559***	0.0206***	0.0203***
	(0.00460)	(0.00354)	(0.00454)	(0.00453)
1.nonprimcare			0.000938	0.0203***
			(0.00583)	(0.00493)
school			0.00527***	0.00545***
			(0.000448)	(0.000447)
totpracticest			4.12e-07	9.00e-07
			(6.18e-07)	(6.23e-07)
2.nsize (Small)				0.0165***
				(0.00250)
3.nsize (Medium)				0.108***
				(0.00567)
4.nsize (Large)				0.332***
				(0.0143)
5.nsize (Very large)				0.893***
				(0.0526)
h_pawagemean			0.00687***	0.00705***
			(0.000275)	(0.000271)

h_npwage			-0.00237***	-0.00234***
			(0.000274)	(0.000276)
Size			0.0373***	
			(0.00313)	
Constant	0.286***	0.253***	-0.0790***	-0.0376***
	(0.000518)	(0.00136)	(0.0132)	(0.0126)
Effects	Fixed	Random	Fixed	Fixed
Observations	1,230,624	1,230,624	1,230,624	1,230,624
R-squared (overall)	0.0016	0.0016	0.0688	0.0418
Number of id	284,206	284,206	284,206	284,206

NOTE: Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

The impact of *liberal* is positive and statistically significant in both Model 2.3 and 2.4 and is about 0.02, suggesting that if a practice is in the state with liberal NP SOP, it has on average by about 0.02 more NPs employed in a practice, *ceteris paribus*. The sign on *nonprimcare* coefficient varies depending on the model – in Model 2.4, *nonprimcare* is positive and statistically significant at the 1% significance level, indicating that if a practice specializes in non-primary care, it is on average has by about 0.02 more NPs employed compared to practices specializing in primary care. This result is surprising as it is not consistent with the initial exploration of data performed in the descriptive statistics section. Variable on the number of NP schools available in the state is also positive and statistically significant in both Model 2.3 and Model 2.4, suggesting that a unit increase in the number of NP schools available results in about 0.005 more NPs employed at the practice.

The signs on *totpracticest* and *h_pawagemean* are positive, and only the coefficient on *h_pawagemean* is statistically significant at the 1% significance level. The results are aligned with the hypothesis of positive relationship between these variables and NPs employed in the practice. The sign on *h_npwage*, hourly NP wage, is negative as expected in both models and statistically significant at the 1% significance level, suggesting that the higher the NP wage, the fewer number of NPs are employed at the practice, all else holding constant. *Size*, total number of MDs employed at the practice, in Model 2.3 is positive as expected and statistically significant at the 1% significance level, indicating that a unit change in the number of MDs working in the practice will result in about 0.04 increase in the number of NPs employed at the practice. The practice size by categories, *nsize*, in Model 2.4, suggests that a larger positive effect on the number of NPs employed is seen under categories for 'large' and 'very large' practices compared to solo, small, and medium-sized practices, as expected.

Given the results of Model 2.4, the next step is to explore the impact of liberal NP SOP among practices with various practice sizes and primary or non-primary care specialty. The results of Model 3 in Table 4.13 suggest that number of NPs employed at the practice increases with size of non-primary care practice. The effect of liberal NP SOP on the number of NPs employed at the practice is about zero for size equal to 1 (one MD) and positive and increasing for size greater than

1, primary care practices in states with liberal NP SOP employ more NPs than such practices in states with restricted NP SOP. Number of NPs employed at the practice is less for non-primary care practices for size 1, 2, 3 relative to primary care practices, but then it becomes greater. There is no differentially greater or less effect of *liberal#c.size* (size is a continuous variable) for non-primary care practices relative to primary care practices. I also run a specification with size being categorical variable, and the results were similar to Model 3.

Table 4.13.
Model 3: Linear GLS with Interaction Terms, Fixed Effects and CRSE

VARIABLES	(1) Model 1
1.liberal	-0.00671
	(0.00846)
size	0.0212***
	(0.00480)
1.liberal#c.size	0.00877*
	(0.00462)
1.nonprimcare	-0.0414***
	(0.0140)
1.nonprimcare#c.size	0.0165***
	(0.00522)
1.liberal#1.nonprimcare#c.size	0.000706
	(0.00447)
totpracticest	5.06e-07
	(6.16e-07)
h_npwage	-0.00237***
	(0.000274)
h_pawagemean	0.00681***
	(0.000272)
school	0.00535***
	(0.000447)
Constant	-0.0407***
	(0.0154)
Fixed Effects	Yes
Observations	1,230,624
Number of id	284,206
R-squared (overall)	0.0642

NOTE: Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 4.14.
Model 4: ZIP and ZINB

VARIABLES	(1) ZIP Model 4.1	(2) ZINB Model 4.2
liberal	0.0858***	0.0999***
	(0.00664)	(0.00793)
nonprimcare	-0.172***	-0.565***
	(0.00406)	(0.00470)
size	0.0147***	0.137***
	(5.88e-05)	(0.000681)
school	0.0177***	0.0135***
	(0.000576)	(0.000644)
totpracticest	-3.64e-05***	-3.20e-05***

	(5.67e-07)	(6.45e-07)
h_pawagemean	0.00785***	0.00687***
	(0.000482)	(0.000564)
h_npwage	-0.000258	-0.00532***
	(0.000343)	(0.000402)
Constant	-0.262***	-1.270***
	(0.0222)	(0.0262)
Observations	1,230,624	1,230,624

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

For exploration, I examine whether the impact of *liberal* is still positive on the number of NPs employed by running two count models – zero inflated Poisson (ZIP) and zero inflated negative binomial (ZINB) models. Both Model 4.1 and Model 4.2 in Table 4.14 demonstrate the positive relationship between liberal NP SOP and number of NPs employed at the practice. The coefficient on *liberal* ranges from about 0.09 to 0.1 and is statistically significant at the 1% significance level, depending on the model used. Most of the variables have the expected signs for their coefficients that are aligned with the hypothesis, except *totpracticest*, which is negative and statistically significant at the 1% significance level in both Model 4.1 and Model 4.2. This is surprising and the results may be associated with other factors not considered in the model, such as say perhaps states having larger number of practices may have a higher inclination to employ MDs and/or PAs instead of NPs compared to states that have less number of practices.

Discussion and Limitations

Discussion

The practice-level regression results show a positive effect of NP SOP on NP employment, which is consistent with the literature. A recent review summarized the impact as follows:

> Eight studies included in this review examined the effects of state SOP regulations on the NP workforce, including supply, mobility, and geographic distribution. Consistent evidence has shown that the number of NPs and growth of the NP workforce were highest in states with greater practice authority. Evidence from four studies indicates that states with more favorable NP practice environments have higher per capita NPs. By 2010, states with full SOP regulations had an average of 25 more NPs per 100,000 population (95% confidence interval [1.2, 48.3]) compared with states with the most restrictive SOP.[222]

Most of these studies looked at the state level and or county level. However, this analysis is unique in that it uses practice level data and defines liberal NP SOP based on prescription and

[222] The original text had citations, which were removed in the quoted text above. For further details see Xue et al., 2016.

practice authority. Also, past studies reviewed for this research did not use practice-level data. Moreover, the use of SCM to identify the impact of changing to liberal NP SOP also found a positive effect of liberal NP SOP on NP employment.

Limitations of the study

Data availability on certain variables was limited and proxies were used instead. For instance, there was no data available on NP wages prior to 2012, and I used 90th percentile of RN wages. Moreover, there was no readily available data for graduation and/or enrolment rates for NP programs, and I used number of NP schools instead. There was missing data in SK&A dataset on NP specialization for 2008-2009, and thus, I could not limit my NP pool only to those who specialize in primary care and instead used a proxy for primary care site specialization, which in many cases had a contrary effect on the dependent variable (e.g., Model 2.4). Over the six-year observation window, there were only 7 states that changed their NP SOP regulations, and the impact of NP SOP was not detectable in the state level fixed effects specification. This study attempted to reduce biases presented by the limitations of data availability by utilizing the CRSE and SCM to demonstrate a case study to detect the impact of liberal NP SOP for one state, Maryland.

Concluding remarks

This study demonstrated that liberal NP SOP do matter. Specifically, the empirical results support the hypothesis that states with liberal NP SOP tend to have a higher employment of NPs. Although some of the models had mixed results of NP SOP impact in primary care at the practice level, they do demonstrate that practices consider NP SOP regulations when deciding to employ NPs. As more data becomes available, the clearer picture of the impact of liberal NP SOP on NP employment could be detected.

The key policy implication is that adopting liberal NP SOP is a potential solution for states facing a shortage of PCPs. In addition, using NPs in a practice may save time and money for practices, as physicians could spend their time with patients with cases that are outside of NP SOP. Nurse practitioners need to be educated for about 6 years when compared to physicians (at least 10 years) practicing in primary care. Therefore, a faster solution could be realized when relying on NP workforce rather depending on physicians who may not be entering primary care field in the future at the same growth rate as previously. The rising costs of health care may be a good incentive to consider changing NP SOP regulations that may be a way of alleviating the shortage of PCPs in shortage designated areas and improve access to health care in these areas of the country.

5. The Impact of Nurse Practitioner Scope-of-Practice on Patient Volume

This chapter emphasizes the issue of access to primary care from a realized access perspective. Specifically, it will analyze whether NP SOP regulations have an impact on patient volume that occurred per day in a practice. Patient volume is viewed here as average number of patients seen per day in a practice. The research question that this chapter raises and strives to answer is to identify whether patient volume in a practice, defined as average number of patients seen in a practice in a day in a certain state in a particular year, is affected by NP SOP regulations. The analyses provided in this chapter examine the effect of NP SOP on patient volume at the practice level from a provider's perspective. Empirical analysis of practice-level data using both fixed-effect and random-effect specifications is run. The analyses are preceded by a brief review of findings in the literature and descriptive information about the data used in the analysis. Results indicate that the introduction of liberal NP SOP caused an increase in average daily patient visits. This result is also found with IV specification. Since the practice-level data set has a large number of observations, it was possible to estimate specifications allowing for interaction of the NP SOP indicator with practice size (number of physicians) and whether the practice was primary or non-primary care, controlling for shortage areas with PCP need. The results show that liberal NP SOP leads to an increase in patient volume, which increases with practice size. Further increase in patient volume and extending liberal NP SOP to all states could be expected to help alleviate the projected shortage of health care providers.

Background and Literature Review

Literature Review: access to care and NP SOP

Several studies looked at access to health care given NP SOP and the literature suggests that expanded NP SOP has a positive impact on realized access to care. For instance, two studies focused on the effect of SOP regulations on the number of office-based provider visits[223] utilized by patients, while another focused on the effect of SOP regulations on the extent to which patients with Medicaid were able to receive an appointment at a primary care practice[224]. These studies all identified significant improvement in access to care and use of services in states with less

[223] Stange, 2014.

Traczynski and Udalova, 2014.

[224] Richards, Michael R, and Daniel Polsky, "Influence of provider mix and regulation on primary care services supplied to US patients," *Health Econ Policy Law,* Vol. 11, 2016, pp. 193-213.

restrictive NP SOP regulations. Specifically, Stange found that individuals in states with less restrictive NP prescriptive authority regulations had 3% more visits conditional on having at least one office-based provider visit compared to those in states with more restrictive prescriptive authority[225]. Traczynski and Udalova found that individuals in states with less restrictive SOP regulations were more likely to self-report being able to get an appointment when they wanted to and the probability of receiving a routine check-up increased by 3.8 percentage points[226]. Richards and Polsky[227] found that Medicaid patients are more likely to receive an appointment at practices with more mid-level providers, such as NPs, and are linked to better access particularly in states with expanded SOP. In states with less restrictive SOP regulations, the probability of receiving an appointment in the practice that has at least three mid-level non-physician PCPs for a Medicaid patient was greater than in states with more restrictive SOP regulations[228]. Another study compared demographic and practice characteristics of primary care NPs and primary care MDs and found that NPs are more likely than MDs to "provide care in a wider range of community settings, and treat Medicaid recipients and other vulnerable populations"[229]. Kuo examined the relationship between state regulation and the amount of care provided by NPs and found that between 1998 and 2010 the number of Medicare beneficiaries seen by NPs rose fifteenfold[230]. One study examined the effect of state SOP regulations on the hours worked by different providers in the state and found that in general NPs work 6 to 14% less hours in states that require physician supervision[231]. Cross and Kelly examined relationship between access to care among Medicare patients and NP practice regulations and found, in contrast to other studies, that Medicare survey respondents "in full NP practice states experienced longer waiting times to get an appointment with a provider than those in restricted and reduced practice states"[232]. Graves examined effect of NP SOP on accessibility to primary care NPs and identified that accessibility was highest in rural areas – "there were more accessible PCNPs per 100,000 population in rural areas of restricted scope-of-practice states (21.4) than in urban areas of full practice states (13.9)"[233]. Poghosyan found that underutilization of NP capacities and their advanced skills "leads to NPs taking on tasks that are typically delegated to other team members such as to medical assistants. This also may

[225] Stange, 2014.

[226] Traczynski and Udalova, 2014.

[227] Richards and Polsky, 2016.

[228] Ibid.

[229] Buerhaus et al., 2015.

[230] Kuo, Yong-Fang, Figaro L Loresto, Linda R Rounds, and James S Goodwin, "States with the least restrictive regulations experienced the largest increase in patients seen by nurse practitioners," *Health Affairs,* Vol. 32, No. 7, 2013, pp. 1236-1243.

[231] Kleiner et al., 2016.

[232] Cross, Summer, and Patricia Kelly, "Access to care based on state nurse practitioner practice regulation: Secondary data analysis results in the Medicare population," *Journal of the American Association of Nurse Practitioners,* Vol. 27, No. 1, 2015, pp. 21-30.

[233] Graves et al., 2016.

cause delays in patient processing and increase waiting times"[234]. Krein examined likelihood of provider-based rural health clinics that were geared towards increasing utilization of NPs and PAs in primary care and NP SOP, and found that these clinics were by 30% more likely to be launched by rural hospitals in states authorizing NPs prescription authority compared to states with restricted prescription authority[235]. Fitzpatrick concluded that regulations that restrict NP SOP are barriers, which affect NPs in primary care most markedly and have repercussions on access to care[236].

Literature Review: Patient volume and NPs

Several studies looked at the role of NPs in primary care from the angle of visits or services that are provided by NPs. Pylypchuk and Sarpong examined the effect of patients' visits to NPs on the demand for PCP services and found that patients who visit NPs have significantly less likelihood in visiting PCPs – a reduction in the likelihood by 22.2 percentage points – as well as in receiving prescription, medical check-up, and diagnosis from PCPs[237]. Also, they found that a 10% increase in visiting NPs by a patient decreases visits to PCPs by 0.7%[238]. One study compared primary care nurse practitioners (PCNP) to primary care medical doctors (PCMD) and found that although both providers "deliver similar service and spend their time in nearly identical ways", NPs work less hours, see fewer patients, and a small number of PCNPs have "their salary adjusted for productivity and quality performance"[239]. Several studies also found that APRN-led clinics exhibited increased patient satisfaction by reducing the cost of care, unnecessary advanced imaging studies, preventable patient visits, and work absenteeism[240]. Other studies showed an important role of NPs in nurse-managed health centers (NMHCs), which comprise of more than 250 in the country and provide more than 2.5 million patient encounters yearly and offer care to those in communities who have usually underutilized primary and preventative care services[241]. Morgan, Everett, and Hing examined the number of visits by provider type, when comparing PAs,

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[234] Poghosyan et al., 2013.

[235] Krein, Sarah L, "The adoption of provider-based rural health clinics by rural hospitals: a study of market and institutional forces," *Health services research,* Vol. 34, No. 1 Pt 1, 1999, p. 33.

[236] Fitzpatrick, Joyce J, "The future of nursing: Leading change, advancing health," *Nursing Education Perspectives,* Vol. 31, No. 6, 2010, pp. 347-348.

[237] Pylypchuk, Yuriy, and Eric M Sarpong, "Nurse Practitioners and Their Effects on Visits to Primary Care Physicians," *The BE Journal of Economic Analysis & Policy,* Vol. 15, No. 2, 2015, pp. 837-864.

[238] Ibid.

[239] Buerhaus et al., 2015, Abstract.

[240] Blackmore, C Craig, Jordan W Edwards, Carly Searles, Debra Wechter, Robert Mecklenburg, and Gary S Kaplan, "Nurse Practitioner–Staffed Clinic At Virginia Mason Improves Care And Lowers Costs For Women With Benign Breast Conditions," *Health Affairs,* Vol. 32, No. 1, 2013, pp. 20-26.

Blackmore, C Craig, Robert S Mecklenburg, and Gary S Kaplan, "At Virginia Mason, collaboration among providers, employers, and health plans to transform care cut costs and improved quality," *Health Affairs,* Vol. 30, No. 9, 2011, pp. 1680-1687.

[241] Hansen-Turton, Tine, "The nurse-managed health center safety net: A policy solution to reducing health disparities," *Nursing Clinics of North America,* Vol. 40, No. 4, 2005, pp. 729-738.

Ritter, Ann, and Tine Hensen-Turton, "The primary care paradigm shift: an overview of the state-level legal framework governing nurse practitioner practice," *Health Law.,* Vol. 20, 2007, p. 21.

NPs, and physicians, and found that there were no differences in the number of visits by provider type and time spent per patient in community health centers (CHCs) is similar to each other[242]. However, the results of the study also indicated that NPs in CHCs saw patients the smallest portion of the week when compared to PAs and physicians[243]. Moreover, the study identified that there were 36,469,000 patient visits per year at CHCs, and 21% of the visits were to NPs, 69% to physicians, and 10% were to PAs, such that visits to NPs leaned towards preventative care[244].

Shortage: definition and literature

The Health Resources and Services Administration (HRSA) defines shortage designation criteria and determines whether a geographic area, population group or facility qualifies as a Health Professional Shortage Area (HPSA)[245]. The HRSA uses specific regulations to establish criteria and procedures for identifying geographic areas, population groups, medical facilities, and other public facilities as HPSAs[246]. HRSA applies the criteria and procedures to identify the areas and population groups within the United States that have a shortage of health professionals. Specifically, the HRSA defines a HPSA as follows[247]:

> *Health professional(s) shortage area* means any of the following which the Secretary determines has a shortage of health professional(s): (1) An urban or rural area (which need not conform to the geographic boundaries of a political subdivision and which is a rational area for the delivery of health services); (2) a population group; or (3) a public or nonprofit private medical facility.

The HPSA designation has three categories: primary medical care, dental, and mental health. The key factor in establishing an HPSA designation is "the number of health professionals relative to the population with consideration of high need"[248]. This implies that an area's or group's need for health care must be assessed as part of determining whether it qualifies as HPSA. Further, the need must be "high" relative to the supply of providers.

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[242] Morgan, Perri, Christine M Everett, and Esther Hing, "Time spent with patients by physicians, nurse practitioners, and physician assistants in community health centers, 2006–2010," *Healthcare*, 2014, pp. 232-237.

[243] Ibid.

[244] Ibid.

[245] "Shortage Designation: Health Professional Shortage Areas & Medically Underserved Areas/Populations." Health Resources and Services Administration. As of December 17, 2015.

[246] "HPSA designation criteria". Health Resources and Services Administration. As of December 17, 2015.

[247] Ibid.

[248] "Primary Care Health Professional Shortage Areas (HPSAs)," *The Henry J. Kaiser Family Foundation*, December 31, 2016. As of January 5, 2017.

How are shortage areas determined in primary health care?

To determine if an area can be designated as Primary Care HPSA depends on whether it has a primary care physician-to-population ratio of 1:3500. As of December 31, 2016, there were 6,626 designated Primary Care HPSAs[249]. An additional 8,644 primary care physicians would need to be allocated to these areas for them to exceed the 1:3500 threshold and no longer be designated as HPSA[250]. It must be noted that the number of additional PCPs needed to remove an area from HPSA does not consider the availability of primary care services provided by NPs and PAs in the area[251].

Whether or not an area has a ratio above the threshold, certain groups within particular geographic areas will be identified as experiencing a shortage of primary medical care professionals if "access barriers prevent the population group from use of the area's primary medical care providers"[252]. In this context, access barriers are defined as economic, linguistic, cultural, or architectural, or the refusal of some providers to offer services to some patients such as Medicaid patients.

Literature on shortage in primary care

Numerous studies acknowledged the issue of primary care physician shortage and recommended expanding NP SOP to address it. A recent study used Health Resources and Services Administration's Health Workforce Simulation Models to examine demand and supply projections for primary care practitioners and estimated that 37 states "are projected to have shortages of primary care physicians in 2025", although "no state is projected to have a 2025 shortage of primary care NPs"[253]. Another study projected that shortages of primary care physicians will be at 45,000 by 2020 and 66,000 by 2025[254], while the other study forecasted that the United States will need 52,000 more primary care physicians by 2025[255]. Moreover, these estimates assume non-changing practice patterns and do not account for a possible smaller physician panel size, as primary care physicians started to have a tendency of working part-time more and retiring at earlier ages than previously[256].

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[249] Ibid.

[250] Ibid.

[251] Ibid.

[252] "HPSA designation criteria", no date.

[253] Spetz, Skillman, and Andrilla, 2016.

[254] "Physician shortages to worsen without increases in residency training," *Association of American Medical Colleges*, 2010.

[255] Petterson, Stephen M, Winston R Liaw, Robert L Phillips, David L Rabin, David S Meyers, and Andrew W Bazemore, "Projecting US primary care physician workforce needs: 2010-2025," *The Annals of Family Medicine,* Vol. 10, No. 6, 2012, pp. 503-509.

[256] Fodeman, Jason, and Phil Factor, "Solutions to the primary care physician shortage," *The American journal of medicine,* Vol. 128, No. 8, 2015, pp. 800-801.

There are more APRNs than family practice physicians by about 125,000 to 87,000 and serving areas that would otherwise have no health care services provided[257]. Interestingly, the Negotiated Rule Committee launched by the ACA suggested to the Administrator of the Health Resources and Services Administration in 2011 to update the guidelines on designating health professional shortage areas by counting NP, PA, or CNMs as 75% of a physician to define HPSA status, although acknowledging that the evidence for this recommendation was not adequate[258].

There are several studies that recommend using mid-level providers more intensively to mitigate potential shortages in primary care physicians[259]. NPs are viewed as an important lever in addressing shortages[260]. Sullivan-Marx found that up to 75% of primary care services could be offered by NPs[261]. APRNs are important in delivering primary care services in rural and medically underserved areas, where physician oversight may not be locally accessible[262]. Altman, Butler, and Shern acknowledged the shortages of primary care providers to be a challenge in the United Stated and emphasized the significance of "collaborative practice among a full array of health professionals as the model for health care for the future in both primary and specialty care"[263]. Conover and Richards also suggested allowing full practice authority for APRNS to reduce a shortage of medical care[264].

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[257] Manion, Amy B, and Janice A Odiaga, "Health care economics and the advanced practice registered nurse," *Journal of Pediatric Health Care,* Vol. 28, No. 5, 2014, pp. 466-469.

[258] *Negotiated Rulemaking Committee on the Designation of Medically Underserved Populations and Health Professional Shortage Areas Final Report to the Secretary*, Health Resources and Services Administration, 10/31/11.

[259] Auerbach, David I, Peggy G Chen, Mark W Friedberg, Rachel Reid, Christopher Lau, Peter I Buerhaus, and Ateev Mehrotra, "Nurse-managed health centers and patient-centered medical homes could mitigate expected primary care physician shortage," *Health Affairs,* Vol. 32, No. 11, 2013, pp. 1933-1941.

Goodell, Sarah, Catherine Dower, and Edward O'Neil, "Primary care workforce in the United States," *Robert Wood Johns Found*, 2011.

Green, Linda V, Sergei Savin, and Yina Lu, "Primary care physician shortages could be eliminated through use of teams, nonphysicians, and electronic communication," *Health Affairs,* Vol. 32, No. 1, 2013, pp. 11-19.

[260] Cooper, Richard A, "New directions for nurse practitioners and physician assistants in the era of physician shortages," *Academic medicine,* Vol. 82, No. 9, 2007, pp. 827-828.

Elsom, Stephen, Brenda Happell, and Elizabeth Manias, "Nurse practitioners and medical practice: opposing forces or complementary contributions?," *Perspectives in Psychiatric Care,* Vol. 45, No. 1, 2009, pp. 9-16.

Fairman, Julie A, John W Rowe, Susan Hassmiller, and Donna E Shalala, "Broadening the scope of nursing practice," *New England Journal of Medicine,* Vol. 364, No. 3, 2011, pp. 193-196.

Naylor, Mary D, and Ellen T Kurtzman, "The role of nurse practitioners in reinventing primary care," *Health Affairs,* Vol. 29, No. 5, 2010, pp. 893-899.

[261] Sullivan-Marx, Eileen M, "Lessons learned from advanced practice nursing payment," *Policy, Politics, & Nursing Practice,* Vol. 9, No. 2, 2008, pp. 121-126.

[262] DesRoches et al., 2013; Buerhaus et al., 2015.

[263] Altman, Stuart H, Adrienne Stith Butler, and Lauren Shern, *Assessing progress on the Institute of Medicine report The Future of Nursing*: National Academies Press, 2016.

[264] Conover, Chris, and Robert Richards, "Economic benefits of less restrictive regulation of advanced practice nurses in North Carolina," *Nursing Outlook,* Vol. 63, No. 5, 2015, pp. 585-592.

Several studies suggested that enlarging the supply of NPs and PAs could lessen the issue of expected primary care physician shortages[265], as educating NPs is faster than physicians and NPs provide comparable quality of primary care[266]. Due to PAs and NPs ability to provide services that frequently "overlap substantially with those of physicians" and due to the ratio of about 1 PA or NP for every 5 practicing physicians has been increasing, PAs and NPs could alleviate the predicted physician shortage in meeting the nation's needs in medical care[267]. A study suggested that if NPs are utilized to their complete capacity, primary care shortage issue could be partially eased[268].

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[265] Iglehart , John K., "Expanding the Role of Advanced Nurse Practitioners — Risks and Rewards," *New England Journal of Medicine,* Vol. 368, No. 20, 2013, pp. 1935-1941.

Fitzpatrick, 2010.

Ku, Leighton, Karen Jones, Peter Shin, Brian Bruen, and Katherine Hayes "The States' Next Challenge — Securing Primary Care for Expanded Medicaid Populations," *New England Journal of Medicine,* Vol. 364, No. 6, 2011, pp. 493-495.

Association, National Governors, "The role of nurse practitioners in meeting increasing demand for primary care," *Washington: National Governors Association*, 2012.

[266] Cooper, Richard A, "Health care workforce for the twenty-first century: the impact of nonphysician clinicians," *Annual review of medicine,* Vol. 52, No. 1, 2001, pp. 51-61.

Horrocks, Sue, Elizabeth Anderson, and Chris Salisbury, "Systematic review of whether nurse practitioners working in primary care can provide equivalent care to doctors," *Bmj,* Vol. 324, No. 7341, 2002, pp. 819-823.

Laurant, Miranda, David Reeves, Rosella Hermens, Jose Braspenning, Richard Grol, and Bonnie Sibbald, "Substitution of doctors by nurses in primary care," *The Cochrane Library*, 2005.

Mundinger, Mary O, Robert L Kane, Elizabeth R Lenz, Annette M Totten, Wei-Yann Tsai, Paul D Cleary, William T Friedewald, Albert L Siu, and Michael L Shelanski, "Primary care outcomes in patients treated by nurse practitioners or physicians: a randomized trial," *Jama,* Vol. 283, No. 1, 2000, pp. 59-68.

Newhouse, Robin P, Julie Stanik-Hutt, Kathleen M White, Meg Johantgen, Eric B Bass, George Zangaro, Renee F Wilson, Lily Fountain, Donald M Steinwachs, and Lou Heindel, "Advanced practice nurse outcomes 1990-2008: a systematic review," *Nursing Economics,* Vol. 29, No. 5, 2011, p. 230.

Venning, Pamela, A Durie, M Roland, C Roberts, and B Leese, "Randomised controlled trial comparing cost effectiveness of general practitioners and nurse practitioners in primary care," *Bmj,* Vol. 320, No. 7241, 2000, pp. 1048-1053.

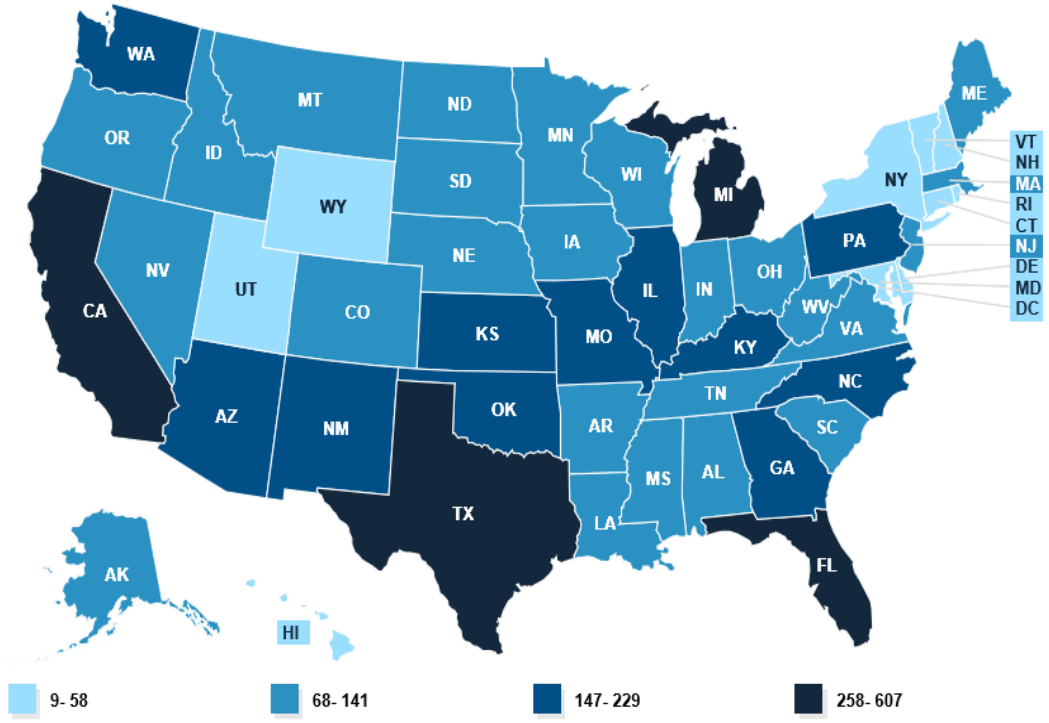
[267] Morgan, Perri A, Justine Strand, Truls Østbye, and Mark A Albanese, "Missing in action: care by physician assistants and nurse practitioners in national health surveys," *Health services research,* Vol. 42, No. 5, 2007, pp. 2022-2037.

[268] Green, Savin, and Lu, 2013.

Facts available on patient volume in the country and shortage

In 2014, eight out of twenty-two states with at least 20% of their population lived in a primary care HPSA that had liberal NP SOP[269]. As of April 2014, there were a total of 6087 HPSAs, 60.41% of needs met, and 8073 practitioners needed to remove their HPSA designation in the United States[270]. However, as of December 31, 2016, these numbers increased, and there were a total of 6,626 HPSAs, 56.77% of needs met, and 8,644 practitioners needed to remove their HPSA designation in the country, as shown in Figure 5.1[271].

Figure 5.1.
Map of HPSAs in the US, 2016



The map in Figure 5.2 represents average patient volume in a state aggregated across all the practices in 2013, categorized by NP SOP[272].

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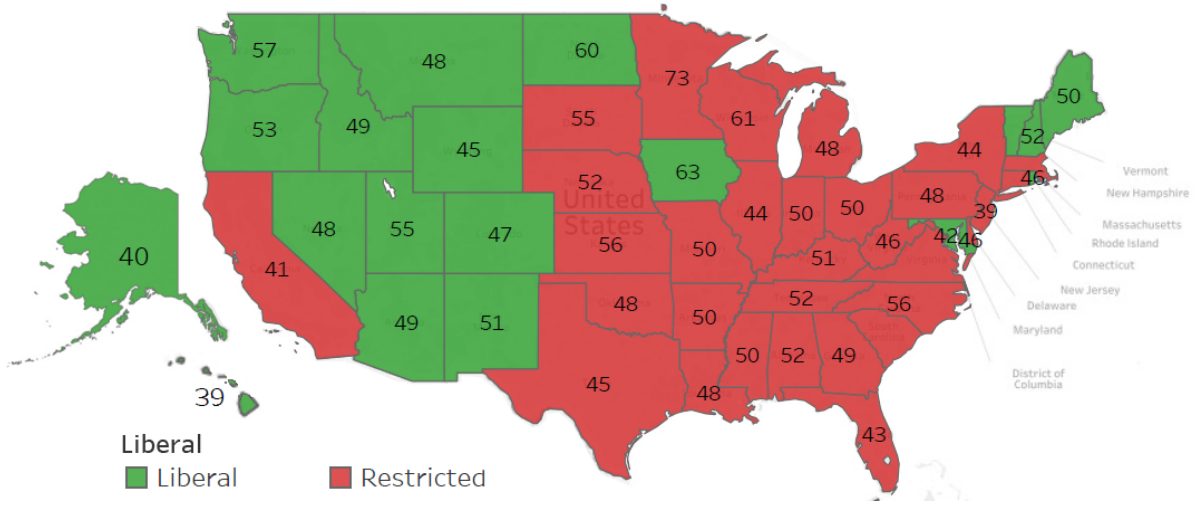
[269] Vleet, Amanda Van, and Julia Paradise, "Tapping Nurse Practitioners to Meet Rising Demand for Primary Care," January 20, 2015. The Henry J. Kaiser Family Foundation.[269]

[270] "Primary Care Health Professional Shortage Areas (HPSAs)," *The Henry J. Kaiser Family Foundation.*, December 31, 2016. As of May 5, 2017. Map and Data.

[271] Ibid.

[272] SK&A data was used to calculate average patient volume across all practices per state in 2013. Linda Pearson Report was used for categorizing states by "Liberal" and "Restricted" NP SOP, as defined in this dissertation.

Figure 5.2.
Map of State Patient Volume Aggregated Across All Practices, 2013



Map based on Longitude (generated) and Latitude (generated). Color shows details about Liberal. The marks are labeled by sum of ratio of total number of NPs by population. Details are shown for State.

Conceptual Model

Logic model and theoretical framework for patient volume: the practice perspective

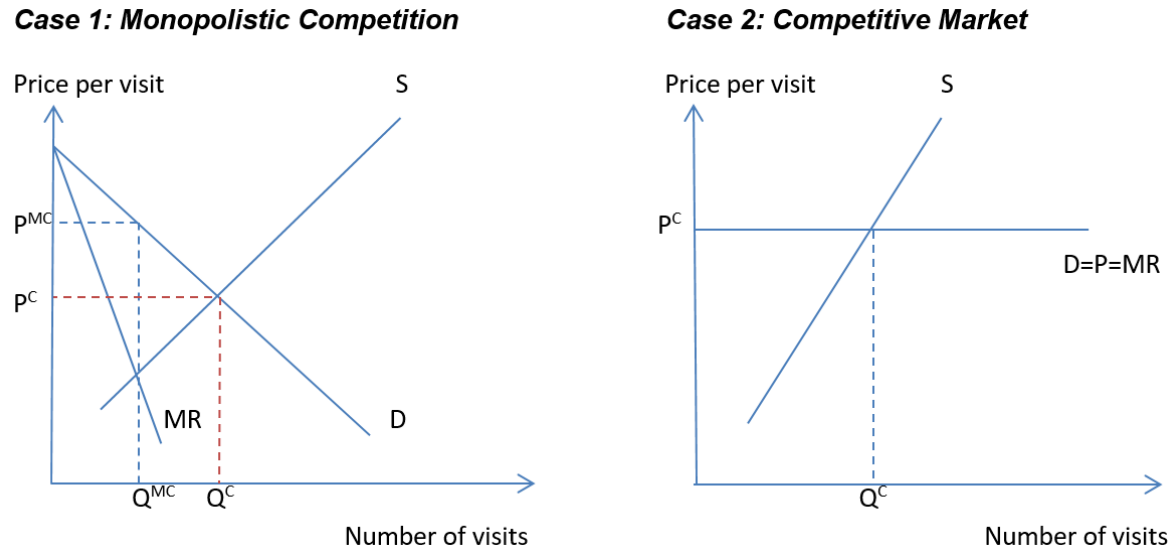
Before developing a logic model for patient volume, it is important to take a look at the supply and demand analysis[273]. In particular, there exists demand for and supply of health care services, such that suppliers are medical providers and demanders – patients. The simplified way of looking at the so-called 'medical visits' market is to consider number of visits and price/cost of visits to a practice:

The market for medical care services could be viewed either under monopolistic competition or competitive market structure. Although in both cases, a producer (practice/clinic) will decide how much to supply its medical services at a given price per visit where marginal revenue equals to marginal cost, the former varies in both cases, and therefore, equilibrium quantities and prices will be different.

Under monopolistic competition, there is a regular downward sloping demand curve for health care services, such that the higher the price of services, the less quantity demanded of visits will be, all else equal. However, marginal revenue curve differs from the demand curve, and therefore, the price of services is higher and the quantity supplied and demanded is lower if compared to a

[273] The discussion presented in the "Conceptual Model" section is similar to discussion presented in Chapter 3.

Figure 5.3.
Number of Visits for Monopolistic Competition vs Competitive Markets



competitive market case, where demand curve is equal to the price of a visit and to marginal revenue. The two cases showing monopolistic competition and competitive market for number of visits are presented in Figure 5.3.

Although physician practices may closely be characterized by monopolistic competition, the logic model and theoretical framework developed below assumes competitive market. A practice perspective is considered in developing the logic model for patient volume. Constraints that a practice/clinic faces as well as supply and demand side factors that affect number of patients seen by a practice on average each day when a practice is in operation are described below.

Constraints faced: Time (hours of operation and days of operation) and Space (number of rooms)

Supply side factors: competition faced by other clinics nearby (could be measured by provider density or number of practices available in total by a particular area – either zip code, county, or state), number of workers a practice hires – including mix of NPs, PAs, MDs (the number of MDs working in a practice is affected by shortage versus non-shortage of PCP), and associated NP SOP, capacity of a facility (number of rooms in which patients could be seen), clinic's specialty (primary care, multispecialty, etc.), hours and days of operation.

Demand side factors: wait time (which is affected by shortage vs. non-shortage of PCP), distance to travel, accepting new patients, Medicare and/or Medicaid, type of payment system (fee for services, capitation, etc.), number of patients a practice has (pool of patients served on a regular basis per year), which could be proxied by population.

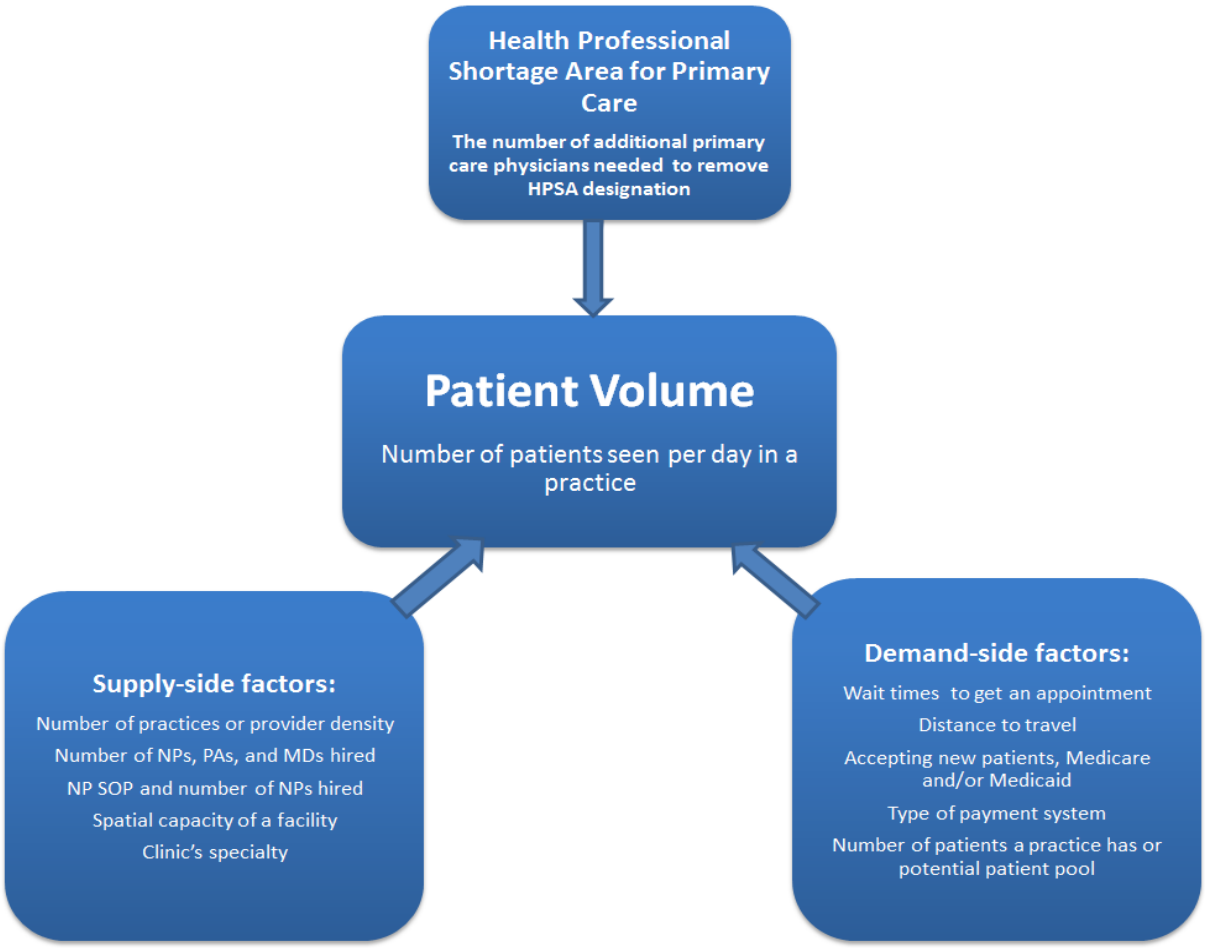
Health Professional Shortage Area for Primary Care: practitioners needed to remove health professional shortage area (HPSA) designation, which refers to the "number of additional primary care physicians needed to achieve a population-to-primary care physician ratio of 3,500:1 (3,000:1 where high needs are indicated) in all designated primary care HPSAs, resulting in their removal from designation"[274].

Health Professional Shortage Area will have an indirect effect on supply-side and demand-side factors, such as ability to hire as many primary care physicians as needed and wait times for appointments, respectively. Figure 5.4 shows the above described factors affecting patient volume.

Given the focus of this chapter and keeping in mind the data available, the research questions are whether the volume of patient visits is related to the number of nurse practitioners employed by a practice, and whether this relationship is stronger in states with liberal SOPs.

[274] "Primary Care Health Professional Shortage Areas (HPSAs)," *The Henry J. Kaiser Family Foundation.*, December 31, 2016. As of May 5, 2017.

Figure 5.4.
Factors Affecting Patient Volume



Theoretical framework: producer perspective under competitive market (price taker) case

Here, theoretical model is described. The clinic or practice perspective is used and competitive[275] market is assumed. Competitive market refers to agents – patients, PCPs, and clinic – that are being price takers, visits are assumed to be 'homogenous commodity', no barriers to entry and exit into and out of the medical care market are present, and there exists perfect information about the 'medical care visits' market. The demand for medical services – visits – is

[275] Although some literature considers physician visits under monopolistic competition market, due to difficulty of obtaining certain data and for simplifying certain aspects of the model, the competitive market is assumed.

For instance, Folland, Goodman, and Stano argue that individual "physician practices are not pure monopolies, but because the numerous competitors of each are differentiated by reputation, patient loyalty, and patient/practice distance, each physician probably has some market power. Many economists treat physician markets as monopolistically competitive". For further details see Folland, Sherman, Allen C Goodman, and Miron Stano, *The economics of health and health care*, 7 ed., Upper Saddle River, NJ: Pearson Prentice Hall, 2013, page 43.

perfectly elastic and is determined by the market at a given constant price, such that the demand for visits is equal to the price of a visit (as well as to marginal revenue accrued from a visit).

Specifically, from the viewpoint of a medical care practice, the modeling below is based on the following assumption: medical care practices are profit maximizers that are price-takers in the markets for their outputs and inputs. This means the price they receive for a given 'unit' of care is not affected by their actions, and similarly, the salaries they pay for nurse practitioners and physician assistants are not affected by their actions. The assumption that output and input prices are determined by the market does not mean that the prices are the same throughout the United States. Moreover, it is further assumed that individual states represent different markets, and the market prices of outputs and inputs differ across states and may differ by type of practice (primary care, specialty care, multispecialty, etc.). A practice will, in equilibrium, choose the volume of care and input mix that maximizes profit.

The production function of a practice/clinic will have built in the space and time constraints and will show the relationship between the rate of input utilization (e.g., NP hours per unit time) and the rate of output (health care services per unit time). In the short run some aspects of production are fixed (e.g., office space, the number of staff members, equipment, etc.), but in the long run they are variable. This model views the theoretical effect of a change in NP price on output (measured as patient volume) as qualitatively the same in the short run as in the long run, and similarly, the effect of more liberal NP SOP on volume might be qualitatively the same in the short and long runs. Therefore, the model only focuses on NP and PA inputs and assumes that the practice has a given number of physicians and can choose the profit maximizing level of NP and PA inputs (given the number of physicians). In the longer run, the firm can change the number of physicians and vary other aspects of its production – provision of medical care services. Also, it is assumed that the number, types, and size distribution of providers is fixed and given.

The profit maximization problem a practice faces is such that it only has prices of its services (which is price per visit that will vary depending on the type of service rendered and practice's specialization) times output (patient volume = number of services supplied or number of visits a practice handles per day on average) subtracting the costs of operation (with wages paid to PAs and NPs) on each particular day. The notation and associated assumptions follow:

Let

x_{NP} – represent NP hours worked at a clinic per day (aggregate hours for all of the NPs employed at a particular day) and w_{NP} – NP wage per hour

x_{PA} – PA hours worked at a clinic per day (aggregate hours for all of the PAs employed at a particular day) and w_{PA} – PA wages per hour

$f(x_{NP}, x_{PA}) = y$ is output level – number of visits or patient volume per day, given input level of x_{NP} and x_{PA}

p – price of practice's services, such as price of visits
TC = $w_{NP}x_{NP} + w_{PA}x_{PA}$, total cost of inputs x_{NP} and x_{PA} at wages w_{NP} and w_{NP}
w_{NP}, w_{PA}, p – are fixed and given

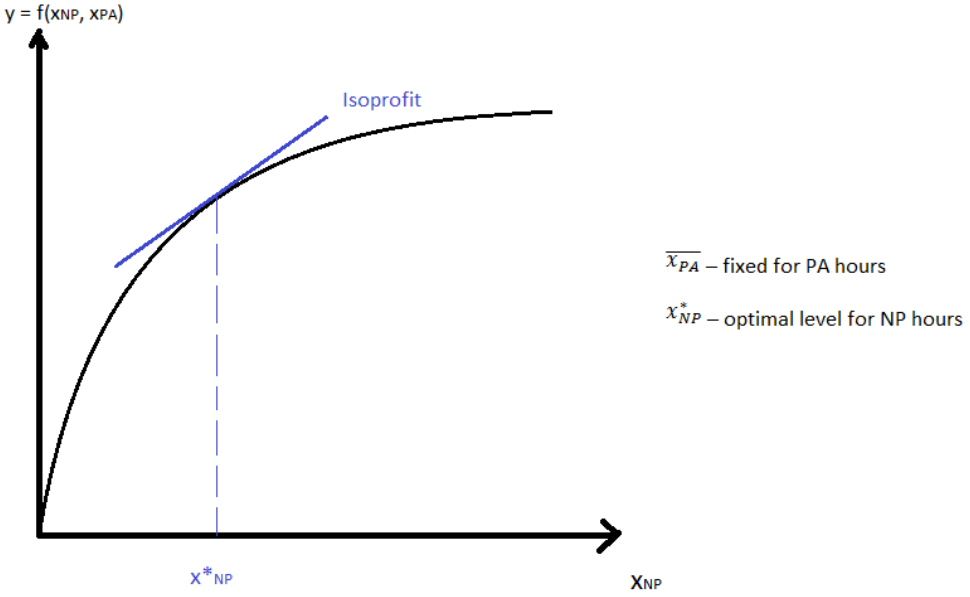
The production function is assumed to be Cobb-Douglas, $f(x_{NP}, x_{PA}) = Ax_{NP}^{\alpha}X_{PA}^{\beta}$, where A, α and β are positive constants. In particular, α and β are the shares of each input with assumption of decreasing returns to scale such that $\alpha + \beta < 1$. Further, without loss of generality, it is assumed that productivity factor, A = 1. Note that A, under the practice view, could be considered as size of a clinic, i.e., number of MDs practicing at the clinic. α and β could be viewed as productivity levels of NPs and PAs, such that NP and PA marginal products are positively related to α and β, respectively.

Digression: α may represent NP SOP change within a state, when a state decides to allow for full practice authority (change over time for one unit of consideration). Also, NP SOP varies across states at one particular time (year in the empirical model presented). Hence, if NP SOP is liberal, α is higher relative to states that have NP SOP restricted or α is higher when NP SOP changes compared to last period of observation for one state. However, since I assume that certain parameters, such as prices, wages, and market structure are given in the model, I only focus at one period. Further, the practice is assumed to operate at each distinct market in each particular state with certain variables fixed[276]. Specifically, it is assumed that health care services market varies across states, such that each state has their own distinct health care services market, with their own distinct supply and demand and relevant prices (and prices are exogenous, since sellers of services – clinics are price takers and buyers of services – patients are price takers as well and sellers of inputs – NPs and PAs are also price takers as wages are given).

Now focusing on one market for health care services in one state, Arizona, I consider a clinic in AZ that needs to solve its profit maximization problem. Figure 5.5 shows the profit maximization curve for this clinic.

[276] The assumptions above may implicitly suggest short run profit maximization case.

Figure 5.5.
Profit Maximization With Respect To x_{NP}



$$\max_{x_{NP},x_{PA}} pf(x_{NP},x_{PA}) - w_{NP}\,x_{NP} - w_{PA}x_{PA}$$

$$s.t.\ x_{NP}^{\alpha}x_{PA}^{\beta} \geq f(x_{NP},x_{PA})$$

$$\alpha + \beta < 1$$

$$Solving\ for\ x_{NP}\ (hours\ of NP)\ and\ x_{PA}\ (hours\ of PA):$$

$$x_{NP}^{*} = \frac{\alpha p f(x_{NP},x_{PA})}{w_{NP}} = \frac{\alpha py}{w_{NP}} = \alpha^{\frac{1-\beta}{1-\alpha-\beta}}\,\beta^{\frac{\beta}{1-\alpha-\beta}}\,w_{NP}^{-\frac{(1-\beta)}{1-\alpha-\beta}}\,w_{PA}^{\frac{-\beta}{1-\alpha-\beta}}\,p^{\frac{1}{1-\alpha-\beta}}$$

$$x_{PA}^{*} = \frac{\beta p f(x_{NP},x_{PA})}{w_{PA}} = \frac{\beta py}{w_{PA}} = \alpha^{\frac{\alpha}{1-\alpha-\beta}}\,\beta^{\frac{1-\alpha}{1-\alpha-\beta}}\,w_{NP}^{\frac{-\alpha}{1-\alpha-\beta}}\,w_{PA}^{-\frac{(1-\alpha)}{1-\alpha-\beta}}\,p^{\frac{1}{1-\alpha-\beta}}$$

$$y = \underbrace{\left(\frac{p\alpha}{w_{NP}}\right)^{\frac{\alpha}{1-\alpha-\beta}}}_{a}\ \underbrace{\left(\frac{p\beta}{w_{PA}}\right)^{\frac{\beta}{1-\alpha-\beta}}}_{b}$$

If α changes and $\overline{\beta}$, $\overline{w_{NP}}, \overline{w_{PA}}, \overline{p}$ is fixed, then $b\uparrow$ and $a\uparrow$. Therefore, $y\uparrow$.

However, if α and w_{NP} both change, say, as $\alpha\uparrow$, we may see demand for $x_{NP}\uparrow$ and then $w_{NP}\uparrow$; we do not know what happens to a, and thus, y.

Hence, the empirical question is whether α varies independently of w_{NP}. If so, it is possible to estimate the effect of each, holding other things constant.

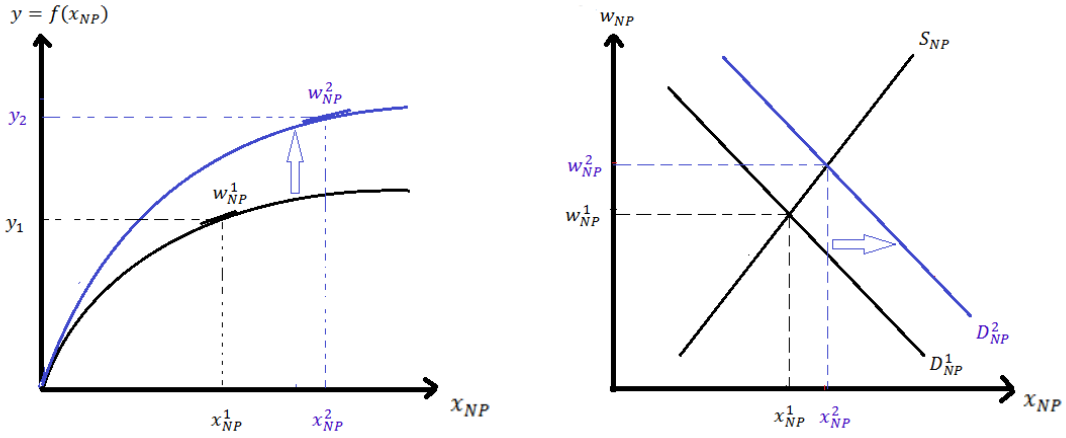
Assuming α is productivity (i.e., NP SOP in this case), then we are looking at how output (or patient volume) changes given a change in α. α implies that there is some change to input, and in turn, it creates changes in output. Productivity increase is supposed to expand production function. So, the question arises, what happens to wages of NPs:

- NP wage is an input price for supply of services (or patient volume)

There could be three scenarios for this productivity increase when NP SOP changes[277] (all else being constant):

i) NP wage, w_{NP}, increases if demand for NPs increases - this is the case where NP supply is not perfectly elastic.

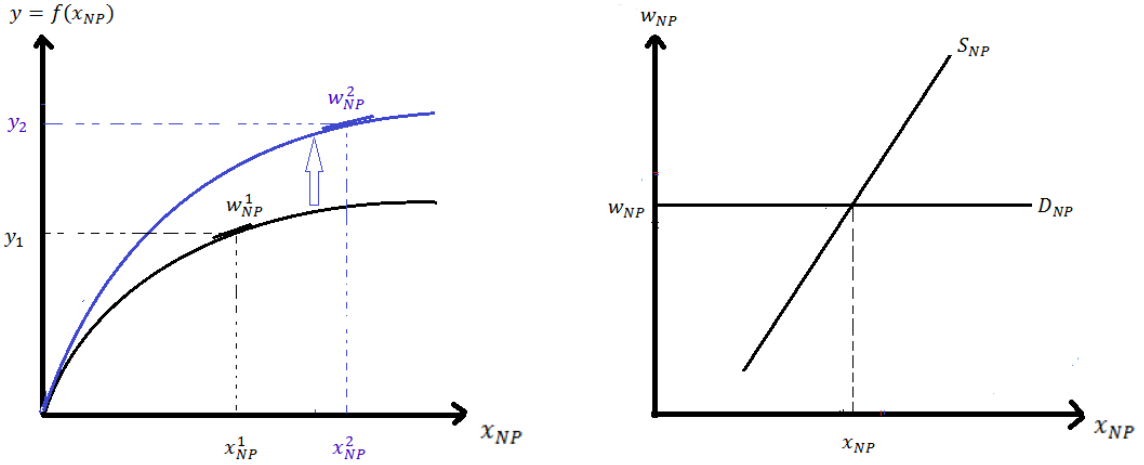
Figure 5.6.
Increase in w_{NP}



[277] Recall that Perry examined the impact of NP SOP on earnings of NPs and physicians and identified that if NPs have greater practice authority, defined in the study as NPs having controlled substance prescription authority and/or NPs having reimbursement authority, their earnings increase. For further details see Perry, 2009.

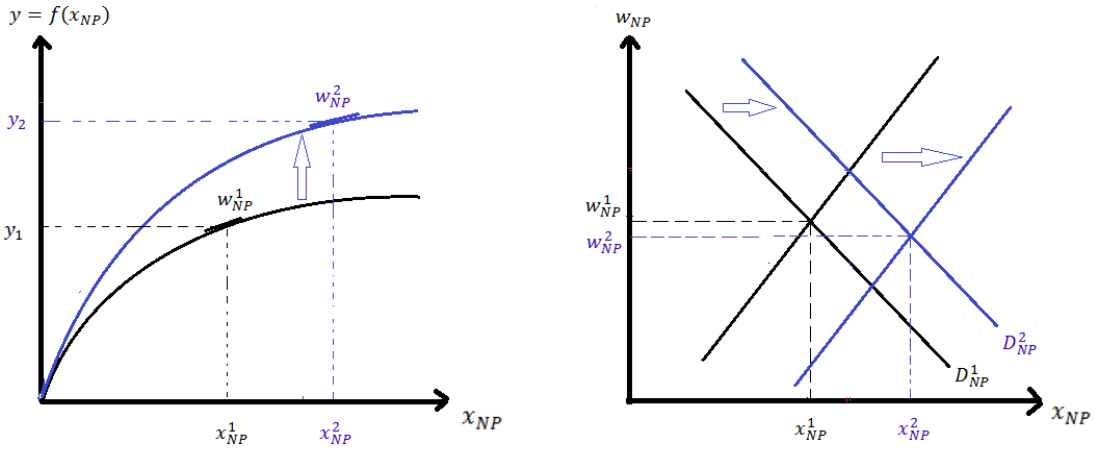
ii) NP wage, w_{NP}, stays the same if demand for NPs does not change - this is the price-taker case.

Figure 5.7.
No Change in w_{NP}



iii) NP wage, w_{NP}, decreases if demand for NPs decreases – this is possible but seems unlikely. It is a case where the move to liberal NP SOP not only increases the demand for NPs, but also causes a shift out in supply, and the shift in supply is greater than the shift in demand, resulting in a decrease in the market wage. Maybe the story here is that many trained NPs who are not currently working in practices, decide to find work in practices because, with liberal SOP, they believe the work will be more fulfilling (personally satisfying).

Figure 5.8.
Decrease in w_{NP}



$\overline{x_{PA}}$ is fixed in Figure 5.6 through 5.8.

The empirical questions that will follow in the results section of this chapter will address the following:

A) How patient volume depends on NPSOP [productivity, α, changes]
B) How patient volume varies by practice specialty
C) How patient volume varies by size of a practice
D) How patient volume is affected in places with higher HPSA primary care shortage.

Note that given the above theoretical framework, one would consider to look at how patient volume changes if wages of NPs change and whether NP SOP affects patient volume under the scenario of NP wage change. So, the question is — does patient volume unambiguously increase when the price of NP decreases, other things constant? Recall that NP and PA are substitutes to some extent, so one possibility is that the practice uses more NP and less PA but does not change its volume (output). Another possibility is that the practice uses more NP and increases its volume. Still another possibility is that although NP price has decreased, it has not decreased enough for the practice to hire another NP on a full-time basis, so unless the practice can hire a part-time NP there is no change in volume. However, since I assume a competitive market structure, I incorporate assumption of price-taking, i.e. prices are given and are exogenous to the other variables in the model, and therefore, this question is not explored in the empirical analyses followed below.

Methodology and data sources

Data sources

The data sources used in this chapter come from four main sources for the period of 2008-2013: SK&A, Linda Pearson Report, Census, and HRSA. Specifically, SK&A provides data on average number of patients seen daily by a practice at the practice level; practice specialty; size of a practice/number of MDs employed at the practice; total number of NPs and PAs employed at the practice; Pearson Report – NP SOP regulations, i.e., whether an NP has prescription and practice authority and number of NP schools at the state level; Census – population by state and designation of regions (Northeast, Midwest, South, West[278]); HRSA – number of practitioners needed to remove HPSA designation at the ratio of 1:3500[279]. HPSA designation data represents the last quarter of each previous year (i.e., for 2008 estimation, the data comes from December 2007).

[278] "Census Regions and Divisions of the United States," Prepared by the Geography Division: U.S. Department of Commerce Economics and Statistics Administration U.S. Census Bureau. As of May 5, 2017.

[279] Data received via email request. "Data on Primary Care Health Professional Shortage Areas ", Health Resources and Services Administration. As of August 10, 2016.

Methods used

The study design involved a literature review on patient visits and NP SOP and quantitative analyses addressing the research question regarding the impact of NP SOP on a daily patient volume in a practice. The quantitative analyses involved using STATA 12 software to run GLS with fixed and random effects and Tableau 10.3 was used to generate a map (Figure 5.2).

The literature review examined studies with emphasis on NP SOP regulations and their effect on realized access. It reviewed studies which estimated the impact of NP SOP given various regulations with regard to a patient's ability to seek and obtain medical care. Also, it focused on literature that explored the issue of shortage in primary care and the role of NPs under this situation.

The quantitative analysis involved using generalized least squares regression[280] with fixed effects and robust standard errors specification to test the effect of NP SOP on number of patients seen daily in a practice by its specialization as well as by size, and how HPSA primary care shortage – number of PCPs needed, defined by HPSA 1:3500 criteria – affected patient volume. Same as in the previous chapter, liberal NP SOP refers to no supervision for prescription and practice. The model will assume that the indicator for liberal NP SOP is exogenous to unobserved factors (in the error term) affecting the number of NPs.

To address the traditional challenge of production function models, i.e., where the firm chooses the inputs such that the inputs cannot be considered exogenous, the IV regressions are run. It could be argued that the change from restricted NP SOP to liberal NP SOP is exogenous to the practice. This seems plausible. It seems unlikely that any practice had enough political influence to induce regulators or legislators to change restricted NP SOP to liberal NP SOP. For IV regressions, NP demand regressions are used as instrumental variable equations. For an IV, number of NPs is regressed on variables that help to explain their variation but are exogenous to the medical practice (the presence of NP education programs and NP SOP regulations). The equation is used for predicting values of NP and is used in the patient volume regression. In this set-up, the effect of NP SOP on NP is identified in the IV regression, and the effect of NP SOP in the patient volume regression is a combination of the effect on NP and the direct effect on patient volume. The effect of NP SOP regulation on NP could be subtracted from the estimate of liberal on patient volume to get the direct effect on patient volume.

[280] GLS was chosen based on the large data advantage. According to Diehr (1999), utilization data are "usually non-normal, right-skewed, and heteroscedastic", but in the large datasets, ordinary least squares regression on the untransformed data that could have zeroes as well will generate unbiased estimates with possibility of having standard errors to be too small, but even then "significant effects are usually so strong that doubling or tripling the standard error would have little effect on the conclusions" (page 9). For further details see Diehr, Paula, D Yanez, A Ash, M Hornbrook, and DY Lin, "Methods for analyzing health care utilization and costs," *Annual review of public health,* Vol. 20, No. 1, 1999, pp. 125-144.

Model

Realized access to primary care depends on the availability of primary care providers in a certain geographic area and a particular time (in this case, *year*). There are several factors that have a direct impact on average patients seen daily in a practice, by practice specialty. Since the focus of this research study is to test whether state NP SOP has impact on patient volume, the suggested model is used to estimate the effect of NP SOP on daily average patients seen by a practice:

Practice Model: $\text{Average number of patients seen daily}_{\text{at practice p in year y and state s}} = \alpha + \beta * \text{Regulation NP SOP}_{\text{in state s and year y}} + \delta * \text{Total Number of NPs}_{\text{at practice p in state s and year y}} + \theta * \text{Total Number of PAs}_{\text{at practice p in state s and year y}} + \psi * \text{Total Number of MDs}_{\text{at practice p in state s and year y}} + \zeta * \text{Number of PCPs needed to remove HPSA}_{\text{in state s and year y}} + \sigma * \text{Primary care practice}_{\text{in state s and year y}} + \mu * \text{Population}_{\text{in state s and year y}} + \varepsilon_{\text{at practice p in year y and state s}}$

Average number of patients seen daily refers to average number of patients seen in a particular practice, year, and state in SK&A. Note that SK&A dataset does not include complete information on NPs and PAs. Moreover, practices that have patient volume equal to zero are the ones for which there is missing information[281].

Logarithm transformation is applied to the model as well. For the log specification, as there are practices that have either zero number of NPs, PAs, a scalar of one {log(x+1)} was added to run the pertinent regressions for practices that hire none of NPs and/or PAs. As to concern of number of MDs, practices that had no MD on site were removed from the analyses.

Null hypothesis, H_o: States with liberal NP SOP (or full practice authority that allows for independent prescription and practice authority) have higher daily average number of patients seen by a practice, all else being constant.

Under this hypothesis, the coefficient on NP SOP, α, has a causal effect on the patient volume. So, it is expected that α will have a positive sign, implying that average number of patients seen by a practice should be higher in states with liberal NP SOP compared to states with restricted NP SOP.

Also, I will analyze the impact of number of NPs employed on the patient volume, and how the outcome varies depending on the size of a practice and PCP need.

[281] Mendez, John, "Inquiry OM325064," Email correspondence, February 28, 2017.

Results

Steps for conducting analyses

The conducted analyses are founded on the idea of addressing several questions, which are a part of the hypothesis of having liberal NP SOP that is more likely to lead to higher patient volume seen, all other things being equal. As discussed in the previous chapter, the number of trained nurse practitioners exceeds the number of nurse practitioners employed by medical care providers. This means that the market supply of nurse practitioners is not likely to be strictly inelastic even in the short run; if the market demand shifts out, the market wage will rise and the quantity of nurse practitioners' services supplied to the market will increase. The increase in wage will attract some trained nurse practitioners who are working at non-medical care jobs. In addition, nursing schools provide newly trained nurse practitioners. Also, there is some overlap between the medical care services provided by nurse practitioners and physician assistants, that is, to some extent they are substitutes in production. Under these assumptions, the question arises whether there are theoretical conditions implying a positive (negative) relationship between nurse practitioners and patient volume. A practice will, in equilibrium, choose the volume of care and input mix that maximizes profit, which in turn leads to the questions raised prior and will be answered in this section:

(i) How liberal NP SOP affects patient volume;
(ii) How specialty of a practice, size of a practice, availability of NPs and PAs in a practice, and PCP need affects patient volume.

Before looking at the summary statistics and running regressions, the description of the variables is given in Table 5.1.

Table 5.1. Description of the Variables in the Regressions

Name	Description
patvoln	Patient volume, daily average number of patients seen in a practice
lpatvoln	Log of patvoln
liberal	Dummy variable for NP SOP; liberal = 1, restricted =0
np_indicator	Dummy variable for a practice to employ (or not) an NP (1 or more NP = 1, 0 = otherwise)
totnp	Total number of NPs employed at the practice (at a particular year, state, practice)
ltotnp	Logarithm of total number of NPs employed at the practice (at a particular year, state, practice)

pa_indicator	Dummy variable for a practice to employ (or not) a PA (1 or more PA = 1, 0 = otherwise)
totpa	Total number of PAs employed at the practice (at a particular year, state, practice)
ltotpa	Logarithm of total number of PAs employed at the practice (at a particular year, state, practice)
size	Total number of physicians (MDs) employed at the practice (at a particular year, state, practice)
lsize	Logarithm of total number of physicians (MDs) employed at the practice (at a particular year, state, practice)
primcare	Dummy variable to designate a practice either as specializing in primary care or not (if yes =1, 0 = otherwise)
pcp_need	Number of needed PCP to remove HPSA designation, given 1:3500 ratio at a certain state in a particular year
lpcp_need	Logarithm of number of needed PCP to remove HPSA designation, given 1:3500 ratio at a certain state in a particular year
popn	Population by year and state
lpopn	Logarithm of population by year and state

I start with descriptive statistics to explore the data and then I run regressions that will answer the questions above, and overall, address the hypothesis of this chapter[282].

Descriptive statistics

I start with exploring average of patient volume by state and year to examine how average of patient volume (obtained as average across all the practices in a state for a particular year) varies over six years per each region (Northeast, Midwest, South, West), which is presented in Figure 5.9.

[282] Appendix A1 describes detailed steps with regards to cleaning data and restricting the sample for the pertinent chapters.

Figure 5.9.
Average Patient Volume by State and Year

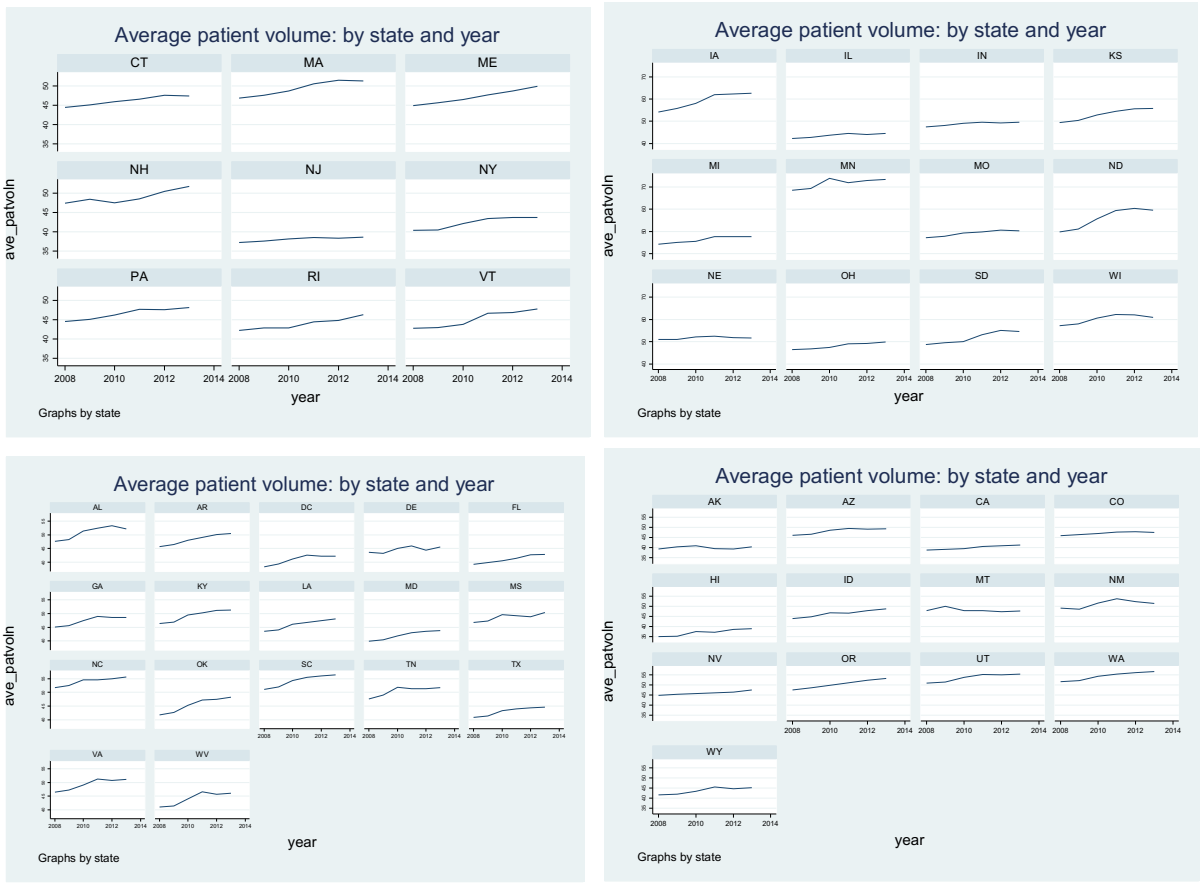


Figure 5.9 shows that the average patient volume by state and year exhibits increasing trend, indicating that each state experiences higher number of patient visits annually.

The next step involved checking the patient volume for these practices, categorized by number of MDs employed in a practice per year and whether NPs are employed by NP SOP and practice's specialty. Solo, small, and medium size practices that have at least one NP employed tend to have higher patient volume if they specialize in primary care across both restricted and liberal NP SOP states (Figure A3.5).

Table 5.2 examines the number of practices categorized by patient volume groups and NP SOP. As seen in the table, the number of practices each year is higher in restricted NP SOP compared to liberal NP SOP states per each category of patient volume. Given these results, one may deem that in this dataset there are more observations for practices in restricted NP SOP than for liberal NP SOP states; and thus, this may affect the relevant coefficients.

Table 5.2.
Number of Practices by Patients Seen Per Day in a Practice and NP SOP, Categorized by Year

Average patient volume per day in a practice	NP SOP			Average patient volume per day in a practice	NP SOP		
	Restricted	Liberal	Total		Restricted	Liberal	Total
	Year: 2008				Year: 2011		
1-20 patients	52,160	4,756	56,916	1-20 patients	48,499	7,295	55,794
21-80 patients	111,555	9,602	121,157	21-80 patients	105,834	14,208	120,042
81-180 patients	15,237	1,814	17,051	81-180 patients	17,512	3,032	20,544
181-420	2,658	355	3,013	181-420	3,425	630	4,055
421 or more patients	351	44	395	421 or more patients	411	57	468
Total	181,961	16,571	198,532	Total	175,681	25,222	200,903
	Year: 2009				Year: 2012		
1-20 patients	50,800	4,851	55,651	1-20 patients	53,130	8,655	61,785
21-80 patients	114,258	10,462	124,720	21-80 patients	110,003	15,729	125,732
81-180 patients	15,756	1,958	17,714	81-180 patients	18,999	3,438	22,437
181-420	2,729	382	3,111	181-420	3,904	753	4,657
421 or more patients	342	44	386	421 or more patients	464	73	537
Total	183,885	17,697	201,582	Total	186,500	28,648	215,148
	Year: 2010				Year: 2013		
1-20 patients	48,876	5,446	54,322	1-20 patients	55,172	9,376	64,548
21-80 patients	104,244	10,921	115,165	21-80 patients	111,690	17,168	128,858
81-180 patients	15,962	2,295	18,257	81-180 patients	19,919	3,816	23,735
181-420	3,095	480	3,575	181-420	4,181	845	5,026
421 or more patients	381	46	427	421 or more patients	471	75	546
Total	172,558	19,188	191,746	Total	191,433	31,280	222,713

About 18% (194,848/1,092,018) of the practices employ at least one NP in restricted NP SOP states compared to 23% (32,350/138,606) of practices in liberal NP SOP states across 2008-2013 years (Table A3.8). The results in Table A3.9 show that there are about 41% (444,243/647,775) of practices that specialize in primary care in states with restricted NP SOP and about 39% (53,712/138,606) in states with liberal NP SOP aggregated through six years. The largest group of practices is "solo" with the largest category for patient volume is 21-80 patients per day in both liberal and restricted NP SOP states (Table A3.10).

Based on these cross-tabulations and economic theory, it is expected that the coefficients for *liberal*, *totnp*, *totpa*, *size*, and *pcp_need* are positive, and it is not clear what relationship exists between primary care and patient volume (and thus, it will be identified in the models below).

Tables of regressions

Practice level regressions

Table 5.3 shows summary statistics of the variables used in the GLS models at the practice level. Again, the dependent variable, average patient volume per day at the practice, represents average daily number of patients seen in a practice in a certain state and year.

The cleaned dataset includes 1,230,624 observations for 284,206 practices throughout six years. The mean value of patient volume is on average about 46 patients seen per day in a practice. The number of NPs employed in practices ranges from none to 43, whereas the number of PAs is between 0 and 41, respectively. The number of MDs employed in a practice is between 1 to 406. The mean value of number of PCP needed to remove HPSA designation is about 326.

I start with exploring data by running GLS with clustered robust standard errors (CRSE) with three different specifications: the first model is run without full controls (Model 1.1, Table 5.4), second model (Model 1.2, Table 5.4) is run with fixed effects specification, and third model (Model 1.3, Table 5.4) is run with random effects specification to identify the impact of liberal NP SOP on patient volume.

Table 5.3.
Practice Level Regressions: Summary statistics for 2008-2013

Variable	Mean	Std. Dev.	Min	Max
patvoln	45.70404	51.52526	1	2000
lpatvoln	3.51096	0.753458	0	7.600903
size	2.793843	4.82771	1	406
lsize	0.6195348	0.774949	0	6.006353
totnp	0.2904567	0.805487	0	43
ltotnp	0.1628536	0.368497	0	3.78419
totpa	0.2185469	0.738948	0	41
ltotpa	0.1206244	0.328316	0	3.73767
pcp_need	326.2664	286.9821	1	1140
lpcp_need	5.236979	1.235201	0	7.038784
school	13.63308	7.753354	1	28
liberal	0.1126307	0.316141	0	1
primcare	0.4046362	0.490822	0	1
nsize	1.679474	0.8462	1	5
popn	14,000,000	10,800,000	546,043	38,400,000
lpopn	16.12427	0.88613	13.21045	17.46394

N = 1230624, n = 284206, T-bar = 4.33004.

Table 5.4.
Model 1: All Raw

VARIABLES	(1) Model 1.1	(2) Model 1.2	(3) Model 1.3
liberal	2.808***	2.511***	1.274***
	(0.209)	(0.258)	(0.200)
totnp		2.096***	4.015***
		(0.298)	(0.272)
totpa		1.741***	3.952***
		(0.314)	(0.304)
size		0.940***	2.545***
		(0.112)	(0.180)
primcare		-2.634***	-1.032***
		(0.262)	(0.238)
pcp_need		0.000484	-0.00154***
		(0.000434)	(0.000348)
popn		1.42e-06***	-1.05e-07***
		(9.91e-08)	(1.13e-08)
Constant	43.43***	22.82***	37.46***
	(0.0909)	(1.463)	(0.592)
Effects	None	Fixed	Random
Observations	1,230,624	1,230,624	1,230,624

R-squared (overall)	0.0006	0.0197	0.2863
Number of id	284,206	284,206	284,206

NOTE: Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

As can be seen from the results in Table 5.4, *liberal* has a positive effect on average daily patient visits, *ceteris paribus*, in all the three specifications. The coefficient on *liberal* ranges from 1.274 to 2.808 depending on the specification and is statistically significant at the 1% significance level in these three models. The signs of coefficients on the total number of NPs, PAs, and MDs employed in a practice are also positive, suggesting a positive effect of each on average daily visits, all else being constant. The coefficient for primary care is negative and statistically significant, suggesting that practices specializing in primary care are expected to have lower patient volume, holding all else constant. This result may imply that the number of primary care practices is 497,955 and the number of non-primary care is 732,669. Therefore, given that there are more practices that are non-primary care, these results seem to be aligned with the data. Practices situated in states with a higher PCP need seem to have lower patient volume, *ceteris paribus*. However, *pcp_need* is statistically significant only in Model 1.3, contrary to the hypothesis I had prior. The expected hypothesis on population is that the larger the population, the higher the number of daily patient visits is expected. The coefficient on *popn* is positive when fixed effects specification is used in Model 1.2 and consistent with expected hypothesis, however, it changes sign to the negative under Model 1.3 when random effects specification is utilized.

To identify which specification to use in subsequent regressions, I conducted the Hausman test, the results of which showed that fixed effects specification is a better-fitted model. Fixed effects specification shows that NP SOP has a larger effect on patient volume compared to random effects coefficient. This is because in the fixed effects specification the variation across the time for a particular practice is observed, and thus, it is expected that the change in the NP SOP from restricted to liberal may have a higher impact on a practice rather than across various practices over time under the random effects specification. As the random effect specification allows for error correlation at the practice level and the estimated coefficients depend on both variation within a practice over time and variation across practices, while the coefficients in the fixed effect specification reflect variation over time within a practice. The fixed effects coefficients are often smaller than the random effects coefficients, suggesting a relatively limited opportunity to expand patient volume during the six-year time frame of the SK&A data, when looking at the impact of employment of NPs in a practice and liberal NP SOP.

Also, I performed another test[283] to identify if standard errors should be adjusted for heteroskedasticity – the results of the test suggest that robust standard errors should be used in the

[283] For further details on xttest3, run "help xttest3" command in STATA 12.

fixed effects model. For further exploration log transformations are applied to dependent and independent variables and the following three GLS fixed effects models with various specifications are run, as shown in Table 5.5.

Table 5.5.
Model 2: Log Transformations

VARIABLES	(1) Model 2.1	(2) Model 2.2	(3) Model 2.3
liberal	0.0261***	0.0206***	0.0202***
	(0.00326)	(0.00391)	(0.00390)
totnp		0.0339***	
		(0.00172)	
totpa		0.0258***	
		(0.00184)	
lsize		0.152***	0.152***
		(0.00239)	(0.00239)
primcare		-7.20e-05	0.000310
		(0.00340)	(0.00340)
lpcp_need		-0.00134	-0.00120
		(0.00169)	(0.00169)
lpopn		0.135***	0.133***
		(0.0135)	(0.0134)
ltotnp			0.0817***
			(0.00300)
ltotpa			0.0717***
			(0.00331)
Constant	3.461***	1.224***	1.251***
	(0.00139)	(0.217)	(0.216)
Observations	1,230,624	1,230,624	1,230,624
R-squared (overall)	0.0003	0.1890	0.2038
Number of id	284,206	284,206	284,206

NOTE: Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Again, the results in the Table 5.5 suggest that *liberal* has a positive impact on patient volume and the coefficient is about 2% and statistically significant in all these three models, as expected, all else being constant. Specifically, the coefficient in Model 2.3 indicates that if a practice is located in the state with liberal NP SOP, average daily visits are expected to be about 2% higher, *ceteris paribus*. Similarly, the coefficients on total number of NPs, PAs, and logarithmic transformation of NPs, PAs, and size (number of MDs) are positive and statistically significant at the 1% significance level, implying positive effect on average daily patient visits, holding everything else constant. The coefficient on primary care is not statistically significant in both Model 2.2 and Model 2.3 and changes signs from negative to positive, depending on the model specification. The sign on the coefficient for logarithmic transformation for the number of PCP needed to remove HPSA shortage designation in the state is positive, but not statistically

significant in both Model 2.2 and Model 2.3. The sign on the coefficient for logarithmic transformation for population is positive, as expected, and statistically significant at the 1% significance level.

Given the varying results for practices specializing in primary care or non-primary care, I ran regressions by restricting my sample to two groups – primary care practices versus non-primary care practices to identify the impact of liberal NP SOP and if it varies across these two groups. Model 3 in Table 5.6 shows these results.

Table 5.6.
Model 3: Comparison of Primary Care Practices to Non-Primary Care

	(1)	(2)	(3)	(4)	(5)
VARIABLES	Model 3.1	Model 3.2	Model 3.3	Model 3.4	Model 3.5
liberal	2.511***	0.756***	3.760***	-0.0109**	0.0416***
	(0.258)	(0.291)	(0.388)	(0.00528)	(0.00550)
totnp	2.096***	2.296***	1.831***		
	(0.298)	(0.219)	(0.477)		
totpa	1.741***	2.200***	1.575***		
	(0.314)	(0.220)	(0.404)		
size	0.940***	1.861***	0.807***		
	(0.112)	(0.410)	(0.112)		
primcare	-2.634***				
	(0.262)				
pcp_need	0.000484	0.00115***	-5.72e-05		
	(0.000434)	(0.000446)	(0.000638)		
popn	1.42e-06***	1.01e-06***	1.54e-06***		
	(9.91e-08)	(1.11e-07)	(1.18e-07)		
ltotnp				0.0772***	0.0815***
				(0.00380)	(0.00451)
ltotpa				0.0760***	0.0676***
				(0.00480)	(0.00439)
lsize				0.158***	0.144***
				(0.00381)	(0.00308)
lpcp_need				0.00503**	-0.00503**
				(0.00229)	(0.00238)
lpopn				0.0468**	0.169***
				(0.0219)	(0.0164)
Constant	22.82***	23.49***	21.91***	2.647***	0.674**
	(1.463)	(1.732)	(1.712)	(0.354)	(0.263)
Observations	1,230,624	497,955	732,669	497,955	732,669
R-squared (overall)	0.0197	0.0316	0.0200	0.3666	0.1680
Number of id	284,206	113,520	186,952	113,520	186,952

NOTE: Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Five GLS fixed effects regressions with various specifications were run. Model 3.1 is used for comparison as it includes both primary and non-primary care practices in its data sample. Model

3.2 is run for identifying an impact of liberal among primary care practices and Model 3.3 is run for non-primary care practices only. The coefficient on *liberal* is positive and statistically significant at the 1% significance level in both Model 3.2 and Model 3.3, as expected; however, the magnitude of the coefficient is higher in Model 3.3. The results suggest that impact of liberal NP SOP on patient volume is larger in practices that specialize in non-primary care. Not surprisingly, the signs on coefficients for total number of NPs, PAs, and MDs (*size*) employed in a practice are positive and statistically significant at the 1% significance level. The coefficient on the number of needed PCPs to remove HPSA shortage designation is either positive or negative, depending on the model specification, but statistically significant only in Model 3.2, given 99% confidence interval, all else being constant. The positive sign on the PCP need may be in line with the theory that practices that specialize in primary care are expected to have higher patient volume if PCP need is higher, all else holding constant. Model 3.4 and Model 3.5 are replica of Model 3.2 and Model 3.3, but with the variables (including the dependent variable) to be logarithmically transformed – with Model 3.4 being on primary care practices and Model 3.5 – non-primary care only, respectively. The sign on coefficient for liberal NP SOP now varies across two models. In Model 3.4, *liberal* is negative, suggesting that if a practice is in the state with liberal NP SOP and specializes in primary care, it has lower patient volume, *ceteris paribus*, and the coefficient is statistically significant at the 5% significance level. While in Model 3.5, *liberal* has a positive effect in among non-primary care specializing practices in state with liberal NP SOP, all else holding constant. The *ltotnp, ltotpa, lsize*'s coefficients have expected signs and statistically significant at the 1% significance level in both Model 3.4 and Model 3.5. Again, depending whether a practice specializes in primary care on non-primary care, the sign on coefficient *pcp_need* varies, with a positive impact on patient volume in practices specializing in primary care, all else being constant. Across all five models, the sign on population coefficient (*popn* and *lpopn*) is positive and statistically significant at the 1% significance level, suggesting that the larger the population, the higher is daily patient volume, holding all else constant.

Does liberal NP SOP have a different impact on the daily average patient visits, depending on the number of MDs employed in a practice? The next step is to further explore the impact of liberal NP SOP among practices grouped by size. Size, number of MDs employed in a practice, is grouped by five categories: (1) Solo: 1 MD in a practice, (2) Small: 2-4 MDs in a practice, (3) Medium: 5-9 MDs in a practice, (4) Large: 10-20 MDs in a practice, and (5) Very large: 21 or more MDs in a practice. The categories were created based on the frequencies of practices in my data sample. In the GLS with fixed effects models in Table 5.7, I chose to run my specifications not including logarithmic transformations for the variables used, as size is grouped into categories, and therefore, it is easier to interpret models if variables are in their non-transformed form.

Model 4.1 is given for comparison and it includes *size* (continuous variable) across all the 5 groups. The next 5 models are for each category specified above. As could be seen from the results

above, the coefficient on *liberal* is positive and significant at the 1% significance level in all the models, except Model 4.2. Nevertheless, the impact of liberal NP SOP increases with the larger group, i.e., if a practice is large or very large, the coefficients on *liberal* are 10.38 or 50.52, respectively, that is if a practice is in the state with liberal NP SOP, the expected daily patient volume is higher by 50.52 patients in very large practices, *ceteris paribus*. These findings are significant and indicate that the role of NP SOP increases with the practice's *size*. As expected, the signs on coefficients for *totnp, totpa, size* are positive and in many cases, are statistically significant at least at the 5% significance level, except in the case of *totpa* in Model 4.6. Signs on coefficients for *pcp_need* and *primcare* vary, depending on the model specification, but in some models these coefficients are not statistically significant. Consistent with expected hypothesis, the sign on *popn* is positive and statistically significant at the 1% significance level in 5 models with the exception of Model 4.6 (where *popn* is statistically significant at the 10% significance level) and indicates that the effect of *popn* is larger with a larger practice size.

Table 5.7.
Model 4: Restricted by Size Categories

	(1)	(2)	(3)	(4)	(5)	(6)
VARIABLES	Model 4.1	Model 4.2	Model 4.3	Model 4.4	Model 4.5	Model 4.6
1.liberal	2.511***	0.154	2.625***	4.122***	10.38***	50.52***
	(0.258)	(0.137)	(0.357)	(0.946)	(3.671)	(17.93)
1.primcare	-2.634***	0.614**	-0.597**	-1.333	-3.809	12.16
	(0.262)	(0.239)	(0.299)	(1.168)	(2.884)	(9.928)
totnp	2.096***	1.960***	2.317***	1.837***	0.150	1.418
	(0.298)	(0.156)	(0.179)	(0.332)	(0.926)	(2.557)
totpa	1.741***	1.937***	2.247***	2.054***	2.318***	-1.680
	(0.314)	(0.153)	(0.180)	(0.349)	(0.677)	(2.363)
size	0.940***		2.592***	1.825***	1.383***	0.198
	(0.112)		(0.104)	(0.170)	(0.294)	(0.125)
pcp_need	0.000484	0.000609***	0.000878	-0.000529	-0.00294	0.0109
	(0.000434)	(0.000186)	(0.000686)	(0.00149)	(0.00657)	(0.0213)
popn	1.42e-06***	1.73e-07***	1.97e-06***	4.59e-06***	6.97e-06***	7.35e-06*
	(9.91e-08)	(3.36e-08)	(1.76e-07)	(6.58e-07)	(1.71e-06)	(4.34e-06)
Constant	22.82***	23.74***	13.56***	14.52*	24.24	119.9**
	(1.463)	(0.525)	(2.452)	(8.387)	(21.55)	(57.68)
Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1,230,624	633,128	416,875	132,408	38,366	9,847
R-squared (overall)	0.0197	0.0103	0.0000	0.0005	0.0002	0.0004
Number of id	284,206	174,486	123,621	40,903	12,174	3,011

NOTE: Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

The final step is to examine the impact of liberal NP SOP by grouping practices by sizes and specialty. Table 5.8 presents results of GLS fixed effects regressions with robust standard errors clustered around practices with various specifications restricted to primary care specialty and grouped by category of a practice's size.

Table 5.8.
Model 5: Restricted to Primary Care Practices Only and by Size

VARIABLES	(1) Model 5.1	(2) Model 5.2	(3) Model 5.3	(4) Model 5.4	(5) Model 5.5
liberal	-0.372**	2.088***	4.256***	-0.560	8.007
	(0.178)	(0.635)	(1.553)	(14.11)	(19.11)
totnp	1.798***	1.774***	2.235***	0.957	16.80
	(0.173)	(0.222)	(0.527)	(1.077)	(16.64)
totpa	1.750***	2.289***	3.201***	3.033	4.661
	(0.188)	(0.276)	(1.045)	(3.628)	(10.30)
size		3.206***	2.822***	-0.229	0.119
		(0.202)	(0.374)	(0.732)	(0.336)
pcp_need	0.000285	0.00152*	-0.00129	0.0287	0.0249
	(0.000247)	(0.000833)	(0.00272)	(0.0240)	(0.0815)
popn	1.66e-08	2.30e-06***	4.68e-06***	7.74e-06**	4.64e-05
	(5.82e-08)	(3.32e-07)	(1.72e-06)	(3.75e-06)	(3.61e-05)
Constant	27.68***	14.76***	26.84	39.06	-427.6
	(0.884)	(4.418)	(20.12)	(46.24)	(442.4)
Fixed Effects	Yes	Yes	Yes	Yes	Yes
Observations	308,805	146,612	36,812	5,171	555
R-squared (overall)	0.0785	0.0002	0.0002	0.0005	0.0406
Number of id	79,713	42,399	10,717	1,793	217

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

The five model specifications demonstrate results for practices specializing in primary care and by five categories for *size*. In two out of five specifications, liberal NP SOP has a negative sign, which is not expected. First, in Model 5.1, the coefficient on *liberal* is -0.37 and statistically significant at the 5% significance level for "Solo: 1 MD in a practice" group with primary care specialization, suggesting that if a practice is in liberal NP SOP state, it is expected to have a lower number of average daily patient visits by 0.37, *ceteris paribus*. As previous data showed, there are fewer practices that are in liberal NP SOP states in my data sample, so these results may account for that. Besides, it may be expected that solo practices have limited capacity on how many patients they could accept daily, and perhaps, in states with liberal NP SOP, the practitioners that own these practices prefer to accept fewer patients per day when compared to solo practices in states with restricted NP SOP. In Model 5.4, the coefficient on liberal is -0.36, but not statistically significant at the 10% significance level for "Large: 10-20 MDs in a practice" category. In all the other cases, the coefficient on *liberal* is positive and ranges from 2.088 to 8.007, depending on the model specification. The signs for *totnp, totpa, size* are all positive (except *size* is negative in Model 5.4) and in many cases, are statistically significant at the 1% significance level. PCP need coefficient's sign varies across models and not statistically significant in all the 5 models, suggesting that one fails to reject the hypothesis that the coefficient on *pcp_need* is statistically different from zero. The coefficient sign on *popn* is positive across all five models, suggesting that given each size of a practice (Solo, Small, Medium, Large, and Very Large), the larger the population, the higher the

number of daily patient visits, all else holding constant. The results for Model 5.4 and Model 5.5 are based on a relatively small number of practices, and therefore, one has to be cautious about its reliability when interpreting the results.

Table 5.9 represents GLS fixed effects regressions with various specifications for practices specializing in non-primary care only and by their size category. For non-primary care practices, liberal NP SOP has a positive impact and is statistically significant at the 1% significance level across all the five model specifications. Interestingly, the coefficient on *liberal* increases with size category, suggesting that the larger the practice that specializes in non-primary care, the higher the impact of liberal NP SOP on patient volume. Specifically, the coefficient on *liberal* ranges from 0.627 for "Solo" practices to 51.94 for "Very large" practices, that is if a practice is in the state with liberal NP SOP it is expected to have about 52 more average daily patient visits if its size is 21 or more MDs, all else being constant. The signs on *totnp, totpa, size* are positive (except in Model 6.4 and Model 6.5), as expected, and in many model specifications are statistically significant (except for *totnp* in Model 6.4 and *totpa* in Model 6.5). Only in two model specifications, Model 6.1 and Model 6.5, the sign on coefficient for PCP need is positive as expected (but only statistically significant at the 1% significance level in Model 6.1), suggesting that if a practice is in the state with a higher number of PCP needed to remove HPSA designation, the larger the daily patient volume is, all else being constant. Consistent with hypothesis, *popn* is positive and statistically significant at the 1% significance level in all models, except Model 6.5.

Summarizing the impact of liberal NP SOP across the six models with different specifications, there is a positive effect of liberal NP SOP on average daily patient visits. The results are consistent and robust across almost all the models. Moreover, the number of NPs (and PAs) employed is in many cases associated with higher patient volume.

Table 5.9.
Model 6: Restricted to Non-Primary Care Practices and by Size

	(1)	(2)	(3)	(4)	(5)
VARIABLES	Model 6.1	Model 6.2	Model 6.3	Model 6.4	Model 6.5
liberal	0.627***	3.103***	4.258***	11.99***	51.94***
	(0.202)	(0.436)	(1.172)	(3.654)	(18.57)
totnp	2.328***	2.637***	1.446***	-0.152	0.784
	(0.334)	(0.266)	(0.438)	(1.098)	(2.650)
totpa	2.183***	2.181***	1.673***	2.244***	-1.588
	(0.259)	(0.240)	(0.356)	(0.693)	(2.356)
size		2.176***	1.595***	1.575***	0.210
		(0.125)	(0.192)	(0.324)	(0.132)
pcp_need	0.000869***	0.000796	0.000430	-0.00598	0.00948
	(0.000277)	(0.000951)	(0.00178)	(0.00690)	(0.0218)
popn	2.62e-07***	1.78e-06***	4.60e-06***	6.92e-06***	6.72e-06
	(4.42e-08)	(2.00e-07)	(7.16e-07)	(1.80e-06)	(4.35e-06)
Constant	21.50***	13.09***	7.578	20.86	132.8**
	(0.675)	(2.865)	(9.390)	(22.84)	(57.91)

Fixed Effects	Yes	Yes	Yes	Yes	Yes
Observations	324,323	270,263	95,596	33,195	9,292
R-squared (overall)	0.0007	0.0000	0.0001	0.0004	0.0002
Number of id	97,807	87,461	31,706	10,700	2,837

NOTE: Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

A traditional challenge – or criticism – of production function models is that the firm chooses the inputs so the inputs cannot be considered exogenous. However, it should be noted that the change from restricted to liberal NP SOP was exogenous to the practice and this appears to be credible.

As a thought experiment, let us assume that the change from restricted NP SOP to liberal NP SOP was exogenous to a practice, and then one can describe the full effect on patient volume of this change as follows:

Let Δx represent the change from restricted to liberal NP SOP. Then Δpatient volume/ Δx = Δconstant/ $\Delta x + \alpha^* \Delta$Number of NPs/ $\Delta x + \beta^* \Delta$Number of PAs/ Δx. In the regression, Δconstant/ Δx is represented by the coefficient on liberal; it is the change in the constant when 'liberal' is on. Information about ΔNumber of NPs/ Δx and ΔNumber of PAs/ Δx comes from the earlier regressions on the effect of 'liberal' on the number of NPs and PAs employed by a practice. However, there is still the concern that coefficients on the number of NPs and PAs are biased, because number of NPs and PAs employed are endogenous. The direction of the bias for the number of NPs employed will be positive and negative for number of PAs employed in the states with liberal NP SOP, as it is more valuable to employ NPs in states where NPs could be as close substitutes to MDs, whereas PAs are more as complements to MDs. Therefore, I ran a simple IV regression to see whether the impact of NP SOP differs from the above results.

The chosen IV for estimating the equation on the decision of a practice to employ NPs are number of NP schools available in the state and liberal NP SOP categorical variable. I do not include liberal NP SOP in the equation on estimating the patient volume[284]. The impact of availability of NPs is positive and statistically significant at the 1% significance level and is higher than the impact of availability of PAs in both Models 7.1 and 7.2 in Figure 5.10 (with logarithmically transformed variables). Further, the coefficient on the number of NPs is much larger than the coefficient on the number of NPs employed in a practice from the earlier regressions.

[284] I ran one that included *liberal* variable both in the first and second equations, however, the results for most of the coefficients are not statistically significant and the performance of the overall model seems to be not plausible.

As seen in the regressions above[285], the results are robust and strong – no matter what model I run the NP SOP has an impact on patient volume — we expect to see higher realized access to care in states with liberal NP SOP compared to states with restricted NP SOP. In addition, the impact of liberal NP SOP is higher in magnitude if practices specialize in non-primary care compared to primary care while grouped by size of a practice. Although not consistent across all the models, nevertheless, the results also suggest that overall, the number of NPs hired affects patient volume more than the number of PAs, all else being constant. In general, employment of NPs and/or PAs in a practice increases patient volume, all else being constant. Another interesting finding from the above empirical results is that PCP need changes its sign from positive to negative, depending on model's specification. Although, in many of the regressions run, the coefficient on PCP need is not statistically significant, but in some cases it is positive, which might indicate that if there are more PCPs needed to remove HPSA designation, the higher the patient volume is expected. The coefficient on indicator variable for primary care specialty, *primcare*, changes its sign across different models, however, in many model specifications, it has a negative sign, suggesting a negative relationship between patient volume and specialty of a practice being primary care. These results may merely indicate that there are more non-primary care specialty practices with higher patient volume than primary care specialty practices, since there are about 40% (or 497,955 out of 1,230,624) of practices that specialize in primary care in my SK&A data sample.

Table 5.10.
Model 7: IV Regressions

	(1)	(2)
VARIABLES	Model 7.1	Model 7.2
totnp	38.82***	
	(2.745)	
totpa	0.862***	
	(0.104)	
size	-0.415***	
	(0.103)	
1.primcare	-2.510***	0.000618
	(0.192)	(0.00252)
pcp_need	5.05e-05	
	(0.000313)	
popn	9.50e-07***	
	(6.39e-08)	
ltotnp		1.046***
		(0.0829)
ltotpa		0.0939***
		(0.00297)
lsize		0.105***

[285] For comparison reason, I also ran Poisson regressions and the results were similar to the results obtained in the other models presented.

		(0.00426)
lpcp_need		0.00465***
		(0.00139)
lpopn		0.0512***
		(0.0105)
Constant	23.07***	2.414***
	(0.774)	(0.160)
Instrumented: totnp (ltotnp)		
Instruments: totpa size 1.primcare pcp_need liberal school (ltotpa lsize 1.primcare lpcp_need 1.liberal lschool)		

NOTE: Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Discussion and Limitations

Limitations

Some of the data is not reliable, as could be deduced from the observations on patient volume and the number of NPs and PAs working at the practice[286]. This could affect the estimated impact of the number of NPs employed. Due to data limitations, better measures of PCP need were not available, and therefore, the impact of PCP need might be biased. Also, I did not include provider density to account for the competition among practices, which may have an impact on patient volume. The rationale was to use a simpler model that focuses on identifying the effect of NP SOP and the availability of NPs versus PAs on the patient volume and to not increase the number of variables in the model that may bias the results further given the limitations associated with data quality. Another limitation of this study is that I did not run analyses using IV regressions as well as Poisson regression pertaining to the count data model to a full extent, but only for a comparison to see if the impact of NP SOP is identified in these models as well. Although the results are consistent across various models, one should be cautious about interpreting the coefficients, especially with respect to PCP need and employment of NPs and PAs.

Discussion

[286] When I inquired SK&A representative, Michele Smith, said that the number of NPs and PAs is not the "entire universe": "If the site already has NPs and/or PAs listed, RA confirms the name and that they are still at the location. The RAs are also required to ask if there are any additional NPs or PAs at the location during the call verification. Also if one of the listed NPs or PAs is no longer at the location, the RA asks for a replacement name" (Smith, Michele, "SK&A Data Survey," Email and phone correspondence, October 24, 2016).

Also, in email correspondence with SK&A representative, it was found the data on patient volume may have missing values, which are represented by zeroes; although these observations were eliminated from my data sample. Mendez, John, "Inquiry OM325064," Email correspondence, February 28, 2017.

The empirical results aligned with the findings in literature. Liberal NP SOP has a positive impact in health care, affecting realized access to health care. For instance, Stange[287] found a three percent increase in visits in states with less restrictive NP prescriptive authority, conditional on having at least one office-based provider visit. In my Model 2.3, states with liberal NP SOP have 2.15% higher patient volume, controlling for other variables, and the magnitude of the coefficient on liberal NP SOP is relatively close to Stange's findings. In my study, liberal NP SOP requires both independent prescription and practice authority, which differs from Stange's NP prescriptive authority only.

As discussed in the literature review section, the findings of my analyses are consistent with what could be inferred from the various studies in this area. The employment of NPs, especially in locales with a higher shortage of PCPs, improves access to health care, as some of the literature hypothesized.

Concluding remarks

The empirical results imply that realized access to health care – patient volume – is affected by a state's NP SOP. Liberal NP SOP has a higher impact, measured by the magnitude of the coefficient, in non-primary care practices than in primary care practices. PCP need appears to have little impact on patient volume, however.

The regression results suggest that access to health care could be improved if states adopted liberal NP SOP regulations. This would especially benefit states facing a shortage of PCPs and could enable them to increase access to health care, including primary care. NPs and PAs do help to alleviate physician workloads and increase number of patients seen. Similarly, changing to liberal NP SOP could help to ease the forecasted shortage of physicians. Population aging will increase the demand for medical providers including primary care providers, and NPs are trained not only to provide care but also to encourage prevention. Avoiding hospitalization and usage of emergency rooms by using more of preventative care, improving access to primary care, and availability of PCPs may be a relatively accessible solution and affordable approach, deserving further attention by policy makers.

[287] Stange, 2014.

6. The Center for Medicare and Medicaid Innovation's Comprehensive Primary Care Initiative and Nurse Practitioner Scope-of-Practice in Primary Care

The previous two chapters focused on potential and realized access to primary care with the focus on how NP SOP affected number of NPs working in a practice and average daily patient visits. This chapter will investigate the relationship between the Center for Medicare and Medicaid Innovation's Comprehensive Primary Care Initiative (CMMI's CPCI[288]) innovative payment and practice model on Primary Care Transformation and NP SOP in the seven regions that piloted it. One of the primary objectives of the CPCI is to reduce costs in health care and improve access to primary care via usage of special payment and practice model under this initiative. This chapter attempts to identify the relationship between NP SOP regulations and participation of the practices in the Center for Medicare and Medicaid Innovation's Comprehensive Primary Care Initiative innovative payment and practice model on Primary Care Transformation. The focus of this chapter is to investigate the association between practices participating in the CPCI and their likelihood of employing NPs and whether employment of NPs working in these CPCI practices varies under NP SOP regulations. The analyses provided in this chapter examine the relationship between NP CPCI participation at the practice level from a provider's perspective. The results of logit regressions show that a practice is more likely to participate in the CPCI if it has NPs and/or PAs employed and the likelihood is higher if a practice is located in the region with liberal NP SOP. The following sections will cover concise background information on the CMMI's CPCI payment model[289], literature review on the CPCI, methodology, and study results, followed by discussion and concluding remarks.

Background and literature review

Before developing the mathematical model, let us first look at how the CPCI payment model works. The mathematical model will be developed based on the specifics of the CPCI payment model.

Description of the CPCI payment model

Briefly about CPCI and payment model

[288] Later in the text, I use "CPCI" instead of "CMMI's CPCI".

[289] Appendix A2 presents detailed description of the CPCI payment model.

The CPCI "integrates a defined payment model with a specific practice redesign model to support *improved care, better health for populations, and lower health costs* through improvement"[290]. The 'payment model' entails (1) a monthly non-visit based care management fee and (2) the opportunity to share in any net savings to the Medicare program. The 'practice redesign model' entails offering resources for practices to provide five comprehensive primary care functions that are (1) access and continuity, (2) planned care for chronic conditions and preventive care, (3) risk-stratified care management, (4) patients and caregiver engagement, and (5) coordination of care across the medical neighborhood.

The way one could view the CPCI is that to implement redesign and transformation of primary care[291], a practice receives funds via a special payment method that includes regular fee-for-services base fee, management care fees per member per month, and potential for sharing in net savings to the Medicare program.

What are the components of the enhanced payments?

Each CPCI participating practice receives enhanced payments from the CMS and other participating payers. These enhanced payments include non-visit-based payments (also called as non-visit based care management per-month-per-member (PMPM) fees) and the opportunity to share in any net savings to the Medicare program on top of base fee-for-services. The first two forms of financial support are paid by the participating payers on behalf of practice's fee-for-service Medicare (or CPC-attributed) beneficiaries in addition to the practice's usual revenue for supporting the hiring of additional primary care staff, infrastructure, and care management, associated with participation in the CPCI[292]. For instance, non-Medicare FFS payers paid practices about 40 percent of total CPC funds – which is $50.1 million in CPC enhanced payments in PY2014[293]. In 2015, attributed CPC patients included 40% of the total number of patients for the CPCI participating practices and for these patients CPC participating payers paid $104.3 million in care management fees, as shown in Figure 6.1[294].

[290] "Comprehensive Primary Care Initiative ", no date.

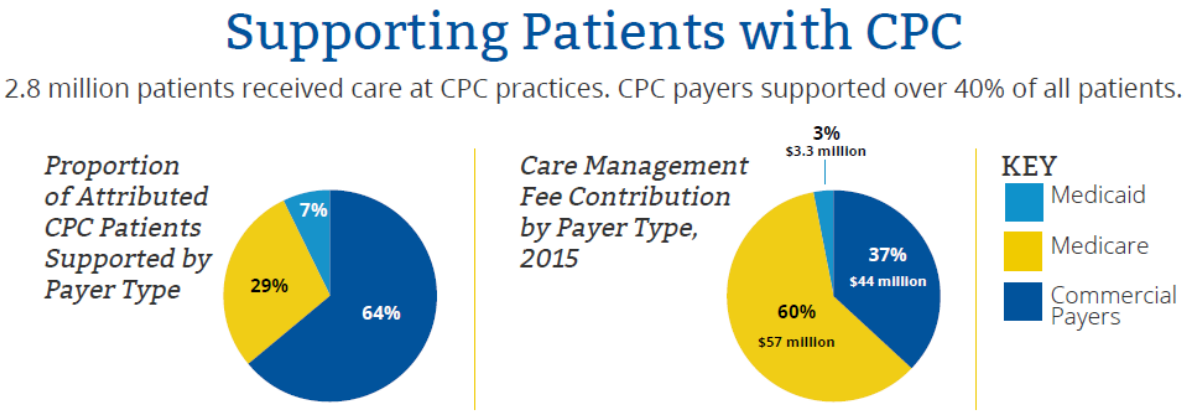
[291] For further details see Peikes, Deborah , Arkadipta Ghosh, Aparajita Zutshi, Erin Fries Taylor, Grace Anglin, Lara Converse, Stacy Dale, Kaylyn Swankoski, Randall Brown, and Ann O'Malley, *Evaluation of the Comprehensive Primary Care Initiative: Second Annual Report*, Mathematica Policy Research, 2016. page 14.

[292] Taylor et al., 2015.

[293] Peikes et al., 2016, page 18.

[294] "Comprehensive Primary Care Initiative: Fast Facts", 2016.

Figure 6.1.
Supporting Patients with CPC



How does NP SOP and employment of NPs and/or PAs affect the decision whether a practice participates in the CPCI? Is there any relationship?

One of the ways to see the benefit of a practice having NPs and/or PAs employed prior to the CPCI is that now if a practice decides to participate in the CPCI, it could invest the care management PMPM fees largely into developing IT system or other areas rather than spending much on hiring extra staff to meet annual milestones required by participation in the CPCI, as it already has NPs and PAs in place. In the case of how NP SOP will play role in the decision of whether to participate in the CPCI and benefit from it, one could deem that liberal NP SOP will likely facilitate practice's decision to hire more NPs for attaining such functions as providing extra care hours and working in interdisciplinary teams with the goal to provide a comprehensive primary care for their patient pool.

How could employment of NPs and PAs prior to the CPCI be viewed vis-à-vis 'redesign and transformation' of primary care provided by the practices?

Generally, one could view that if a practice employs NPs and PAs for expanding hours of operation and/or using interdisciplinary teams in providing medical care or for any other reason to meet the five functions of the comprehensive care (and/or to meet the annual milestones in participating in the CPCI), it is *on the pathway* to meet one of its goals in 'redesigning and transforming' the care it provides to its patients. However, there are total five functions (managing care for patients with high health care needs; ensuring access to care; delivering preventative care; engaging patients and caregivers; coordinating care across the medical neighborhood) that a practice has to achieve while providing primary care services, when it redesigns its care to attain 'comprehensive primary care' status. Thus, a practice that already employs NPs and PAs could not be viewed as having 'redesigned' its care completely, although, it could be deemed that the practice already had made prior steps in 'redesigning and transforming' the care it provides.

Furthermore, these practices may be viewed as more flexible and adaptable to innovations and reforms of this sort.

Is there reason to believe that if CPCI succeeds in lowering the cost of caring for a patient population, the revenue received by a practice from Medicare and other payers will decrease by as much as the decrease in cost?

The Medicare reimbursement rates, or Medicare care management PMPM fees are set based on the risk adjustment[295] – HCC score of a patient, which are updated once a year. The Medicare care management PMPM fees are set such that they would decrease each year[296], with the highest fees being in the first two initial years to help CPCI participating practices cover up the initial startup costs. Analogous scenario follows for other CPC participating payers when it comes to paying practices care management fees. However, suppose that CPCI succeeds in lowering the cost of caring for a patient population, the care management fees will still be paid based on the number of CPC attributed beneficiaries (patients) during the four years of the initiative, but there could be potential in having cost savings sharing in 2-4 years of participation. Assuming that a CPCI participating practice is a rational agent, one could consider that if CPCI succeeds in lowering the cost of caring for a patient population, a practice would still be participating in the CPCI (even though the revenue received by a practice from Medicare and other payers decreases by as much as the decrease in cost and it might be the case that the profits might stay the same, otherwise, the practice that would not see any positive profit or start incurring losses associated with CPCI participation will exit the CPCI in the nearest quarter – as it needs to satisfy the 90-day requirement to notify payers about its withdrawal from the CPCI). Although some practices expressed concerns about sustainability of investments when CPC funding decreases or stops upon the end of the CPC initiative, other practices were less concerned as they spent the CPC funds on infrastructure improvements that "would have long-term usefulness, such as acquiring a risk stratification tool"[297].

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[295] According to Taylor, two "participating payers indicated that they chose not to include their Medicare Advantage lines, because participating practices were receiving risk-based payment for patients enrolled in these plans. Thus, the practices already had incentives to serve those patients in a cost-effective manner." For further details see Taylor, 2015, p. 19.

[296] The management care PMPM fees are guaranteed, but they are based on the number of Medicare beneficiaries, which vary each quarter, and HCC scores, which are updated annually.

According to Taylor, provided "there are net savings in Medicare Part A and B health care costs in the second, third, and fourth years of the initiative, practices may be eligible to receive a portion of the savings. In the third and fourth years of the initiative, CMS will reduce its PMPM payments for Medicare FFS beneficiaries to an average of $15." For further details see Taylor, 2014, p. 3.

[297] Taylor, 2014, p. 50.

Literature review

Limited literature is available on the CPCI. At the current moment[298], no articles were published on the relationship between NP SOP and CPCI participation, and therefore, the focus in this literature review will be based on findings from currently published studies pertaining to the CPCI.

One study found that during the first two years of the CPCI, practices obtained a median of $115,000 per clinician in care management fees[299]. When comparing CPCI practices to comparison practices, changes in average monthly Medicare expenditures per patient did not vary significantly. However, there was a 4% reduction in primary care visits observed when comparing CPCI practices to comparison practices[300]. Ayanian and Hamel found that CPC enhanced payments along with CPCI guidance allowed practices participating in the CPCI to improve access by using telephone, patient portals, and e-mail, "all of which probably contributed to the significant 3% reduction in primary care visits, since patients' needs could be met in other ways"[301]. Moreover, they stated that[302]:

> Care-management fees paid to primary care physicians achieved the changes in practice that the initiative encouraged. However, these fees did not provide direct financial incentives to avoid unnecessary spending or to improve performance on measures of quality, and the initiative did not engage specialists in efforts to transform care. In the second year of the initiative, primary care practices that met targets for improved quality could share with payers the savings they had achieved through cost control; however, physicians were unable to share in savings from their patients' care unless participating practices in their region also achieved overall savings. These potentially strong financial incentives for primary care practices were thus contingent on spending by many other practices.

Blumenthal, Abrams, and Nuzum claimed that the program reduced monthly Medicare expenditures per beneficiary by $14 (or 2%), but quality of care after 1st year was not improved[303]. Another study examined the baseline characteristics of 496 CPCI practices and found that most of these practices were small – 44% reported 2 or fewer full-time equivalent physicians; also, 53%

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[298] As of April 2017.

[299] Dale, Stacy B, Arkadipta Ghosh, Deborah N Peikes, Timothy J Day, Frank B Yoon, Erin Fries Taylor, Kaylyn Swankoski, Ann S O'Malley, Patrick H Conway, and Rahul Rajkumar, "Two-year costs and quality in the Comprehensive Primary Care Initiative," *New England Journal of Medicine,* Vol. 374, No. 24, 2016, pp. 2345-2356.

[300] Ibid.

[301] Ayanian, John Z, and Mary Beth Hamel, "Transforming Primary Care—We Get What We Pay For," Mass Medical Soc, 2016.

[302] Ibid.

[303] Blumenthal, David, Melinda Abrams, and Rachel Nuzum, "The affordable care act at 5 years," Mass Medical Soc, 2015.

of practices reported having NPs and PAs[304]. In 2015, the CMS reported that the CPCI resulted in $57.7 million in gross savings across Medicare Parts A and B, but this amount was $0.3 million less than what the CMS paid in care management fees[305]. Four – Arkansas, Colorado, Oregon, and Greater Tulsa – out of seven regions shared savings in 2015 and 95% of practices (481 participating practices) met quality of care requirements[306].

Methodology and data sources

Mathematical Model

Three scenarios on the decision of a practice to participate in the CPCI will be presented, followed by the mathematical model.

Once a practice applies to participate in the CPCI and is selected, it will be willing to participate in the CPCI if the expected gain from participation is positive relative to not participating. There are three scenarios that a practice faces once it chooses to participate in the CPCI:

Scenario A ("Optimistic"): The care management fees are sufficient to cover the costs of 'redesign and transformation of primary care' such as from updating IT system, acquiring new EHR, or hiring new staff, etc. In addition, the expected revenues in future years beyond CPCI are higher than they would be if not participating in the CPCI.

Scenario B ("Neutral"): The care management fees are sufficient to cover the costs associated with 'redesign and transformation of primary care,' but future expected revenues beyond CPCI are unchanged. With management fees, the practice can purchase new technology and/or update EHR, which may serve the practice after the pilot finishes. However, practices that spend a large proportion of their care management fees on employing additional staff may not be able to keep them, as the extra funding from the CPCI will end[307]. In any case, a practice will know whether IT system changes, EHR, or staff hires are improvements and may decide to keep these 'redesign and transformation' changes even after the pilot ends.

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[304] Peikes, Deborah N, Robert J Reid, Timothy J Day, Derekh DF Cornwell, Stacy B Dale, Richard J Baron, Randall S Brown, and Rachel J Shapiro, "Staffing patterns of primary care practices in the comprehensive primary care initiative," *The Annals of Family Medicine,* Vol. 12, No. 2, 2014, pp. 142-149.

[305] Whitman, By Elizabeth, "CMS touts savings, quality under primary-care initiative," October 17, 2016. *Modern Healthcare*. As of April 30, 2017.

[306] Ibid.

[307] According to Taylor, CPCI practices "expressed early concerns about sustaining investments when Medicare FFS (and perhaps other payers') PMPM payments decrease in PY2015 and stop when the initiative ends. As noted above, many practices used CPC payments to hire new staff or purchase new equipment. Some deep-dive practices are concerned that when CPC enhanced payments decrease (and eventually stop), they will be unable to update new HIT systems or will need to fire newly hired staff. Some practices were less concerned about sustainability and reported that they were using CPC funds for infrastructure improvements that would have long-term usefulness, such as acquiring a risk stratification tool." For further details see Taylor et al., 2015, p. 50.

Scenario C ("Pessimistic"): The care management fees are not sufficient to cover all the costs associated with 'redesign and transformation of primary care.' Alternatively, there might be other initiatives available that a practice learns about, which are more profit-maximizing for the practice, and to participate in them the practice must withdraw from the CPCI[308]. Therefore, once a practice evaluates its condition in the CPCI and finds out that it incurs losses or does not get any extra benefit from participating in the CPCI, it will withdraw from participation with a 90-day notice[309] prior to its withdrawal[310].

Perhaps many or most practices base their decision to participate in CPCI on the expected gains from transformation given that the cost of transformation would be covered by the extra money they would receive from the CMS and other CPC payers. Therefore, practices would not face a 'risk' of incurring losses from participating in the CPCI, yet would only participate if the expected longer term (post-CPCI) gain were positive. The practice would not want to be worse off from participating than it would have been without participating. Stated differently, if a practice perceived significant downside risk from participating, it would not want to participate. But if the practice expected CPCI participation to cover the cost of transformation and the practice would be able to pocket benefits, then it would have an incentive to participate. The pilot was perceived as 'trial' period for various 'redesign and transformation' approaches by participating practices that had desired to implement these approaches prior to the CPCI, but did not have extra funds to pay for these 'trials'.

Not all of the benefits would go to the practice. From a societal perspective, if a practice that participated in the CPCI could provide a better and more cost-efficient primary care services including prevention, the patients would be better off and the cost of care borne by Medicare and other payers could be lower. Improved care and lower cost would be socially beneficial. If a practice also benefits in terms of increasing revenues and reducing its costs of operations due to CPCI, it also benefits, and again society overall is better off. The current research considers only the factors differentiating the practices selected for, and choosing to participate in, the CPCI in comparison to non-participants (in regions covered by CPCI). Longer-term analysis of the effects

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[308] A practice is allowed to participate in the CPCI if a "practice is not participating in another CMS shared savings program, such as the Medicare Shared Savings Program (known as the Medicare ACO), Advance Payment or Pioneer ACO Model, Independence at Home, or other shared savings initiative". For further details see "Comprehensive Primary Care (CPC) Initiative: Primary Care Practice Solicitation." Centers for Medicare and Medicaid Services. As of April 10, 2017.

[309] A practice considering to withdraw from the CPCI before the end of the 4-year program period, "must notify CMS at least 90 calendar days before the planned day of withdrawal and termination of its participation. For further details see "Comprehensive Primary Care (CPC) Initiative: Primary Care Practice Solicitation", no date.

[310] Note that between October 2012 and December 2016, the number of CPCI participating practices was reduced from 502 to 441 practices ("Comprehensive Primary Care Initiative: Fast Facts", 2016), or roughly 88% of practices remained in the CPCI for full 4-years. Some practices were terminated from participation, others withdrew, others merged with another practice or split into two practices (Peikes et al., December 2016, pp. 12-13).

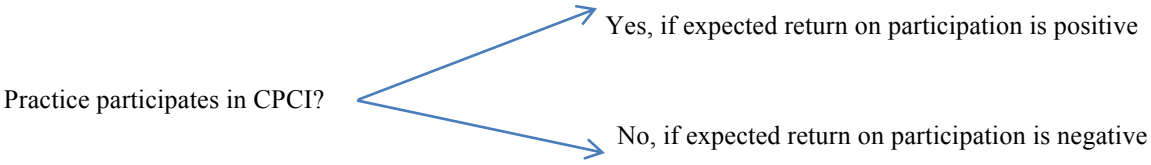
of the CPCI on access, cost, and quality of care and on population health can be pursued in future research as data become available**.**

Mathematical Model: A practice's decision to participate in CMMI's CPCI

To understand why certain practices within 7 regions participating in the CMMI's CPCI decided to opt in the pilot, the theoretical model viewing a practice's decision via lens of profit maximization is presented.

Practice's behavior in deciding whether to participate in the CPCI or not

Let us model the CPCI participation decision of practice that applies for participating in the pilot and is being selected. Recall that a practice would be expected to participate for four years, but the option to withdraw at any time remains. If it leaves, there is no replacement.



The model developed here focuses on the initial decision to participate in a "one-period" framework. This framework does not build in the option of withdrawing in future period, although it is understood that a participating practice could withdraw if, during participation, its net expected gain from continued participation proved to be negative. That could occur, for instance, because of higher than expected costs of transformation, difficulty hiring new staff, or other unexpected, attractive initiatives. The one-period model is simpler but still suitable for identifying key factors affecting the decision to participate.

Let **q** represent quantity of services produced per year, such that $q = q_{CPCI} + q_{OTHER}$, where q_{CPCI} – services provided to CPC-attributed patients (i.e., patients whose payers participate in the CPCI) and q_{OTHER} – any patients, other than CPC-attributed patients.

Let **p** represent the price charged for services provided to the patients. It is assumed that prices charged for the CPC-attributed patients are the same as for non-CPC patients.

The care management PMPM fee depends on who the payer is. Various methodologies are used to determine the number of CPC-attributed beneficiaries assignable to a practice. Depending on the payer, this list is determined by the previous two-year usage (or other specified look-back period) by a patient and/or by the practitioner assigned to the patient, or by claims data that demonstrated a plurality of utilization of health care services from the practice. Hence, to determine what care management PMPM fee should be, one needs to make assumptions about a "typical" payer that decides how to attribute patients to a practice, based on some aspects of care

utilization. I make several assumptions to simplify the aspect of calculating the care management PMPM fees.

Let **ε** represent the care management per-member-per-month (PMPM) fee. It is a function of the number of CPC-attributed patients, based on the quantity of services provided in the prior quarter: $\varepsilon(n_{CPCI}(q_{CPCI}))$. Care management PMPM fees could vary each year, depending on the practice's number of Medicare beneficiaries, adjusted for risk, in addition to the CPCI condition that fees decrease in the third and fourth years. Practices get higher management PMPM fees in the first two years to cover startup costs. Also, under the CPCI payment model, a participating practice expects to receive base fee-for-service (FFS), care management per-member-per-month (PMPM) fee, and shared savings, which are determined on an aggregate market level. In the first year of the pilot there are no shared savings, and I have assumed that base fee-for-services is the same for CPCI-attributable and non-CPCI patients. Thus, I define ε only in terms of the PMPM fee. This fee is adjusted for risk based on a patient's health condition.

In the second year and later, practices may receive shared savings, and the latter are calculated by region and distributed provided that there are net savings. To simplify the model, however, it is assumed that shared savings are expected to be zero.

Let $\mathbf{l_{NP}}$, $\mathbf{l_{PA}}$, and $\mathbf{l_{MD}}$ represent labor *or* number of NP, PA, MDs employed at the practice and $\mathbf{w_{NP}}$, $\mathbf{w_{PA}}$, and $\mathbf{w_{MD}}$ be the corresponding wages. Let $\mathbf{f(l_{NP}, l_{PA}, l_{MD})}$ be the production function of output, or patient volume. Importantly, the production technology can change because of investments in the transformation of care. Let $\mathbf{c(l_{NP}, l_{PA}, l_{MD}, q)}$ be the corresponding cost function that represents the total cost to produce q-level of output with the labor employed.

Assume that the practice is profit maximizing and prices are exogenous. Other possible objectives of the firm such as improving the usage of electronic health records, participating in the CPCI-related technical assistance seminars, etc., are not modeled[311].

Then, modeling the practice's decision to participate in the CPCI, if selected, will be based on profit-maximizing behavior: max $\pi_{CPCI} = TR - TC$[312].

Step 1: Find the cheapest way to obtain output, q (patient volume)

$$c(w_{NP}, w_{PA}, w_{MD}, q) = \min w_{NP} l_{NP} + w_{PA} l_{PA} + w_{MD} l_{MD}$$
$$\text{with respect to } l_{NP}, l_{PA}, l_{MD}$$

[311] According to the *Mathematica* evaluation report, in "many cases, CPC participation was aligned with existing practice goals" – such as preexisting efforts to innovate and improve quality, and some "practices noted that they were already in the process of implementing changes that leadership had wanted to make for some time, such as moving toward a more quality-focused approach and providing care coordination". Moreover, the CPCI's "aligned multipayer environment provided an opportunity to support practice change" For further details see Taylor et al., 2015, pp. 24-25.

[312] The model is based on the notes in Board, Simon, "Profit Maximization," UCLA: Economics Department. As of April 30, 2017.

subject to $f(l_{NP}, l_{PA}, l_{MD}) \geq q$

Note that l_{NP} will depend on NP SOP. Also, because of investment in transformation, the production function could differ when the practice participates in CPCI compared to when it does not. As a result, the cost functions may differ.

Step 2: Find π-maximizing output

$$\pi(p, w_{NP}, w_{PA}, w_{MD}) = \max [pq + \varepsilon(n_{CPCI}(q_{CPCI}))] - c(l_{NP}, l_{PA}, l_{MD}, q^*) - c(\text{transformation})$$
with respect to q
subject to $\varepsilon(n_{CPCI}(q_{CPCI})) > 0$

Note that for a non-participating practice, there will be no terms for fees or transformation cost. As mentioned, the cost functions may also differ.

Solving the above equation, yields optimal output $q^*(w_{NP}, w_{PA}, w_{MD}, p)$.
So, the maximized profits are:

$$\pi(p, w_{NP}, w_{PA}, w_{MD}) = pq^* + \varepsilon(n_{CPCI}(q^*_{CPCI})) - c(w_{NP}, w_{PA}, w_{MD}, q^*) - c(\text{transformation})$$

The practice can expect management fees to be positive, $E[\varepsilon(n_{CPCI}(q^*_{CPCI}))] > 0$. A practice will decide to participate in the CPCI, once selected, if profit conditional on participation exceeds profit conditional on non-participation. Stating the participation choice this way allows production technology, inputs, and outputs to differ when participating in CPCI versus not participating.

In a broader model, the practice might be concerned with the variance of fees. A high variance might increase the difficulty of covering the cost of investing in transformation, which could deter investment or require the practice to borrow. Similarly, the cost of transformation could be uncertain.

So, then the question arises how NP SOP and NP/PA (labor composition) affect practice's decision to participate in the CPCI. First, let us assume that a practice that hires an NP and/or PA (at least one mid-level practitioner) incurs lower costs compared to a practice that employs only MDs.

Cost-efficient labor composition → Lower costs

Then, a practice located in a state with liberal NP SOP, incurs even lower costs of operation if it has an NP on site. Why? NPs are "capable" of doing more tasks, which does not require supervision or substantial collaboration such that they can overtake cases that are within the scope and leave "harder"/serious cases for an MD (task-shifting among interdisciplinary team members based on the case's difficulty). So, patient case load among practitioners is allocated based on the

comparative advantage, rather than the absolute advantage. Also, note that care management PMPM fee is risk adjusted for a patient type, and therefore, $E[\varepsilon(n_{CPCI}(q^*_{CPCI}))]$ is dependent on the type of a CPC-attributed patient pool a practice has.

Therefore, the expected profits for participating in the CPCI are higher, $E[\pi_{CPCI}] > E[\pi]$, and may be greater in practices that employ NPs and/or PAs[313] and it might be even higher in states with liberal NP SOP (assuming that NPs are more productive and may generate higher revenues per their case load/patient volume).

Relationship between CPCI and NP SOP, NP and PA employment

It is necessary to address initial questions for setting up the model. Assume a profit-maximizing practice (max π):

1) Under what condition(s) will expected profit be higher under the CPCI than under non-CPCI, $E(\pi)_{CPCI} > E(\pi)$?

   Recall that there are three incentives that practices receive if they participate in the CPCI, including monetary incentive. The incentives associated with partaking in the CPCI for a practice are enhanced payments, data feedback, and availability of a learning system and technical assistance to help practices build the capacity to make transformative changes[314].

   In developing the theoretical model, I assumed that only financial support is what drives the decision to participate in the CPCI or not for a selected practice and the value of data feedback and availability of a learning system and technical assistance are assumed to be zero.

   Based on the above information, $E(\pi)_{CPCI} > E(\pi)$ will hold true if the payments provided by participating in the CPCI are higher than when a practice does not participate in the CPCI and does not get any extra payments provided by other organizations (along with a condition that costs associated with transformation are lower than the expected payments provided by participating in the CPCI), all else holding constant.

   Hence, the only realistic condition for expected profits for participating CPCI practices to be higher could be viewed via these extra payments provided by the CPCI participation.

   Besides, recall that $\pi = TR - TC$, and TR and TC will vary depending on the practice's structure, number of attributed CPC beneficiaries, and such.

2) How does $E(\pi)_{CPCI} > E(\pi)$ relate to the following variables[315]?
   - *liberal* NP SOP

[313] Practices that participated in the CPCI used a portion of the extra funds received from the CPCI on 'Interdisciplinary Teams' and 'Extended Hours', which could imply the use of PA/NPs in this case. Moreover, I consider the usage of funds on these two aspects more as transforming and redesigning primary care.

[314] Taylor et al., 2015.

[315] The complete description of each variable is provided in Table 6.4.

- *totnp* or *np_indicator* (total number of NPs working in a practice or an indicator for NPs working in a practice)
- *totpa* or *pa_indicator* (total number of PAs working in a practice or an indicator for PAs working in a practice)
- *size* (number of MDs working in a practice)
- *patvoln* (average daily patient visits)
- *nonprimcare* (a practice specializing in non-primary care)
- *liberalnp* (interaction term between indicator variables for NP SOP and NPs working in a practice)

Let us recall how eligibility for choosing practices was determined and which criteria were used to select practices favorably: the major numerical criteria were related to having a certain number of Medicare FFS beneficiaries, have a minimum revenue of $200,000 annually per practitioner, and receive at least 40-50% of revenues from CPCI participating payers. Thus, it was not specifically based on the labor composition of the practice (NPs, PAs, MDs, etc.).

To relate $E(\pi)_{CPCI} > E(\pi)$ inequality with the variables listed above, the following are the testable hypotheses:

- *liberal*: if a practice chooses to participate in CPCI, one may expect that a practice is more likely to participate in the CPCI if it employs NPs and is located in a state with liberal NP SOP. Why? Assuming liberal NP SOP affects productivity of a practice to produce services leads to more productive NPs at a cheaper cost than MDs, but providing the same services as MDs for the illnesses and/or conditions they are allowed to diagnose and treat. Further, NPs will be preferred more than PAs in states with liberal NP SOP, as PAs will be viewed as complements to MDs and NPs as substitutes, given the scope of practice. So, a practice that prefers to hire NPs and is in a state with liberal NP SOP, has been already on the track of reducing costs by having interdisciplinary teams, and thus, is more likely to opt in participating in the initiative.
- *totnp* and *totpa*: if a practice decides to employ NPs and/or PAs, it is more likely trying to reduce its operating costs (or TC associated with labor it hires) by having more NPs and/or PAs rather than employing MDs; and thus, there is higher probability that it will be participating in the CPCI.
- *size*: the larger the practice, or the more MDs are employed in the practice, the higher the likelihood that it would want to participate in the CPCI, as it would like to reduce costs and get monetary incentive provided by the CPCI to switch to a new payment system that may be more cost-efficient at the expense of the pilot. Besides, the criteria, that the minimum of revenues per provider should be $200,000 per annum may also imply that some larger practices (with larger number of MDs) are more likely to meet the CPCI eligibility criteria.
- *patvoln*: the higher the patient volume a practice receives on average, the more likely it has higher number of CPC attributed beneficiaries, and as such, it is more likely to decide to apply to the CPCI and participate in the CPCI, as it will meet the CPCI selection criteria. Further, if it has a larger number of patient visits, it will have a higher care management fees, based on the number of CPC attributed beneficiaries, holding other variables constant.

- *nonprimcare*: a practice that specializes in non-primary care is expected not to participate in the CPCI, as it will have lower number of PCPs, and thus, lower number of CPC attributed beneficiaries, and maybe not meet the CPCI eligibility criteria.
- *liberalnp* = liberal*np_indicator (the interaction term between liberal NP SOP and a practice having at least one NP on its site): one would expect a practice more likely to participate in the CPCI, if it is in the liberal NP SOP state and employs at least one NP, as these type of practices may increase their profits, π, by reducing costs on labor (hiring NPs instead of MDs) and since NPs are "more productive" in states with liberal NP SOP than in states with restricted NP SOP. Although there are only two states that were chosen to participate in CPCI with liberal NP SOP, so the results may not show considerable significance of this variable.

Assumptions made in the above hypotheses:

- CPCI participation helps improving payment system and at the same time costs of operating (running payment system under CPCI) are reduced due to incorporating a new redesign and payment models.
- The practices that participate in the CPCI have NPs and/or PAs employed, as these practices are already on the pathway to reducing costs by using various "methods" (at least if viewing labor costs associated with employing NPs and PAs or different collaborative practitioner teams) to run practices more cost-effectively, and NPs/PAs are complements or cheaper substitutes for some of the MD work.

Data sources

The data sources used in this chapter come from three main sources for the period of 2013: SK&A, Linda Pearson Report, and CMS. Specifically, SK&A provides data on total number of NPs and PAs employed at a particular practice, practice specialty, size of a practice/number of MDs employed at the practice, average number of patients seen daily by a practice at the practice level; Pearson Report – NP SOP regulations, i.e., whether an NP has prescription and practice authority; CMS – practices participating in the CPCI (the list is based on data from October 2016[316]). To identify practices that partook in CPCI, the data from CMS' website[317] is utilized. Also, to restrict my data to 7 regions[318] where the CPCI took place (at statewide and region-county

[316] I use CMS data on identifying practices participating in the CPCI from October 2016, although for all of the other variables 2013 data is used. The rationale for using the most recently available data (the prior data for 2013 was not readily available) is that it shows which practices remained in the CPCI for 4 years. Note that the number of practices in October 2016 is 442. However, according to the recently published facts ("Comprehensive Primary Care Initiative: Fast Facts", 2016) in December 2016, there were 441 practices. The updated data on the CPCI practices is not available and only lists practices as of October 2016. A one practice difference should not cause any considerable bias, given that I was able to match only 327 CPCI participating practices out of 442 CPCI participating practices with the practices in the SK&A data.

[317] "Where Innovation is Happening: Comprehensive Primary Care Initiative ". Centers for Medicare & Medicaid Services. As of April 15, 2017.

[318] For the regions that participated in the initiative (not at the statewide level), I looked up the counties and matched them with my data, and removed the remaining counties that didn't participate in the pilot within the state(s). For the regions at the statewide level, I included the whole state in my dataset.

based level), I identified counties[319] in which practices are located and matched corresponding FIPS[320] codes for areas from the CPCI participating regions to SK&A data. Since Linda Pearson's NP Report for 2013[321] was not available, the changes in NP SOP regulations were based on comparing 2012 and 2014 Linda Pearson Report and examining any regulation changes in these two years via official Board of Nursing websites.

Methods

The research question was the cornerstone in developing methods, which are described in full details later in the text. The general question was to examine if there were any relationship between the likelihood of practices to participate in the CPCI and NP SOP. Note that only two regions (Colorado and Oregon participated at the statewide level) had liberal NP SOP. The remaining five regions were located in states with restricted NP SOP.

The study design involved a literature review on CPCI and NP SOP along with quantitative analyses addressing the research question regarding the relationship between CPCI participation and NP SOP as well as NP, PA employment by a practice. The quantitative analyses involved using STATA 12 software to run logit regressions.

The literature review searched for studies with emphasis on NP SOP regulations, NPs and CPCI. It also sought research articles regarding CPCI and its impact in primary care. The literature review did not result in identifying sufficient studies on CPCI. Specifically, there were no studies found that looked at the relationship of NP SOP and CPCI. Moreover, there were no studies identified that examined the relationship between employment of NPs and PAs and CPCI, except one study that examined baseline composition of practitioners in the CPCI practices[322]. However, there were few evaluation studies of the CPCI, which were presented in the 'Background and literature review' section of this chapter. Also, due to the lack of sufficient literature on the topic, the emphasis of the 'Background and literature review' section was on brief description of how the CPCI payment model works, which served as the basis for theoretical model developed above.

The quantitative analysis involved using logit[323] regression to test if employment of NPs and/or PAs as well as if NP SOP affect the likelihood of a practice to participate in the CPCI, controlling for number of practitioners employed at a practice, patient volume, and practice's specialty. Same as in the previous chapters, liberal NP SOP refers to no supervision for prescription and practice.

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[319] "Comprehensive Primary Care Initiative: Seven Regions." Centers for Medicare and Medicaid Services. As of April 1, 2017.

[320] United States Census Bureau generates FIPS codes to identify counties and states.

[321] Pearson, Linda "Details on Pearson Report," E-mail correspondence with Linda Pearson., January 6, 2016.

[322] Peikes et al., 2014.

[323] I use 'logit' code when I run my regressions in STATA: "logit fits a logit model for a binary response by maximum likelihood; it models the probability of a positive outcome given a set of regressors…" ("logit — Logistic regression, reporting coefficients," STATA. As of April 15, 2017.).

The model will assume that the indicator for liberal NP SOP is exogenous to unobserved factors (in the error term).

Model

The decision of a practice to participate in the CPCI depends on profit maximization, discussed in the "Mathematical Model" section of this chapter. Recall that a logit model is[324]:

$$\text{Logit}(p) = \ln\left(\frac{p}{1-p}\right)$$

That is logit(p) is the log with base e of the likelihood ratio or odds ratio that the dependent variable is equal to one, where p is probability, $p \in [0, 1]$. So, the conditional probability p is:

$$p = \Pr(y=1 \mid x) = F(x_i'\beta) = \frac{e^{x'\beta}}{1+e^{x'\beta}}$$

where $x'\beta$ is an index function, such that x is a K x 1 regressor vector, β is a vector of unknown parameters, and $F(\cdot)$ is the cumulative density function of the logistic distribution. This notation is used in the model specifications below.

As was discussed prior, there are several factors that could affect likelihood of participation in the CPCI. Once a practice applies to participate in the CPCI and is being selected by the CMS, it has an option whether to accept the offer to participation in the pilot or not. Since the focus of this research study is to examine an impact of NP SOP on participation in the CPCI, the model developed below tests whether NP SOP, number of NPs and PAs affect the likelihood of a practice to participate in the CPCI, controlling for other explanatory variables used in the following model specifications:

Model Specifications

Model 1:

$$\begin{aligned}\Pr(\text{CPCI Participation}_{\text{ of practice p in region r}} = \text{Yes}) = F(&\beta_0 + \beta_1 * \text{Regulation NP SOP}_{\text{ in region r}} \\ &+ \beta_2 * \text{Total Number of NPs}_{\text{ at practice p in region r}} + \beta_3 * \text{Total Number of PAs}_{\text{ at practice p in region r}} \\ &+ \beta_4 * \text{Total Number of MDs}_{\text{ at practice p in region r}} + \beta_5 * \text{Non-primary care specialty}_{\text{ at practice p in region r}} \\ &+ \beta_6 * \text{Patient Volume}_{\text{ at practice p in region r}} + \beta_7 * \text{NP indicator} * \text{Regulation NP SOP}_{\text{ at practice p in region r}} \\ &+ \varepsilon_{\text{ at practice p in region r}})\end{aligned}$$

[324] The notations are adopted from:
Cox, Mike, "Logistic Regression," Newcastle University. As of April 15, 2017.
Cameron, A. Colin, and Cameron, Pravin K Trivedi, *Microeconometrics Using Stata*, 2010.

Model 2:

$$\Pr(\text{CPCI Participation}_{\text{of practice p in region r}} = \text{Yes}) = F(\beta_0 + \beta_1\text{*Regulation NP SOP}_{\text{in region r}} + \beta_2\text{*NP indicator}_{\text{at practice p in region r}} + \beta_3\text{*PA indicator}_{\text{at practice p in region r}} + \beta_4\text{*Total Number of MDs}_{\text{at practice p in region r}} + \beta_5\text{*Non-primary care specialty}_{\text{at practice p in region r}} + \beta_6\text{*Patient Volume}_{\text{at practice p in region r}} + \beta_7\text{*NP indicator*Regulation NP SOP}_{\text{at practice p in region r}} + \varepsilon_{\text{at practice p in region r}})$$

Model 3:

$$\Pr(\text{CPCI Participation}_{\text{of practice p in region r}} = \text{Yes}) = F(\beta_0 + \beta_1\text{*Regulation NP SOP}_{\text{in region r}} + \beta_2\text{*Total Number of NPs and PAs}_{\text{at practice p in region r}} + \beta_3\text{*Total Number of MDs}_{\text{at practice p in region r}} + \beta_4\text{*Non-primary care specialty}_{\text{at practice p in region r}} + \beta_5\text{*Patient Volume}_{\text{at practice p in region r}} + \beta_6\text{*NP indicator*Regulation NP SOP}_{\text{at practice p in region r}} + \varepsilon_{\text{at practice p in region r}})$$

CPCI Participation $_{\text{of practice p in region r}}$ refers to practices that either participate in the CPCI or not in a particular region, in 2013.

NP indicator $_{\text{at practice p in region r}}$ refers to whether a practice has any NPs employed or not. Similarly, PA indicator $_{\text{at practice p in region r}}$ is an indicator variable and refers to whether a practice employs PAs or not.

NP indicator*Regulation NP SOP is an interaction term between NP indicator variable and NP SOP variable.

Total Number of MDs $_{\text{at practice p in region r}}$ refers to the size of a practice, that is the total number of physicians working in a practice.

Non-primary care specialty $_{\text{at practice p in region r}}$ defines if a practice specializes in non-primary care.

Patient Volume $_{\text{at practice p in region r}}$ refers to average daily patient visits.

Null hypothesis, Ho: There is a higher likelihood (probability) of a practice to participate in the CMMI's CPCI, which is geared towards increasing access and reducing costs of primary health care, if it has NPs employed, and this likelihood is higher in states with liberal NP SOP compared to states with restricted NP SOP regulations.

Under this hypothesis, the coefficient on NP SOP, β_1, has a causal effect on the likelihood of participating in the CPCI. So, it is expected that β_1 will have a positive sign, implying that a practice located in the region with liberal NP SOP is more likely to participate in the CPCI compared to regions with restricted NP SOP. Furthermore, the coefficient on Total Number of NPs employed in the practice in region r, β_2, and Total Number of PAs employed in the practice in region r, β_3, are also expected to have a positive sign. Similarly, the coefficient on Total Number of NPs and PAs $_{\text{at practice p in region r}}$ is also expected to have a positive effect on the likelihood of a practice to participate in the CPCI.

The coefficient on NP indicator $_{\text{at practice p in region r}}$ is expected to be positive, implying a practice employing an NP (one or more), is more likely to participate in the CPCI. Similarly, the coefficient on PA indicator $_{\text{at practice p in region r}}$ is expected to have a positive sign.

As to concern of a control variable, Total Number of MDs $_{\text{at practice p in region r}}$, $\beta_{4,}$ it is expected that the higher the number of MDs (size of a practice) in a practice, the more likely a practice to participate in the CPCI, due to the previously mentioned CPCI requirements for participating in the pilot. Therefore, it is expected that its coefficient, β_4, is positive. Similarly, Patient Volume $_{\text{at practice p in region r}}$, β_6 (Model 1 and 2) $_{\text{or}}$ β_5 (Model 3), is expected to have a positive effect on the likelihood of a practice to participate in the CPCI.

The coefficient on Non-primary care specialty $_{\text{at practice p in region r}}$ is expected to be negative, given that CPCI is geared towards practices that mostly function under primary care framework.

The coefficient on NP indicator*Regulation NP SOP $_{\text{at practice p in region r}}$ is also expected to be positive.

Results

Descriptive statistics

This section will describe practices that participate in the CPCI as well as compare the CPCI participating practices with those that do not participate. The description of the variables that will be used in this section is given in Table 6.1.

In this section, descriptive statistics regarding CPCI practices using SK&A data for 2013 is presented. As of October 2016, there were total 442 CPCI participating practices. Out of 442 CPCI participating practices, 327 practices were matched in SK&A data.

Table 6.1.
Description of the variables in the regressions

Name	Description
CPCI	Indicator variable for a practice to participate in the CPCI or not; participating in the CPCI = 1, not participating in the CPCI = 0
liberal	Indicator variable for NP SOP; liberal = 1, restricted =0
np_indicator	Indicator variable for a practice to employ (or not) an NP (1 or more NP = 1, 0 = otherwise)
totnp	Total number of NPs employed at the practice (in a particular state)
n_np	Categorical variable – number of NPs working in a practice grouped into 4 categories (in a particular state)
pa_indicator	Indicator variable for a practice to employ (or not) a PA (1 or more PA = 1, 0 = otherwise)
totpa	Total number of PAs employed at the practice (in a particular state)
size	Total number of physicians (MDs) employed at the practice (in a particular state)
patvoln	Patient volume, daily average number of patients seen in a practice
nonprimcare	Indicator variable to designate a practice as specializing in non-primary care or not (if yes = 1, 0 = otherwise)
n_nppa	Total number of NPs and PAs combined that work in a practice (in a particular state)
liberalnp	Indicator variable that represents interaction between NP SOP and whether a practice employs at least one NP (if a practice is in the state where NP SOP is liberal and it hires at least one NP = 1, 0 = otherwise)
n_size	Categorical variable – number of MDs working in a practice grouped into 10 categories (in a particular state)
n_patvoln	Categorical variable – average daily patient visits in a practice grouped into 12 categories (in a particular state)

Table 6.2 shows that in 2013, there were total 327 practices that participated in the CPCI and 26,087 practices did not participate in the CPCI in these 7 regions, among which 223 practices were in states with restricted NP SOP and 104 practices in liberal NP SOP.

Table 6.2.
Initial number of practices by CPCI participation and NP SOP, 2013

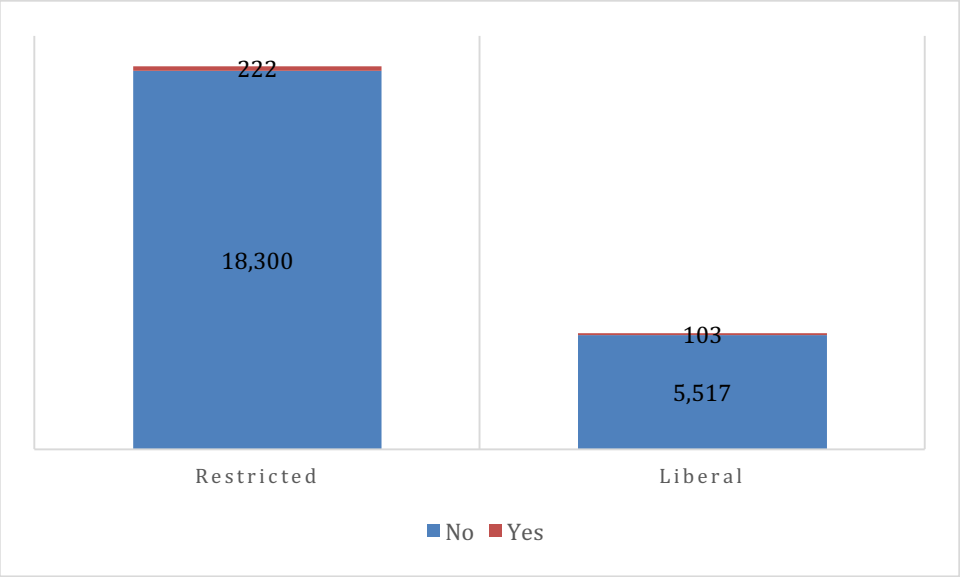
	NP SOP		
CPCI	Restricted	Liberal	Total
No	19,879	6,208	26,087
Yes	223	104	327
Total	**20,102**	**6,312**	**26,414**

I started with checking the initial data for outliers and zeroes in the number of MDs and patient volume. There are no CPCI participating practices identified that have zero number of MDs (no physicians). However, there are 243 non-CPCI practices that have no physicians employed in the

practice. 2,116 practices are identified having zero patient volume, two of which are CPCI participating practices. According to the SK&A[325], zero may imply that there is missing data, that is at the time when the practice was inquired about their daily average patient volume, the respondent was unable to answer. Also, there are 2 practices that have patient volume over 2,000 – one practice has 2,150 average patient daily visits and the other 50,000 average patient daily visits, both of which are non-CPCI practices. Examining the data entries closely for these outliers, it seems that there might be an error pertaining to these numbers. To keep consistency with previous chapter, I limited my sample[326] to practices that have data on patient volume, have at least one MD on site, and I removed outliers. Specifically, I removed observations with *size* (number of MDs in a practice) equal 0, *patvoln* equal 0, and *patvoln* >2000. After data was cleaned, the sample included 24,142 practices, among which 325 practices participated in the CPCI. Figure 6.2 shows the number of practices by CPCI participation and NP SOP after data cleaning.

Out of the matched CPCI practices to SK&A data, 103 out of 5,620 (about 2%) were participating in the CPCI and were in the regions with liberal NP SOP compared to 222 out of

Figure 6.2.
Number of Practices by CPCI Participation and NOP SOP, 2013



[325] As per SK&A representative, "there are 22 questions being asked of an office contact when we are validating data. There are times when the individual does not know the info, does not answer the info, or it is captured on the next update/verification call." Mendez, John, "Inquiry OM325064," Email correspondence, February 28, 2017.

[326] I removed patvoln = 0; I restricted my sample to statewide and by region (keeping states – AR, CO, NJ, OR and participating counties of NY Hudson Valley, OK Tulsa, OH-KY Cincinnati-Dayton). The list of participating counties for each region were obtained from the CMMI's website ("Comprehensive Primary Care Initiative: Seven Regions". Centers for Medicare and Medicaid Services. As of March 15, 2017.) and corresponding FIPS codes (5-digit number) for each county were used to identify the participating regions and comprised the set for my analysis. The logit regression was run for 7 pertinent regions that opted in participating in the CPCI (set – 7 regions; subset – CPCI participating practices). Note that there were total 269,680 practices in the SK&A data for all the 50 states and D.C. in 2013, but after restricting my sample to 7 CPCI regions only, the number of practices in the dataset was limited to 24,142. Moreover, note that only 325 (out of 442 that were participating in the October 2016) CPCI practices were utilized in the analysis.

18,522 (about 1%) practices that were participating in the CPCI and were in the regions with restricted NP SOP.

Figure 6.3.
Proportion of Practices by CPCI Participation and State, 2013; in %

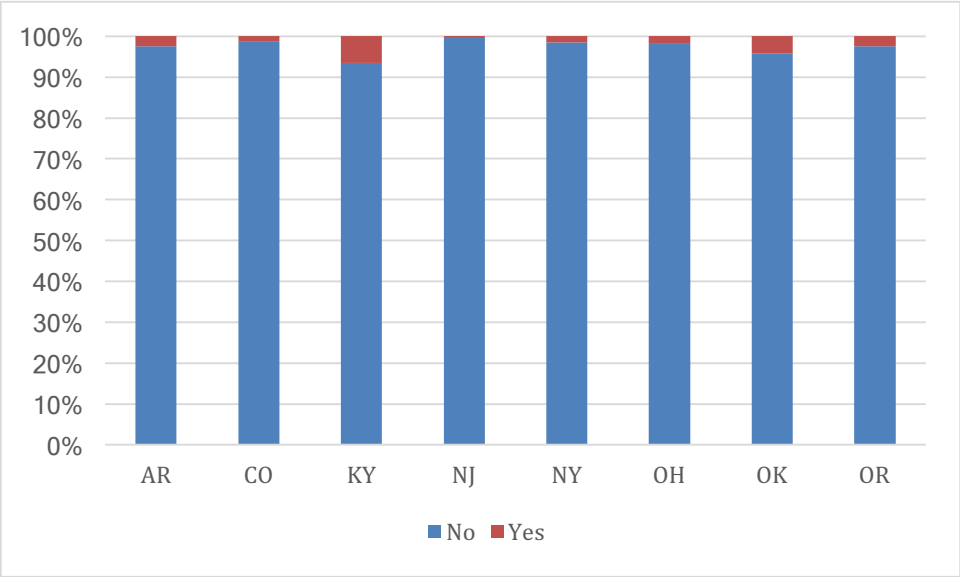


Figure 6.3[327] indicates proportion of practices by CPCI participation and state. Note that only Colorado and Oregon were two states with liberal NP SOP that participated in the CPCI (at the statewide level), that is about 32% of matched CPCI participating practices were in states with liberal NP SOP. The remaining 222 matched CPCI participating practices were in regions that had restricted NP SOP in 2013.

Approximately 35% of CPCI practices employed at least one or more NPs compared to about 16% (3,709 out of 23,817) of non-CPCI practices in 2013; whereas, about 29% (94 out of 325) of CPCI practices employed at least one or more PAs compared to approximately 11% of non-CPCI practices (Table A3.13). There is some prevalence of employing NPs and PAs in practices that partake in the CPCI.

About 35% (114 out of 325) of CPCI practices employ NPs versus 16% (3,709 out of 23,817) of non-CPCI practices (Table A3.14). Compare that to 29% of CPCI participating practices that employ PAs versus 11% of non-CPCI practices (Table A3.15). The results show that more practices employ NPs than PAs. This is corroborated by the fact the number of employed NPs is greater than employed PAs overall.

[327] Table A3.12 shows the number of practices by CPCI participation and state.

About 39% of practices hire NPs in states with liberal NP SOP compared to 33% practices located in restricted NP SOP among CPCI participating practices, respectively (Table 3.16). Although, this is not a considerable numerical/percentage difference (6%), there is still some observable trend that practices are likely to employ more NPs in states with liberal NP SOP. Table 3.16 also suggests that there are fewer practices that employ three or more NPs compared to practices that employ one or two NPs among CPCI participating practices across both liberal and restricted NP SOP regions for a given size of a practice.

Among CPCI participating practices, practices in regions with liberal NP SOP tended to participate less (3 out of 103 or about 3%) in the CPCI if having only 1-20 average daily patient visits compared to practices in regions with restricted NP SOP (15 out of 222 or about 7%) (Table A3.17), all else holding constant.

Regardless of whether the CPCI participating practice is situated in a state with full practice authority or restrictive one, the trend demonstrates that most practices tend to employ one or two NPs (but rarely more) for a given average daily number of patient visits (*patvoln*) (Table A3.18).

Twenty eight percent (91 out of 325) of CPCI practices specialize in non-primary care (Table 3.19). Given that the CPCI is geared towards improving primary care and lower costs of care, the result is not surprising that almost ¾ of practices that specialize in primary care participate in the CPCI. Note that non-primary care practices receive their CPCI enhanced payments based on the number of CPCI beneficiaries attributed to the primary care practitioner that works in the non-primary care practice.

About 51% (113 out of 222) of CPCI practices that are in the regions with restricted NP SOP employ neither NP nor PA, compared to about 36% (37 out of103) of CPCI practices in liberal NP SOP regions (Table A3.20). Among non-CPCI practices, about 81% (14,771 out of 18,300) of practices do not have NPs or PAs in regions with restricted NP SOP compared to about 63% (3,468 out of 5,517) of practices in liberal NP SOP (Table A3.20). Given these results, it seems that employment of NPs and PAs (or both) is higher in liberal NP SOP (49% versus 64% for CPCI participating practices in restricted versus liberal NP SOP, respectively; and 19% versus 37% for non-CPCI practices, respectively) and it is even higher in practices that opted in partaking in the CPCI (64% of CPCI practices employing NPs, PAs, or both versus 37% of non-CPCI practices employing NPs, PAs, or both).

Tables of regressions

Three models are tested with various specifications to examine the relationship between CPCI and of NP SOP along with employment of NPs and PAs. Each model is presented in Tables 6.3 through 6.8.

Table 6.3 shows that the logit coefficient (β_1) for *liberal* is positive and statistically significant across almost all specifications, except Model 1(vi). Odds ratios ($e^{\beta 1}$) are all above 1, indicating there are higher odds for a practice in a region (state) with liberal NP SOP to participate in the CPCI than a practice in a region (state) with restricted NP SOP, all else holding constant. Given the results of each specification, Model 1(v) is chosen as best performing model that explains the likelihood of a practice to participate in the CPCI, as it aligns with prior hypotheses and yields expected results with respect to impacts of the parameters chosen in the model. Hence, the results of the logit regression will be interpreted below specifically for Model 1 (v). The odds ratio for liberal is 1.33 and statistically significant at the 5% significance level, suggesting that if a practice is in the region with liberal NP SOP, the odds in favor of participating in the CPCI increase by 1.33 or about 33%, *ceteris paribus*.

The next variable of interest is *totnp*. The odds ratio for total number of NPs employed in a practice is 1.11 and statistically significant at the 5% significance level, indicating that the odds of participating in the CPCI will increase by 11% with a one-unit increase in total number of NPs employed, *totnp*, all else holding constant. Similar positive relationship is identified for *totpa*. Specifically, the odds ratio for *totpa* is 1.28 and statistically significant at the 1% significance level, suggesting that the odds for participating in the CPCI will rise by 28% with a unit increase in total number PAs employed, holding everything else constant.

Table 6.3.
Model 1: Logit Regression

Determinants of whether a practice participates in the CPCI or not, 2013

	Dependent variable: CPCI participation (Yes/No)					
	(i)	(ii)	(iii)	(iv)	(v)	(vi)
liberal	0.4311193***	0.2721066**	0.291499**	0.2770878**	0.2857835**	0.2376513
	(0.120207)	(0.1259658)	(0.1307536)	(0.1305819)	(0.1311353)	(0.1497565)
	1.538979	1.312727	1.338432	1.319282	1.330804	1.268267
totnp		0.2208867***	0.1290246**	0.1397673***	0.1044062**	0.0871129
		(0.0391802)	(0.052385)	(0.0498048)	(0.0527656)	(0.0630468)
		1.247182	1.137718	1.150006	1.110051	1.09102
totpa		0.2683431***	0.2775625***	0.2724504***	0.2501741***	0.2486749***
		(0.0398634)	(0.0487647)	(0.0474878)	(0.0471507)	(0.0474061)
		1.307796	1.319909	1.313178	1.284249	1.282325
size			0.0434756***		0.0199921**	0.0202128*
			(0.0139333)		(0.0101794)	(0.0103653)
			1.044434		1.020193	1.020418
nonprimcare			-1.716485***	-1.669325***	-1.716949***	-1.711822***
			(0.1355404)	(0.1328766)	(0.132881)	(0.134285)
			0.1796966	0.1883741	0.1796132	0.1805366
patvoln				0.0053935***	0.0047731***	0 .00477***
				(0.0011708)	(0.0012497)	(0.0012538)
				1.005408	1.004785	1.004781
liberalnp						0.1498895
				`		(0.2529726)
						1.161706
constant	-4.411979***	-4.519946***	-3.862001***	-4.040721***	-4.037151***	-4.032413***
	(0.0675229)	(0.0679681)	(0.0801034)	(0.0890776)	(0.0878794)	(0.0874637)
No. of observations	24142	24142	24142	24142	24142	24142
Wald Chi2(1)	12.86	118.21	249.33	284.65	291.55	294.33
Pseudo R2	0.0035	0.0178	0.0780	0.0902	0.0916	0.0918

Note : Robust standard errors are used and showed in parentheses. Reported coefficients are betas. The third row for each variable is exp(beta) or odds ratio.
* p<0.1, ** p<0.05, *** p<0.01

size and *patvoln* – number of MDs working in a practice and average daily patient visits – also have odds ratios that are larger than 1 and statistically significant at the 5% and 1% significance levels respectively, indicating that per each unit increase in the variable the odds of participating in the CPCI for a practice increase, all else holding constant.

The odds ratio for *nonprimcare* is about 0.18 and statistically significant at the 1% significance level, that is if a practice does not specialize in primary care, *nonprimcare*, then the odds of participating in the CPCI decrease by 72% (1 - 0.18 = 0.72), *ceteris paribus*. Although the odds ratios are more suitable to present the results of logit regression in this case,

Table 6.4 presents the marginal effects for Model 1. Note that the average marginal effects would be small and therefore the focus is on odds ratios. This is due to low probability of a practice to participate in the CPCI. There were about 987 practices that applied to participate in the CPCI and only 502 practices were chosen. However, only 441 practices stayed till the end of the pilot. Moreover, I was able to match only 325 practices that opted into CPCI. This is about 1.35% (325/24,142) of the practices that participated in the CPCI in my data sample. Therefore, the estimates of marginal effects of each parameter are expected to be small, given that there are only 325 practices that I have data on. Recall that marginal effects, $\frac{\partial p}{\partial x_j}$, are $p(1-p)\beta$ [or $F(x'\beta)\{1-F(x'\beta)\beta_j\}$][328].

Table 6.4.
Model 1: Logit Regression, with Marginal Effects

Determinants of whether a practice participates in the CPCI or not, 2013

	Dependent variable: CPCI participation (Yes/No)					
	(i)	(ii)	(iii)	(iv)	(v)	(vi)
liberal	0.0063417***	0.0038137**	0.0040506**	0.0037971**	0.0039222**	0.0032235
	(0.0019598)	(0.0018758)	(0.0019387)	(0.0019003)	(0.0019145)	(0.002139)
totnp		0.0029151***	0.0016808**	0.0018038***	0.0013466**	0.0011234
		(0.0005444)	(0.0006875)	(0.0006493)	(0.0006844)	(0.0008154)
totpa		0.0035414***	0.0036158***	0.0035161***	0.0032266***	0.0032069***
		(0.000562)	(0.0006617)	(0.0006364)	(0.000628)	(0.000631)
size			0.0005664***		0.0002578*	0.0002607*
			(0.0001858)		(0.0001321)	0.0001345
nonprimcare			-0.0235777***	-0.0225651***	-0.0233031***	-0.0232082***
			(0.002088)	(0.0019666)	(0.0019926)	(0.0020121)
patvoln				0.0000696***	0.0000616***	0.0000615***
				(0.0000158)	(0.0000166)	(0.0000167)
liberalnp						0.0020455
						(0.0036508)
No. of observations	24142	24142	24142	24142	24142	24142

Note : Robust standard errors are used and showed in parentheses. Reported coefficients are average marginal effects.
* p<0.1, ** p<0.05, *** p<0.01

Examining the coefficients of the average marginal effects of Model 1(v), it could be seen that likelihood of CPCI participation increases with *liberal* at a rate such that, if the rate were constant, CPCI participation would increase by about 0.4% when a practice is in liberal NP SOP region[329], all else holding constant. Similar positive relationship is found for other variables, except for *nonprimcare* variable, the results of which are aligned with the hypothesis presented earlier.

[328] Cameron and Trivedi, 2010, p. 461.

[329] The interpretation of results are adopted from STATA manual. For further details see "margins — Marginal means, predictive margins, and marginal effects," STATA. As of April 15, 2017. p. 25.

Next, a second model with emphasis on indicators on NP and PA employment is run; Table 6.5 presents the results. Again, given the results of each specification, Model 2(v) is chosen as the best performing among others. Most of the logit coefficients (β_j) are statistically significant and have expected signs, except *liberal*. Although the odds ratio is 1.11 and indicates that the odds for a practice to participate in the CPCI increase by 11% if a practice is in region with liberal NP SOP, however, the coefficient estimates are not statistically significant at the 10% significance level. The next two variables of interest – *np_indicator* and *pa_indicator*. The odds ratio for indicator variable whether there is an NP employed in a practice or not is about 1.83, suggesting that the odds of a practice to participate in the CPCI increase by 83% if a practice is in liberal NP SOP region, all else holding constant. Similarly, the odds ratio for *pa_indicator* is above one (about 2.76), that the odds of participating in the CPCI rise by 176% for a practice that employs at least one PA, *ceteris paribus*. The odds ratios for *size* and *patvoln* are above 1 and statistically

Table 6.5.
Model 2: Logit Regression

	Dependent variable: CPCI participation (Yes/No)					
	(i)	(ii)	(iii)	(iv)	(v)	(vi)
liberal	0.4311193***	0.1115032	0.0983642	0.105887	0.1050524	0.271418*
	(0.120207)	(0.129474)	(0.1373526)	(0.1374296)	(0.1376119)	(0.1627504)
	1.538979	1.117957	1.103365	1.111696	1.110769	1.311823
np_indicator		0.93296***	0.6880837***	0.6363639***	0.6020056***	0.7519708***
		(0.1236368)	(0.1309536)	(0.130898)	(0.1310939)	(0.1533874)
		2.542022	1.989899	1.889598	1.825777	2.121176
pa_indicator		1.054413***	1.092935***	1.035963***	1.013823***	1.01308***
		(0.1362145)	(0.1462683)	(0.1480513)	(0.1484619)	(0.1476547)
		2.87029	2.983017	2.817819	2.756117	2.75407
size			0.0426172***		0.0219777**	0.0224719***
			(0.012649)		(0.0088107)	(0.0085187)
			1.043538		1.022221	1.022726
nonprimcare			-1.659586***	-1.610073***	-1.67134***	-1.675838***
			(0.1349384)	(0.1322232)	(0.1319241)	(0.1321694)
			0 .1902177	0.1998731	0.1879949	0 .1871513
patvoln				0.005055***	0.0042634***	0.0042459***
				(0.0010684)	(0.0011512)	(0.0011324)
					1.004273	1.004255
liberalnp						-0.4442078*
						(0.2609908)
						0.6413321
constant	-4.411979***	-4.747337***	-4.080181***	-4.224142***	-4.216979***	-4.2625***
	(0.0675229)	(0.0765046)	0.0873525	(0.0925721)	(0.0916509)	(0.0964831)
No. of observations	24142	24142	24142	24142	24142	24142
Wald Chi2(1)	12.86	189.31	337.23	351.20	382.34	378.71
Pseudo R2	0.0035	0.0397	0.0960	0.1049	0.1068	0.1077

Note : Robust standard errors are used and showed in parentheses. Reported coefficients are betas. The third row for each variable is exp(beta) or odds ratio.
* p<0.1, ** p<0.05, *** p<0.01

significant, indicating there is a positive relationship between CPCI participation and *size, patvoln*, respectively. As expected, the odds ratio for *nonprimcare* is less than 1, and thus, the odds of participating in the CPCI decrease by 81% if a practice specializes not in primary care, *ceteris paribus*.

Table 6.6 presents the results. Again, looking at the average marginal effects, it should be expected that the coefficients would be small, given that probability of being a CPCI participating practice is already low. The results for average marginal effects indicate a positive relationship among almost all the variables, except for *nonprimcare* variable, and are aligned with the hypothesis presented earlier. The marginal effect of *liberal* is positive, but not statistically significant.

To check for robustness of the results, the final model, Model 3, with 6 specifications is run with emphasis on employment of NPs and PA combined into a single variable, *n_nppa*. The rationale to combine both total number of NPs, *totnp*, and total number of PAs, *totpa*, as a sum is to investigate the aggregate relationship of employment patterns among CPCI and non-CPCI practices. Besides, given that the data on the number of NPs and PAs in SK&A data may not be

Table 6.6.
Model 2: Logit Regression with Marginal Effects

Determinants of whether a practice participates in the CPCI or not, 2013

	Dependent variable: CPCI participation (Yes/No)					
	(i)	(ii)	(iii)	(iv)	(v)	(vi)
liberal	0.0063417***	0.0015011	0.0013005	0.0013911	0.0013794	0.0036979
	(0.0019598)	(0.0017826)	(0.0018524)	(0.0018442)	(0.001845)	(0.0023529)
np_indicator		0.0158715***	0.010554***	0.0095139***	0.0089138***	0.0116576***
		(0.0026942)	(0.0023721)	(0.0022733)	(0.0022341)	(0.0028802)
pa_indicator		0.0197512***	0.0203836***	0.0186363***	0.0180788***	0.0180433***
		(0.0035342)	(0.0037973)	(0.0036283)	(0.0035809)	(0.0035527)
size			0.0005526***		0.0002827**	0.0002891***
			(0.0001686)		(0.0001145)	(0.0001108)
nonprimcare			-0.0225346***	-0.0215417***	-0.0224751***	-0.0225619***
			(0.0020548)	(0.0019352)	(0.0019593)	(0.0019642)
patvoln				0.000065***	0.0000548***	0.0000546***
				(0.0000144)	(0.0000152)	(0.000015)
liberalnp						-0.0049393**
						(0.0025127)
No. of observations	24142	24142	24142	24142	24142	24142

Note : Robust standard errors are used and showed in parenthesis. Reported coefficients are average marginal effects.

* p<0.1, ** p<0.05, *** p<0.01

precise and under the assumption that NPs and PAs are substitutes in restricted NP SOP states, it is important to check the relationship. The results are presented in Table 6.7.

Model 3(v) is chosen as the best performing among others and used to interpret the estimates. All the variables are statistically significant either at the 10%, 5%, or 1% significance level. The odds ratio for *liberal* is 1.36 and statistically significant at the 5% significance level, suggesting that the odds for a practice to participate in the CPCI increase by 36% if a practice is in the region with liberal NP SOP, all else being equal. The odds ratio of *n_nppa*, total number of NPs and PAs employed in a practice, is equal to 1.19, indicating that the odds of participating in the CPCI increase by 19% with a unit increase in *n_nppa*, *ceteris paribus*. The odds ratio for *size* and *patvoln* are above 1, that is there is a positive relationship between CPCI participation and *size, patvoln*, respectively. As expected, the odds ratio for *nonprimcare* is less than 1, and thus, the odds of participating in the CPCI decrease by 82% if a practice specializes not in primary care, *ceteris paribus*.

Lastly, looking at the average marginal effects in Table 6.8, the coefficients are as small as expected due to the probability of being a practice that participates in the CPCI, which is less than

Table 6.7.
Model 3: Logit Regression

Determinants of whether a practice participates in the CPCI or not, 2013

	Dependent variable: CPCI participation (Yes/No)					
	(i)	(ii)	(iii)	(iv)	(v)	(vi)
liberal	0.4311193***	0.2809797**	0.319103**	0.3010407**	0.3109167**	0.3053562**
	(0.120207)	(0.1249907)	(0.128967)	(0.1287878)	(0.1294567)	(0.1459989)
	1.538979	1.324427	1.375893	1.351264	1.364675	1.357108
n_nppa		0.242651***	0.197254***	0.2005375	0.1730569***	0.1720175
		(0.025607)	(0.035805)	(0.0332578)	(0.0334803)	(0.0365138)
		1.274624	1.218053	1.222059	1.188934	1.187699
size			0.0420704***		0.018879*	0.0188925*
			(0.0138258)		(0.00971)	(0.0097345)
			1.042968		1.019058	1.019072
nonprimcare			-1.694349***	-1.65049***	-1.694352***	-1.693464***
			(0.1334635)	(0.1312356)	(0.1308976)	(0.1331088)
			0.1837188	0.1919559	0.1837181	0.1838814
patvoln				0.0053847***	0.0047936***	0.004793***
				(0.0011684)	(0.0012477)	(0.0012483)
				1.005399	1.004805	1.004805
liberalnp						0.0172841
						(0.2385598)
						1.017434
constant	-4.411979***	-4.522341***	-3.874386***	-4.054396***	-4.051702***	-4.051302***
	(0.0675229)	(0.0679963)	(0.0800958)	(0.0886799)	(0.0875629)	(0.0872292)
No. of observations	24142	24142	24142	24142	24142	24142
Wald Chi2(1)	12.86	111.21	247.90	278.96	287.58	288.62
Pseudo R2	0.0035	0.0176	0.0769	0.0893	0.0906	0.0906

Note : Robust standard errors are used and showed in parentheses. Reported coefficients are betas. The third row for each variable is exp(beta) or odds ratio.
* p<0.1, ** p<0.05, *** p<0.01

1.5%. The results are similar to previous results and delineate a positive relationship among almost all the variables, except for *nonprimcare* variable.

All three models show that the liberal NP SOP are positively correlated with practice's participation in the CPCI. The odds ratio for liberal NP SOP varies across different models and ranges from 11% to 36% in terms of increasing odds for a practice to participate if a practice is located in the region with liberal NP SOP. Moreover, a practice that specializes in non-primary care is less likely to participate in the CPCI, which is not surprising, given that the care management fees provided by certain payers are based on the number of PCPs in a practice rather than a total number of physicians.

Patient volume and size are positively related to participation in the CPCI, which is consistent with the payment model, as the latter is based on the number of CPCI attributed patients and PCPs in certain cases. Whether total number of NPs and PAs, or a sum of NPs and PAs, or an indicator variable for employing at least one NP and PA is used, the parameters' estimates show a positive relationship, and thus, practices that have NPs and PAs employed are more likely to participate in the CPCI than those that do not have. The results are revealing, given that the CPCI chose various practices with different size, NP, and PA employment. This finding infers that practices with NPs and PAs are more likely to benefit from participating in the CPCI and therefore opt into CPCI. Unexpectedly, both results in Model 1(v) and Model 2(v), suggest that the impact of employing PA is greater than NP on likelihood of a practice to participate in the CPCI. The bigger the *size* (number of MDs) in a practice the more a practice is interested to participate, which could likely

Table 6.8.

Model 3: Logit Regression, with Marginal Effects

Determinants of whether a practice participates in the CPCI or not, 2013

	Dependent variable: CPCI participation (Yes/No)					
	(i)	(ii)	(iii)	(iv)	(v)	(vi)
liberal	0.0063417***	0.0039465**	0.0044662**	0.0041505**	0.0042947**	0.004212*
	(0.0019598)	(0.0018692)	(0.001939)	(0.0018962)	(0.0019134)	(0.0021561)
n_nppa		0.0032022***	0.0025706***	0.0025888***	0.0022327***	0.0022193***
		(0.0003847)	(0.0004846)	(0.0004483)	(0.0004463)	(0.0004841)
size			0.0005483***		0.0002436*	0.0002437*
			(0.0001843)		(0.000126)	(0.0001264)
nonprimcare			-0.0231835***	-0.0222465***	-0.0229182***	-0.0229026***
			(0.0020406)	(0.0019356)	(0.0019538)	(0.0019865)
patvoln				0.0000695***	0.0000618***	0.0000618***
				(0.0000158)	(0.0000166)	(0.0000166)
liberalnp						0.0002244
						(0.0031172)
No. of observations	24142	24142	24142	24142	24142	24142

Note : Robust standard errors are used and showed in parenthesis. Reported coefficients are average marginal effects.

* p<0.1, ** p<0.05, *** p<0.01

be attributed to higher care management fees per practitioner (due to idea that each practitioner has his/her own Medicare beneficiaries). The larger practices would see a higher benefit in CPCI participation.

Although only specification (v) was analyzed, it should be mentioned that *liberalnp*, was only statistically significant at the 10% significance level in Model 2 (vi) and had a negative sign, suggesting a negative relationship between likelihood of a practice to participate in the CPCI and *liberalnp*, which was not aligned with prior hypothesis of *liberalnp* having a positive relationship with CPCI participation. Nevertheless, the results of the various models with best specification are statistically robust and do show a positive relationship between practice's CPCI participation and employment of NPs, PAs, along with liberal NP SOP.

Discussion and Limitations

Limitations

One of the limitations of this study is data limitation. There was no SK&A data available for 2014-2016 years, and therefore, this study analyzed only one year. The cross-sectional data analysis, hence, will not be the optimal data to identify the impact of NP and PAs employment along with NP SOP on the likelihood of practices to decide to participate in the CPCI. Another limitation was due to matching of practices from the CMS website to SK&A practices. The task involved looking up zip codes, longitude and latitude, and actual addresses and matching them with the names and addresses in SK&A data. This could potentially involve errors, and thus, the matching resulted in 327 practices to be identified rather than all 442 practices that CMS listed in October 2016. The model did not include expected management care fees, which could improve the model results drastically. However, it should be noted that the objective of this research was to identify if there is any relationship between NP SOP, as well as NP and PA employment, and CPCI participation. Therefore, the analysis undertaken in this research, given its limitations, at least offered some indication of the existence of this relationship.

Discussion

Due to limited literature available on the CPCI itself, there was no literature published[330] that looked at the impact of NP SOP, NP and PA employment on practice's CPCI partaking. There was only one study published that looked at the percentage of NPs and PAs employed at the CPCI practices. However, the study was based on 496 practices and found that 53% of the CPCI participating practices had NPs and PAs employed[331]. The results from my sample showed that 175 practices out of 325 employed either NPs, PAs or both, which is about 54%. Given that the

[330] As of April 2017.

[331] Peikes et al., 2014.

results were almost identical, it could be assumed that matching CPCI practices with SK&A data yielded realistic matches/results. Given the scarce literature available on the CPCI (and its relationship with NP SOP), the results of this study might be of interest to other scholars, who are interested in conducting further research of evaluating the impact of NP SOP vis-à-vis CPCI participation.

Concluding remarks

The empirical results of this research study support the proposed hypotheses that practices that employ NPs and/or PAs are more likely to participate in the CPCI, and practices that are located in the regions with liberal NP SOP have higher likelihood of participating in the CPCI and employ NPs and/or PAs. Furthermore, the results of this research suggest that the practices that are in liberal NP SOP regions are more likely to try out new models such as CPCI and are more prone to hire NPs and PAs to lower their costs of operation. These results are noteworthy given that the data on CPCI practices is so limited. Although the results are not conclusive about the short-term effects and long term effects and benefits, at least they indicate that practices have higher propensity to undergo changes, face risk, and be adaptable. These practices seem more flexible and agile to the changes in population dynamics and improving primary care provision. The reader might ponder if there is any long term versus short term benefits for practices from the pilot? This is a question that requires further research and would be useful to examine when data becomes available to evaluate the impact of the CPCI in the longer run.

The results of the study suggest that states (or regions) that are located in liberal NP SOP are more likely to partake in CPCI. Moreover, the results of the study indicate that (although there were only two states with liberal NP SOP) states that are open to policy changes will be more likely to participate in various initiatives to improve health care provided. In these states that are open to try new initiatives and learn what works best for them, while engaging NPs and PAs, the benefit from participating may be higher. Therefore, a policy maker, given the results of this analysis, may deem to conduct initiatives in states that are more open to policy changes and trials as it may result in higher interest and involvement. If these states perform better under any pilot/initiative, a policy maker may decide to implement the changes in more restrictive states. For instance, the CPCI's objective was to improve health care and lower health care costs by utilizing its primary care redesign model and payment reform. Practices within the participating regions that stayed for the full 4 years were more likely to benefit from this initiative in some way or the other. Given the study results, many of these practices employed NPs and PAs and were already saving costs by employing mid-level practitioners while operating their practices. NP SOP regulations are important in primary care, and in the future, it is expected that the role of NPs will be larger, given that states that have restricted NP SOP (Ohio, Indiana, Michigan, and others) have

been considering to change their NP SOP, and perhaps, these changes will result in further ramifications of how comprehensive primary care will be provided in the coming years.

7. Conclusion

The purpose of this dissertation was to determine the impact of NP SOP in primary care. The growing importance of NPs in health care is shown in this research. There is an increasing trend among practices, both in states with liberal and restricted NP SOP, to hire more NPs now than previously, as NPs begin to prove their value to practices, while providing quality of care to patients, which is supported in the existent literature.

This research study examined the relationship between NP SOP and access to health care as well as practices' participation in CPCI. The existing literature demonstrated that NP SOP plays an important role not only in the way NPs practice, but also in various aspects of health care, such as utilization, costs, accessibility of PCPs, and even availability of PCPs in underserved areas.

The growing number of NPs creates larger pool of practicing PCPs to provide access to care. The empirical analysis in this dissertation finds that NP SOP affects the number of NPs employed in primary care as well as specialty care. As shown in Chapter 4, NP employment is higher in states with liberal NP SOP. NP SOP caused an increase in the employment of NPs in a practice, and the increase was larger in larger-sized primary care and specialty practices. Furthermore, as shown in Chapter 5, NP SOP affects realized access to care: liberal NP SOP causes an increase in the patient volume handled by a practice, and the impact varies by practice size and specialty. Currently, 24 states have adopted liberal NP SOP, yet the projected physician shortage is nationwide. These findings are relevant to policy makers. The findings imply that liberal NP SOP, if adopted, can help to avert the denial of access to care that would come with a realized shortage. It is useful to add that as health care continues to transition from individual and small practices to large, multi-physician managed care organizations, the dissertation findings indicate that NPs can be successfully integrated into large practices and that both NP employment and patient volume increase when NP SOP shifts from restricted to liberal.

Another interesting finding from this research study is that NP SOP plays a role in the decision of a practice to participate in the CPCI. Practices that are located in states with liberal NP SOP and employ NPs and/or PAs are more likely to participate in the CPCI than practices located in states with restricted NP SOP. The results of Chapter 6 also suggest that practices that work with NPs and/or PAs are more prone to be proactive when it comes to participating in the initiatives such as the CPCI. This is noteworthy, as it suggests that pilots and initiatives geared towards states (regions or practices) that are inclined to try new approaches in health care are more likely to be interested and successful in implementing new policies or initiatives that a policy maker advances.

There are limitations to the analysis that should be kept in mind. The validity of SK&A data may be questionable when it comes to counts of NPs and PAs. The analysis here included both NPs and PAs, allowing a comparison of the results and in effect helping to account for the possibility that some SK&A respondents recorded NPs as PAs, or PAs as NPs. The empirical analysis in this study does not account for the quality and safety of care provided by NPs, though those topics are included in the literature review. With respect to policy, the study does not advocate for all the states to lobby for granting full practice authority for NPs. It only suggests that the impact in states switching from restricted to liberal in the limited six-year period is positive when it comes to access to health care and could be one of the solutions in tackling the shortage of PCP issue in the longer term.

Nevertheless, given the future estimated shortage of PCPs and the increasing role of NPs in health care, especially in primary care, these findings could be used to suggest certain policy prescription tailored to the state's condition. First, for the states that are more likely to experience a shortage of primary care providers in the future, a possible response is to broaden NP SOP, which might result in higher employment of NPs that are currently licensed but not practicing. For practices, especially of a larger size, expanded NP SOP may imply that NPs will become more beneficial as the latter could potentially take over cases within their scope-of-practice, but for which physicians previously were involved, while physicians may take on more difficult cases. This could be beneficial to all parties including policy-makers that are in the process of finding solutions to PCP shortage; patients that will have a choice between seeing an NP or MD and have a higher likelihood of seeing a practitioner within reasonable time frame with lower wait times; NPs that will have an expanded opportunity to provide care and possibly more satisfaction from their profession[332]; and practice owners that will be able to serve a growing population and do so at lower cost. In addition, PAs may benefit because PAs and NPs could be viewed either as substitutes or complements to an MD and when practices are affected by NP SOP regulations, they are inclined to demand more NPs and PAs for treating larger number of patients, as shown in Chapter 3 and Chapter 4. Therefore, the policy recommendation to expand NP SOP for states that are exposed to an alarming PCP shortage issue might be worth considering.

In states where concern about safety and quality of care received by NPs is questioned, one solution could be to encourage practices to work more collaboratively with NPs and PAs, as these practitioners are less costly but add to a practice's productivity in providing care and thereby

[332] Athey's study found that "feeling one's NP skills were fully utilized, was the factor most predictive of satisfaction". For further details see Athey, Erin K, Mayri Sagady Leslie, Linda A Briggs, Jeongyoung Park, Nancy L Falk, Arlene Pericak, Majeda M El-Banna, and Jessica Greene, "How important are autonomy and work setting to nurse practitioners' job satisfaction?," *Journal of the American Association of Nurse Practitioners,* Vol. 28, No. 6, 2016, pp. 320-326 E.

Also, Bae's study found that nonrural NPs "who agreed that they performed the fullest extent of their states' legal scope of practice were more satisfied than nonrural NPs who did not." For further details see Bae, S. H., "Nurse practitioners' job satisfaction in rural versus nonrural areas," *J Am Assoc Nurse Pract,* Vol. 28, No. 9, Sep., 2016, pp. 471-478.

increase its capacity to handle more cases. Moreover, initiatives, similar to the CPCI, but with the focus on employing NPs and PAs, may be used to try out various collaborations to see if broadened NP SOP may work in the long run for them.

The states that do not face a PCP shortage but are interested in decreasing costs of health care, might still want to consider expanding their NP SOP. These states may develop various schema, depending on the need unique to their state. For instance, they may allow NPs to work in collaboration with MDs for several years before granting full practice authority, which may in turn foster a culture of collaboration among MDs, NPs, and PAs and result in larger caseload that practices may carry at a lower cost.

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Appendix

A1. Description of steps for cleaning SK&A data

I start exploring SK&A data to identify any outliers and restrict my sample size to observations relevant to the research questions to be studied in Chapters 4-6. The following steps were taken before conducting analyses in each pertinent chapter:

1) Initial check-up of data, identifying outliers by exploring graphs and removing them based on plots and needs specific to analyses
   Outliers: patient volume > 2000

2) Eliminating observations not relevant to the study:
- Practices with zero average daily patient volume
- Practices that do not have any MD on site
- Practice specialties that have low proportion of NPs and PAs employed per year (the rationale behind deleting practices with specialties that have tendency to hire small number of PAs and NPs per year is that having these practices in the dataset may skew the results, as the focus of this dissertation is to identify impact of NP SOP on employment of NPs and patient volume in practices that generally have either NP and/or PA on site)

The detailed description of steps taken in cleaning the data is given below.

Before cleaning the data, the initial step involved identifying the number of practitioners per year, which is presented in Table A1.1. Also, I counted unique number of practice sites in the data over six-year period. There are 1,485,754 number of practices in the SK&A dataset. Overall, the total number of observations that had repeated number of practices are 4,913,015, which included 3,426,261 number of observations that were repeated (and are not unique practice IDs). I restrict my sample to unique IDs for practices and remove repeating IDs.

The next step was examining the graph of patient volume for 2008-2013 to identify any outliers, as shown in Figure A1.1.

Table A1.1.
Number of Practitioners by Year and Practitioner Position Held in the Practice

	Year					
Position held at the practice	2008	2009	2010	2011	2012	2013
Nurse Practitioner	49,234	50,967	54,611	59,900	64,281	68,178
Physician Assistant	37,353	38,896	41,057	44,052	46,187	48,166
Physician	483,572	501,888	521,229	538,339	544,284	513,433
Total	**570,159**	**591,751**	**616,897**	**642,291**	**654,752**	**629,777**

Figure A1.1.
Patient Volume for 2008-2013

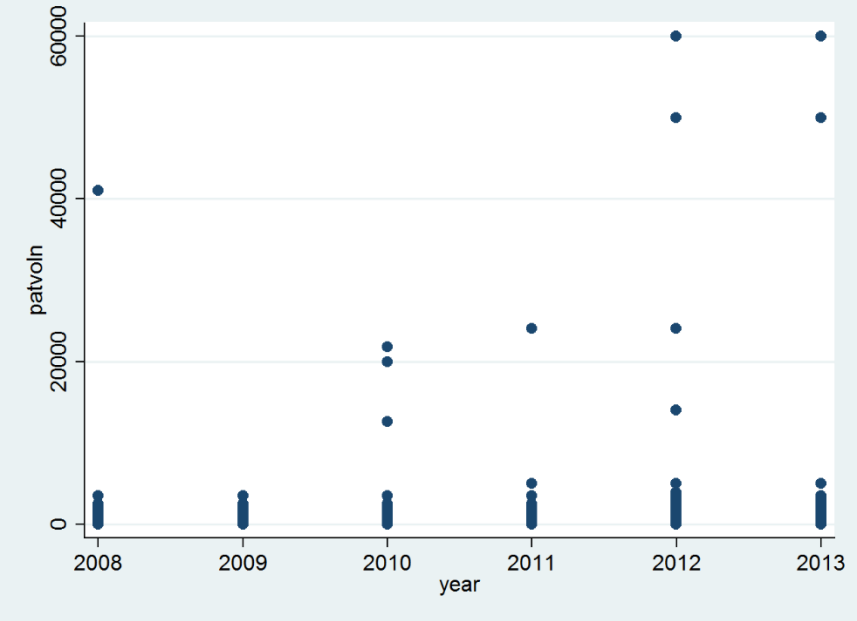

Figure A1.1. shows that there are few observations (n=50 when *patvoln* > 2000) for sites that have more than 2000 average patient daily visits each year. It could be safely assumed that observations with *patvoln* > 2000 are outliers and I eliminated these observations from the sample.

Moreover, there are 158,412 observations where daily patient volume is equal to zero. I removed *patvoln* = 0 from the sample as well. When inquiring SK&A representative[333] about observations that have patient volume equal zero, it was identified that these are mostly missing numbers (during the verification phonecall, a respondent was unable to tell what the average daily patient visits the practice usually has). Therefore, I removed missing data vis-à-vis patient volume.

Next, I looked at the number of MDs employed at the practice – *size*. There are 6,047 observations (or number of practices) that have zero MDs on site. I removed these practices, as the focus of this research study is to identify if MDs are more likely to employ NPs given NP SOP. Note that these 6,047 practices have either a PA or NP employed in the clinic.

Then, I generated a variable by year and practice specialty that counts practices which employ either NPs or PAs (i.e., a positive number of NPs and/or a positive number of PAs, *totnp*>0 U *totpa*>0), *nspec_nppa*. I explored the number of practice specialties with positive number of PAs and/or NPs, which have less than 100 observations per year for that particular specialty and identified the practice specialties, presented in Table A1.2.

[333] Mendez, John, "Inquiry OM325064," Email correspondence, February 28, 2017.

Table A1.2.
Frequency of Practice Specialties, nspec_nppa < 100

Practice Specialty	Frequency
Addiction Medicine	878
Adolescent Medicine	872
Aerospace Medicine	868
Bariatrician	1,324
Colon-Rectal Surgery	3,060
Critical Care Med	1,009
Dentist/Oral Surgeon	6
Dialysis	389
Forensic Psych	12
General Preventative Medicine	875
Genetic Specialist	875
Gynecologic Oncology	1,008
Head & Neck Surgery	94
Holistic Medicine	1,423
Nuclear Medicine	569
Ophthalmology	53,700
Osteopathic Manipulation	340
Other Specified	1,008
Podiatry	27,984
Psychiatry	122
Sleep Medicine Specialist	1,826
Sports Medicine	1,175
Transplant Surgery	797
Trauma Surgery	543
Vascular & Interventional Radio	545

Note that the frequencies indicate the number of times practice specialty is observed in the dataset, but has less than 100 NPs and PAs employed per year.

I also explore the number of practice specialties that hire a positive number of NPs and/or PAs per year with *nspec_nppa* > 100, which is shown in Table A1.3.

After exploring the initial SK&A data for 2008-2013, I removed observations which have *patvoln, size* equal to zero, *patvoln* > 2000, and finally, *nspec_nppa* < 100[334]. Now, I have

[334] Note that nspec_nppa < 100 is not removed in Chapter 6, as the focus of the chapter is to explore employment likelihood among CPCI and non-CPCI participating practices across all practice specialties in 2013. However, all the other above-mentioned steps are undertaken and outliers along with missing data variables are removed (*viz.*, *patvoln* > 2000, *patvoln* =0, and *size* =0).

1,230,624 unique number of practices across six-year period (while removing 256,130 observations/ practices). Also, I explored the number of practitioners after eliminating the above observations in Table A1.4.

Table A1.3.
Frequency of Practice Specialties, nspec_nppa > 100

Practice Specialty	Frequency
Allergy/Immunology	17,038
Anesthesiology	22,371
Cardiology	43,750
Dermatology	35,617
Dialysis	1,807
Emergency Medicine	23,060
Endocrinology	11,183
Family Practice	198,561
Gastroenterology	28,647
General Practice	15,616
General Surgery	41,114
Geriatric Medicine	2,603
Gynecologic Oncology	638
Infectious Disease	6,881
Internal Medicine	152,426
Internal Medicine/Pediatrics	2,994
Multi Specialty	153,797
Nephrology	17,680
Neurological Surgery	9,013
Neurology	28,622
Obstetrics/Gynecology	84,591
Occupational Medicine	8,026
Oncology/Hematology	21,928
Orthopedic Surgery	47,701
Otolaryngology	26,274
Pain Management Specialist	8,146
Pathology	11,607
Pediatrics	78,987
Physical Medicine/Rehab	14,250
Plastic Surgery	38,907
Podiatry	28,398
Psychiatric	91,609
Pulmonology	16,149
Radiology	37,764
Rheumatology	9,501
Thoracic Surgery	6,691
Urology	25,789

Vascular Surgery	5,312

The last step was to explore summary statistics. As Table A1.5. shows, now there are 1,230,624 unique number of practices and observations per each practice pertaining to *size, patvoln, totnp* (total number of NPs in a practice), and *totpa* (total number of PAs in a practice).

Table A1.4.
Number of Practitioners by Year and Practitioner Position Held in the Practice

Position held at the practice	Year						
	2008	2009	2010	2011	2012	2013	Total
Nurse Practitioner	45,990	47,383	49,941	55,280	59,618	63,713	321,925
Physician Assistant	34,722	35,952	37,525	40,937	43,369	45,438	237,943
Physician	407,786	416,381	418,453	437,035	449,574	439,320	2,568,549
Total	**488,498**	**499,716**	**505,919**	**533,252**	**552,561**	**548,471**	**3,128,417**

Table A1.5.
Summary Statistics for 2008-2013

Variable	Mean	Std. Dev.	Min	Max
Patvoln	45.70404	51.52526	1	2000
Size	2.793843	4.82771	1	406
Totnp	0.290457	0.805487	0	43
Totpa	0.218547	0.738948	0	41

N = 1230624

A2. CMMI's CPCI: Background

How were CPC participants selected?

By the end of PY 2016, there were 7 regions, 37 public and commercial payers, 441 practices, and about 1.206 million of CPC attributed beneficiaries (patients) that participated in the CPCI[335]. Once practices were selected into participating in the CPCI, they were offered to participate in the CPCI for 4 years and were given an opportunity to withdraw, if needed (under the condition of 90-day notice prior to their withdrawal). Initially 502 practices were selected[336].

The selection process started from identifying regions[337] based on the interest of payers in these regions. So, the process was initiated by inviting public and private payers to apply for CPCI participation between September 28, 2011 and January 17, 2012. Applications were submitted separately by each payer. CMS determined which regions should be selected based on overlapping market area of payers, by developing a scoring system to select regions[338]. In April 2012, CMS chose 7 regions for CPCI partaking. CMS selected regions on the basis of majority of payer participation with the objective of diverse geographic representation across chosen regions. The first step was to score payers and based on scoring of payers to select regions, which is presented in Figure A2.1[339].

CMS chose to pilot the initiative at the statewide and region-based level. The 7 regions that were selected to participate in the CPCI include regions at:

(1) Statewide level – Arkansas, Colorado, New Jersey, Oregon
(2) Region-based level – New York (Capital District Hudson Valley Region), Ohio/Kentucky (Cincinnati – Dayton Region), Oklahoma (Greater Tulsa Region)

Once selecting regions, CMS asked high-scoring payers to partake in the CPCI. CMS and payers agreed upon their roles in the CPCI under memoranda of understanding (MOUs), which entailed that participating payers would provide CPCI participating practices with[340]:

(1) enhanced, non-visit-based payments
(2) attribution reports at the beginning of each attribution period
(3) periodic data feedback on the health care cost and utilization of attributed patients (or members)
(4) sharing of possible savings in total health care costs

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[335] "Comprehensive Primary Care Initiative: Fast Facts", 2016.

[336] For further details see Peikes et al., December 2016, p. 52.

[337] For instance, CMS did "not choose markets for the Comprehensive Primary Care (CPC) initiative that overlap with sites participating in the Multi-payer Advanced Primary Care Practice demonstration (MAPCP)." For further details see "FAQ: The CPC initiative and participation in other CMS initiatives." Centers for Medicare and Medicaid Services. As of April 10, 2017.

[338] Taylor et al., 2015, p. 2.

[339] Taylor et al., 2015, pp. 10-11.

[340] Taylor et al., 2015, p. 13.

Figure A2.1.
Scoring Payer Applications and Selecting CPC Regions

Scoring payer applications

CMS scored individual payer applications up to a total of 15 points, based on payers:

- Degree of alignment with the CPC approach
- Commitment to enter into compensation contracts with participating practices that (1) enable the practices' primary care functions to be delivered at the point of care and integrated into practice workflow; and (2) include the opportunity for practices to qualify for shared savings
- Agreement to share with CMS their methodologies for attributing patients to a specific practice
- Willingness to provide participating practices with aggregate and member-level data about patients' service use and cost
- Willingness to align quality, practice improvement, and patient experience measures with those of CMS and other regional payers to monitor participating practices' implementation of Milestones, and efforts toward quality improvement and patient experience
- Provision of information on the geographic areas in which they wanted to participate
- Previous community collaborations on quality and related topics, and multistakeholder efforts

After selecting regions, CMS invited payers scoring 11 or more points on their applications to participate in CPC. Payers scoring 6 to 10 points were required to further refine their applications before they could participate. CMS considered inadequate those payers that scored only 1 to 5 points.

Selecting CPC regions from payer applications

CMS used a multistep market scoring system to select CPC regions. CMS:

Step 1. Weighted individual payer scores based on the payer's penetration in the region
Step 2. Assigned each region an impact score between 1 and 10, based on the combined market penetration of all the payers in the region who submitted an application
Step 3. Added together the weighted payer scores and the impact score to determine the region's market score
Step 4. Grouped regions by the 10 U.S. Department of Health and Human Services (HHS) administrative units
Step 5. Considered regions with the highest and second highest market scores in each HHS region as finalists
Step 6. Added two additional points to finalist regions with state participation for Medicaid or public employee benefits
Step 7. Added two additional points to the five finalist regions with the highest proportion of meaningful users of electronic health records (EHRs)
Step 8. Selected the regions with the highest final market scores, with no more than two regions selected in a given HHS area to ensure geographic diversity

(5) considering common approaches to data sharing (such as data aggregation) and to engage in collaborative meetings with other participating payers

Upon the selection of these regions, CMS invited practices located in these regions to apply for participating in the CPCI. Figure A2.2. describes the CPC practice eligibility criteria that were defined in the application[341]. After receiving 987[342] applications, CMS chose 502[343] practices to take part in the CPCI, based on the preference criteria presented in Figure A2.3[344].

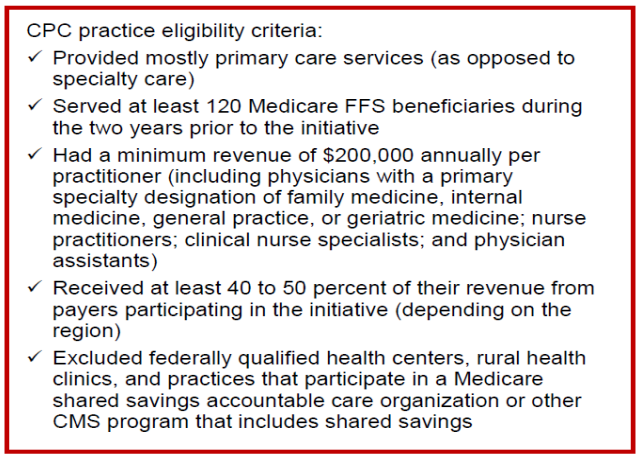
[341] Ibid.

[342] Peikes et al., 2014.

[343] According to the practice solicitation document, practices "that have 60% or more of their current revenue generated from payers that are participating in the CPC Initiative will be better positioned to implement the service delivery model and meet the practice milestones". For further details see "Comprehensive Primary Care (CPC) Initiative: Primary Care Practice Solicitation", no date.

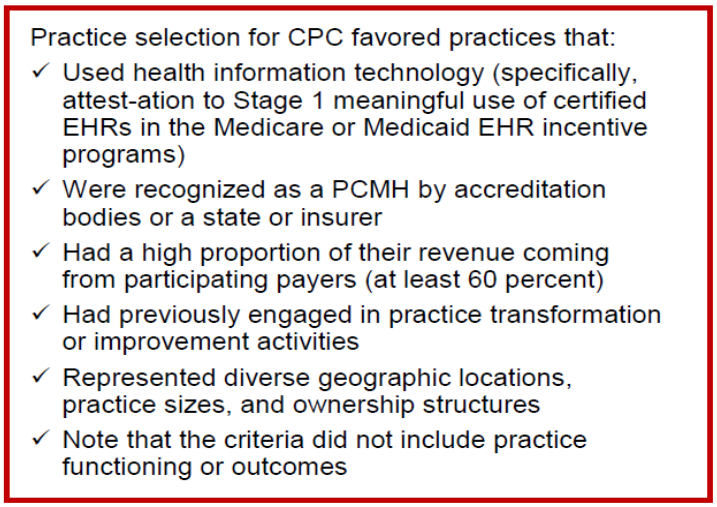
[344] Taylor et al., 2015, p. 13.

Figure A2.2.
CPC Practice Eligibility Criteria



Although ¾ of practice applicants were eligible, given the eligibility criteria, CMS selected "practices that were best positioned to succeed in CPC", with the rationale that "even the best practices had substantial room for improvement in both their structure and their operations"[345]. To

Figure A2.3.
CPC Favored Properties of Practices



participate in the CPCI practices agreed upon implementing needed actions to meet yearly CPC Milestones. Over time, the number of practices partaking in the CPCI decreased due to various reasons, such as its own decision to withdrew or merging with another CPC practice[346].

The CPCI chose regions, payers, and practices directly. However, it did not choose primary care clinicians (physicians, NPs, and PAs) or CPC attributed patients. The clinicians that were

[345] Taylor et al., 2015, p. 13.
[346] Peikes et al., December 2016, pp. 12-13.

employed primarily at the CPC participating practice were counted as number of practitioners employed by CPC practices. Patients did not need to register to be a part of the CPCI. In fact, the CPCI affected both attributed and non-attributed patients. In particular, patients – whether they were attributed to CPCI or not – received comprehensive primary care if they were primarily using the practice that participated in the CPCI. However, the care management PMPM fees were only paid for the number of CPC-attributed beneficiaries. The attribution list was based on several factors with respect to Medicare beneficiary usage of health care at the CPC practice. These factors, depending on the payer, included number of visits in the previous two years (look-back period also varied depending on the payer), and in some cases, on the assignment to a specific primary care provider. In the PY 2013, the CPC participating practices served about 2.5 million patients, among which 1.2 million were CPC attributed beneficiaries[347].

What were the characteristics of the CPCI selectees?

Starting from the first level – regions – characteristics of regions selected varied considerably at baseline, especially when examining such characteristics as medical home certification, ownership by a larger organization, and six or more clinicians working at the practice. Some regions where chosen at statewide level (Arkansas, Colorado, New Hersey, and Oregon) and the other regions were at smaller levels, comprising several counties (the Capital District Hudson Valley region in New York, the Cincinnati-Dayton region in Ohio/Kentucky, and the Greater Tulsa region Oklahoma). The regions differed by geographic scope (statewide or county context), physical characteristics (urban versus rural regions), population characteristics (demographics and health status). For instance, the CPC participating payers and practices are "not evenly distributed across any given geographic area", but "several regions include key submarkets" [348].

At the beginning of the CPCI, there were 31 distinct payers, which encompassed regional private payers, public payers, and national payers – such as Anthem (3 regions), Humana (3 regions), United Healthcare (3 regions), Aetna (2 regions), Amerigroup (2 regions), Cigna (1 region)[349]. Payers also differed by their existing participation in other relevant to CPC initiatives, such as "payment reforms" or "Beacon Community"[350].

The next level of CPCI selectees – practices – also varied considerably within each region and across regions. For instance, in the beginning of the CPCI, practices' self-reports of their primary care functioning and patient ratings of the care received by these practices varied

[347] Taylor et al., 2015, p. 15.
[348] Taylor et al., 2015, p. 28.
[349] Taylor et al., 2015, p. 11.
[350] Taylor et al., 2015, p. 32.

"substantially"[351]. Also, the baseline characteristics of practices differed by patient ratings of care, and socioeconomic status of patients, various sizes, ownership status, meaningful use status, medical home status, primary care functioning[352].

As mentioned prior, although patients were the focus of the CPCI, they were not directly selected to participate in the CPCI. However, it is important to note that within practices and regions patients were also heterogenous and differed by age, health status, socioeconomic status, and such[353].

What was the CPCI timeline and what CPCI Milestones practices had to meet?

The CPCI started in the Fall of 2012. The four-year pilot ended in December 2016. The CPC implementation timeline is presented in Figure A2.4.[354]. During the four years of the pilot, each practice was required to meet the yearly CPC Milestones, which included such areas as budget, care management for high risk patients, access and continuity, patient experience, quality improvement, care coordination across the medical neighborhood, shared decision making, participation in learning collaborative, and health information technology[355]. Practices that did not meet Milestones, were placed on a corrective action plan (CAP). For instance, in PY2015, there were 76 practices that were under CAP[356].

[351] Taylor et al., 2015, p. 27.

[352] For further details see Table 3.3 of Taylor et al., 2015, p. 33.

[353] Taylor et al., 2015, p. 39.

[354] Figure A2.4. is adopted from Peikes et al., December 2016, p. 4.

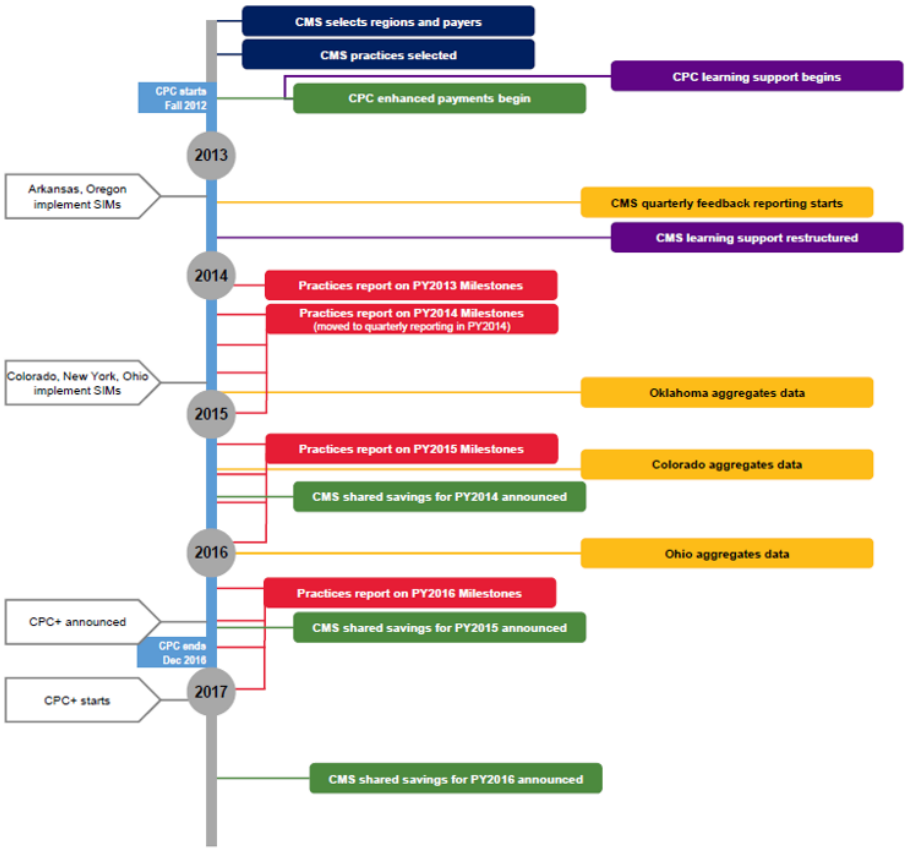
[355] For the detailed description of Milestones by the pilot year see "Comprehensive Primary Care: Milestones." Centers for Medicare and Medicaid. As of April 10, 2017.

[356] For further details see Table 5.19 of Peikes et al., December 2016, p. 126.

What were the payments practices received while participating in the CPCI?

CPC practices received "a large infusion of money for investments in redesigning and transforming care"[357], while participating in the CPCI. For instance, about 60% of the total CPC

Figure A2.4.
CPC Implementation Timeline



Note: State Innovation Models (SIMs) are funded by CMS and led by the state's Medicaid program. States are using SIM awards to test multipayer health care payment and service delivery models that aim to improve health system performance, increase quality of care, and decrease costs.

funding was from Medicare FFS, although about 26% of all CPC attributed patients are Medicare FFS in PY 2013[358]. Similarly, it was almost the same proportion when it came to enhanced payments in PY 2014[359].

Although each year the enhanced payments decreased, however, the payments were still sizeable. In PY 2013, a median practice got $226,849 (representing a rise of 19% in their pre-CPC revenue in 2012) in total CPC care management revenues on top of their usual revenues[360]. In the

[357] Taylor et al., 2015, page xvi.
[358] Taylor et al., 2015, page xvi.
[359] Peikes et al., April 2016, p. xx.
[360] Taylor et al., 2015 page xvi.

three years of the initiative, CPC-side funding per practice was about $227,800 in PY 2013, $203,900 in PY 2014, and $175,780 in PY 2015, respectively[361]. Depending on the state, CPC enhanced payments per clinician ranged from about $35,300 to $113,500 in PY 2013[362].

How is care management fee calculated?

The care management fee that a practice receives is based on the number of CPC attributed beneficiaries it has. Every quarter[363], a practice gets the list of CPC-attributed beneficiaries and the associated care management fees for these patients that use the service of this practice largely. Depending on the type of a payer – whether it is Medicare FFS[364] and non-CMS with open access products or managed products – a list[365] that attributes members could be based either on claims data, an algorithm used for their existing PCMH or care coordination programs, or on the primary care provider selected as part of their insurance enrollment with different look-back periods and use of evaluation and management codes[366]. In cases, where a clinician is used to determine the number of CPC attributed beneficiaries for the practice the rule is that if a clinician works at several practices[367], the practice which he/she selects (one location only) will be assigned as a practice that will receive CPC related benefits for the number of CPC beneficiaries attributed to that practice for that particular clinician[368]. For instance, CMS determines fees based on the corresponding hierarchical condition category (HCC)[369] score a CPC attributed beneficiary is assigned to. This fee should not vary if a clinician is a physician or an NP, as the amount of fee is determined based on the CPC attributed beneficiary's HCC score[370] that assesses a patient's health condition and

[361] Peikes et al., December 2016, p xx.

[362] Peikes et al., December 2016, p. xx.

[363] Per CMS, the "Innovation Center will provide each practice with a list of its attributed beneficiaries prior to the start of the Initiative and quarterly thereafter. The attributed Medicare beneficiary population will fluctuate from quarter to quarter and there will be variation throughout the Initiative." For further details see "Comprehensive Primary Care (CPC) Initiative: Primary Care Practice Solicitation."

[364] According to Peikes, "Medicare FFS beneficiaries were attributed quarterly to CPC practices that delivered the plurality of their primary care visits during a two-year lookback period; other payers use their own attribution methods." Peikes et al., 2016. page 14.

[365] "Each quarter, CPC practices receive lists of attributed patients from Medicare and other payers. Rather than develop an attribution methodology specifically for CPC, most payers applied an algorithm already used for their existing PCMH or care coordination programs." For further details see Taylor et al., 2015, pp. 44-45.

[366] For further details on attribution methodologies see Peikes et al., April 2016.

[367] According to the solicitation guideline, "CMS must be able to attribute patients uniquely to a single practice and group of primary care practitioners. A practitioner who practices in multiple locations must select only one location for participation in the CPC Initiative." For further details see "Comprehensive Primary Care (CPC) Initiative: Primary Care Practice Solicitation."

[368] For more details on the requirement of the CMS to attribute patients to a single practice and group of practitioners see "Comprehensive Primary Care (CPC) Initiative: Primary Care Practice Solicitation."

[369] For more details on HCC see Pope, Gregory C., John Kautter, Melvin J. Ingber, Sara Freeman, Rishi Sekar, and Cordon Newhart, *Evaluation of the CMS-HCC Risk Adjustment Model*, Research Triangle Park, NC: Prepared for Centers for Medicare & Medicaid Services, CMS Contract No. HHSM-500-2005-00029I TO 0006, March 2011.

[370] According to Taylor, the "HCC score represents the beneficiary's risk in the next year; it is calculated based on the medical conditions for which the beneficiary was treated in the two years prior, whether the beneficiary is enrolled in Medicaid, and various demographic characteristics. A beneficiary remains in his or her original risk quartile during CPC unless his or her HCC score

allows for risk adjustment[371]. The HCC score is updated annually[372], and therefore, a practice is expected to receive the same amount of care management fees based on the HCC score each quarter during each year it participates in the initiative.

In general, the care management fee a practice receives is based on the total number of CPC attributed beneficiaries that use the services at that particular practice. In majority of the cases, the number of CPC attributed beneficiaries will depend on how many beneficiaries are attributed to the practice[373], and in some cases, depending on the payer, the number of CPC attributed beneficiaries will be calculated based on the total number of patients assigned to each primary care provider[374] that works at the CPC participating practice. Therefore, total revenue and NP SOP do not directly affect the care management PMPM fees. However, depending on the payer's methodology to attribute CPC beneficiaries, in some cases, the larger the number of practitioners that work at the CPC participating practice, the larger total value of care management PMPM fees a practice would receive, provided that these practitioners are assigned to CPC participating practice.

Depending on the payer's methodology for assigning patients to CPC-attributed beneficiary list, the CPC-attributed patient list could be based on the number of visits a patient had with a particular practitioner at a particular practice in the last 2 years (the look-back period may vary as well from the CPC participating payer). To be qualified as a CPC-attributed beneficiary, a patient has to be seen mostly in a certain practice[375] (i.e. obtain the largest share of their primary care from the practice). In summary, depending on the CPC participating payer, the total value of care management PMPM fees a CPC participating practice receives would be based on the number of attributed CPC beneficiaries (patients), and the latter depends on how many times, which practitioner, what practice a CPC beneficiary visited mostly, based on the claims data, in the last two years, whereas the look-back period may vary as well.

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changes enough to place the beneficiary into a different quartile when the scores are updated annually." For further details see Taylor et al., 2015, p. 3.

[371] For more details on four care management fee levels for Medicare FFS beneficiaries attributed to the practice see Taylor et al., 2015.

[372] According to Taylor, most "non-CMS payers are not risk-adjusting the enhanced payments they make to practices." For further details see Taylor et al., 2015, p. 49.

[373] Recall that to be selected to participate in the CPCI, a practice site had to have a minimum of 150 eligible Medicare beneficiaries that were attributed to the practice. For further details on eligibility criteria see "Comprehensive Primary Care (CPC) Initiative: Primary Care Practice Solicitation."

[374] "Multi-specialty practice sites that include primary care practitioners may participate in the CPC Initiative as long as the predominance of claims and services from the practice site are for primary care." For further details see "Comprehensive Primary Care (CPC) Initiative: Primary Care Practice Solicitation".

[375] For complete details on CPC-attributed beneficiary list see Taylor et al., 2015, page 14 and "Comprehensive Primary Care (CPC) Initiative: Primary Care Practice Solicitation."

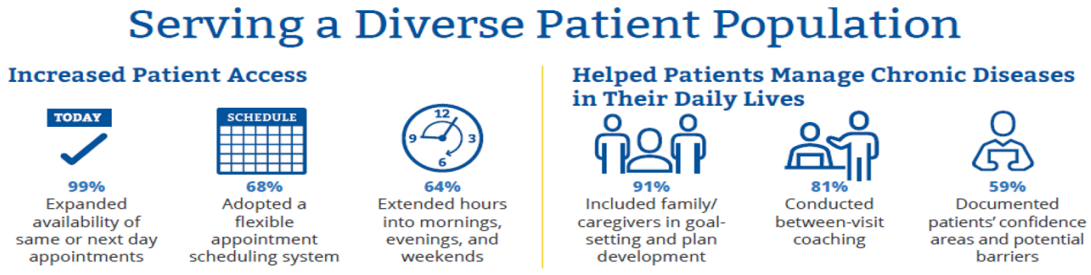
For example, if a payer uses a methodology based on number of visits and number of practitioners working at the facility: Say a CPC participating practice has two physicians and both of them only work at this particular practice, then the care management PMPM fee a practice would receive is based on the summation of the total number of CPC attributed beneficiaries (patients) (and in some cases based on the number of visits a patient had to this practitioner of this practice in the last two years prior to the start of the initiative). Depending on the payer type, range of participating payers' PMPM payments was between $3 and $40 in year 1[376].

Where enhanced payments, or care management PMPM fees, are invested into?

Each practice is reimbursed on a quarterly basis, based on the number of CPC-attributed beneficiaries. As discussed earlier care management PMPM fees depend on the number of CPC attributed beneficiaries (patients), which in turn may (contingent upon payer's attribution methodology used) depend on the number of physicians working in a CPC practice, whose patients are primarily seen in this practice by this practitioner. The enhanced payments from participating in the CPCI have been invested heavily in hiring extra labor and IT system. For instance, the enhanced payments were used for incorporating the CPC functions in redesigning primary care to meet the CPCI milestones in such areas as providing extended hours of services and having availability of same or next day appointments, which is presented in Figure A2.5[377].

Each pilot year, practices utilized care management fees to invest into either Health Information Technology (HIT), hiring care managers or interdisciplinary team members, depending on their need. In the first year of the pilot, CPC practices spent sizeable funds on covering new staff (care managers – $28.04 million) or on reallocating existing staff time to expand services (proactive population management – $20.61 million, interdisciplinary team members $13.35 million, staff for expanded hours) as well as on health information technology (15.97

Figure A2.5.
CPCI Facts, 2016



[376] Taylor et al., 2015, page 48.

[377] "Comprehensive Primary Care Initiative: Fast Facts", 2016.

million)[378]. In the subsequent two years of the pilot a large portion of CPC funding was spent on labor associated costs – $117 million in PY 2014 and $115 million in PY 2015[379].

These CPC related expenditures may imply that practices, once investing into the HIT, had larger need in covering labor associated costs for redesigning and transforming their primary care to meet yearly CPC milestones. These spending patterns are not surprising, as once any practice invests into technology, it would not need to spend much more on HIT later – all it needs is a staff to ensure the acquired HIT is run and used to the full extent.

What are the shared savings and is there potential to receive shared savings?

Starting from the second year of participation in the CPCI, a practice has an opportunity to share net savings from improved care to Medicare beneficiaries attributed to a practice (if savings in health care costs are realized). The savings to the Medicare program are calculated at a regional level and the distribution of the net savings to practices is based on practice's quality metrics performance[380]. Thus, to receive shared savings, a CPC participating practice should meet specific standards in three quality measures – electronic clinical quality measures (eCQMs), claims-derived measures of readmissions and ambulatory care sensitive admissions, and survey-derived measures of patient experience[381]. For instance, in 2015, there were total 465 practices participating in the CPCI and 449 of practices were successful at eCQM Reporting as well as 440 practices were eligible for shared savings based on quality requirements, with gross savings per beneficiary per month amounting to $14.83 across all regions[382].

After the first year of the pilot's completion, some practices did not take into account the opportunity of shared savings in subsequent years. As was mentioned in one of the evaluation reports "some practices are concerned that shared shavings might not materialize and that they will be unable to maintain practice investments; other practices are less concerned" [383].

In PY 2015, CMS paid four regions – Arkansas, Colorado, Oregon, and Greater Tulsa region of Oklahoma – more than $13.1 million in shared savings payments compared to $658,129 of

[378] See Figure 4.5 for PY 2013 in Taylor et al., 2015, page 49.

[379] See Figure 3.6 for PY 2014 Peikes et al., April 2016 (page 21); Figure 3.7 for PY 2015 Peikes et al., December 2016, page 30.

[380] "Comprehensive Primary Care Initiative", no date.

[381] *Comprehensive Primary Care Initiative: eCQM Benchmarking Methodology Report*, Centers for Medicare & Medicaid Services, October 2016.

[382] "Comprehensive Primary Care (CPC) Initiative: 2015 Shared Savings & Quality Results," October 2016. Centers for Medicare and Medicaid. As of April 30, 2017.

[383] Taylor et al., 2015, pp. 50-51.

Medicare shared savings it paid to Greater Tulsa region of Oklahoma, which was the only region that accrued net savings in PY 2014[384].

[384] Peikes et al., December 2016.

A3. Tables and Figures

Chapter 2: Tables and Figures

Table A3.1 shows state NP SOP regulations for 2008-2013[385].

Figure A3.1 shows a map with three categories of NP SOP – full, reduced, and restricted practice authority – across the country in 2017[386].

Table A3.1.
State NP SOP Over 2008-2013

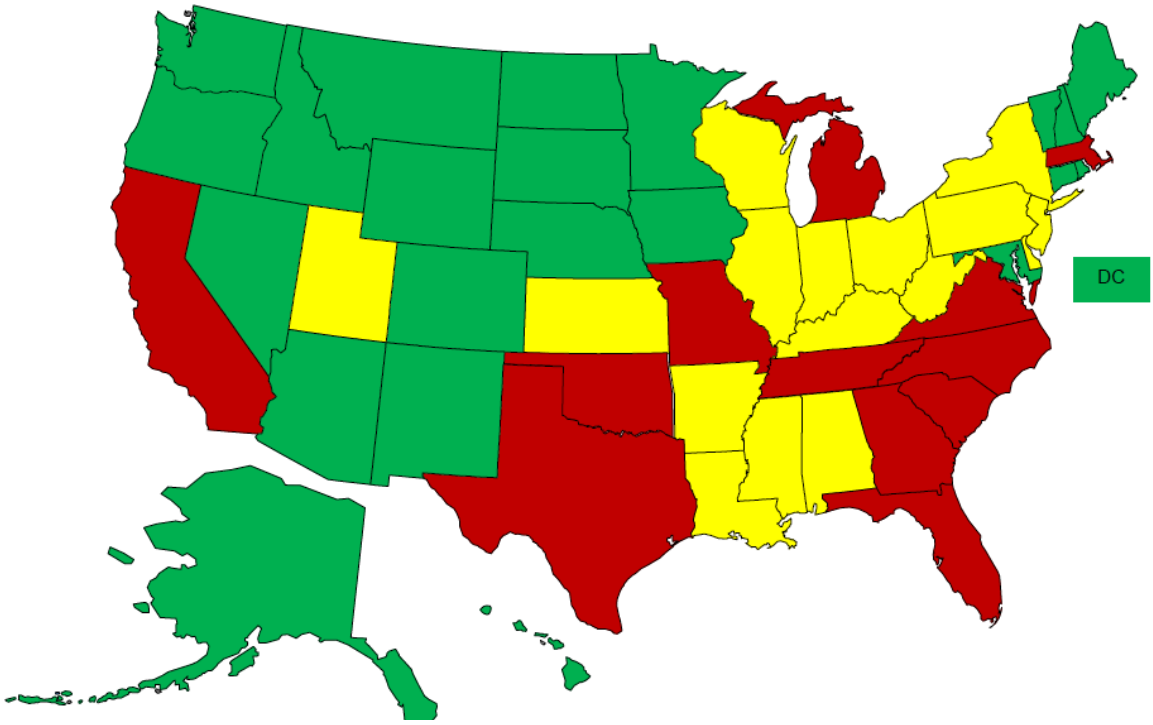
State	2008	2009	2010	2011	2012	2013
AK	1	1	1	1	1	1
AZ	1	1	1	1	1	1
CO	0	0	1	1	1	1
DC	1	1	1	1	1	1
HI	0	0	0	0	1	1
IA	1	1	1	1	1	1
ID	1	1	1	1	1	1
MD	0	0	0	1	1	1
ME	1	1	1	1	1	1
MT	1	1	1	1	1	1
ND	0	0	0	0	1	1
NH	1	1	1	1	1	1
NM	1	1	1	1	1	1
NV	0	0	0	0	0	1
OR	1	1	1	1	1	1
RI	0	1	1	1	1	1
UT	1	1	1	1	1	1
VT	0	0	0	1	1	1
WA	1	1	1	1	1	1
WY	1	1	1	1	1	1
Total	***13***	***14***	***15***	***17***	***19***	***20***

NOTE: ***State NP SOP: 1 - Liberal; 0 - Restricted.***

[385] The table is constructed using Linda Pearson's NP reports for the relevant years.

[386] "2017 Nurse Practitioner State Practice Environment," February, 2017.

Figure A3.1.
Map of Full, Reduced and Restricted Practice Requirements by State



Full Practice
State practice and licensure laws provide for nurse practitioners to evaluate patients, diagnose, order and interpret diagnostic tests, initiate and manage treatments—including prescribe medications—under the exclusive licensure authority of the of the state board of nursing. This is the model recommended by the Institute of Medicine and National Council of State Boards of Nursing.

Reduced Practice
State practice and licensure law reduce the ability of nurse practitioners to engage in at least one element of NP practice. State requires a regulated collaborative agreement with an outside health discipline in order for the NP to provide patient care or limits the setting or scope of one or more elements of NP practice.

Restricted Practice
State practice and licensure law restricts the ability of a nurse practitioner to engage in at least one element of NP practice. State requires supervision, delegation or team-management by an outside health discipline in order for the NP to provide patient care.

Chapter 4: Tables and Figures

Table A3.2 presents the number of practitioners practicing in the country in 2008-2013, after cleaning the data and limiting it to a restricted sample[387].

Figure A3.2 and Figure A3.3 show primary specializations for NPs and PAs, respectively.

[387] I use SK&A data to generate Table A3.2. The restricted sample excludes observations where patient volume is equal to zero or above 2000, number of MDs is equal to zero, and practice specialties that hire less than 100 NPs and PAs combined in a year.

Note that physicians include any physician that holds MD degree and is not limited to primary care providers. Similarly, number of PAs and NPs practicing incorporate all the practitioners practicing in any field of specialization, including primary care.

Table A3.3 and Table A3.4 provide the total number of practices by year and NP, PA employment.

Table A3.5 represents the number of practices by NP and/or PA employment, practice specialty, and NP SOP.

Table A3.6 shows practice specialty by NP and PA employment.

Table A3.7 presents information on the number or proportion of practices that either employ NPs or not by practice's size categories, NP SOP, and whether a practice specializes in primary care.

Figure A3.4 examines the proportion of practices by specialty within primary care[388]. Primary care is defined as a practice that specializes in family practice, general practice, geriatrics, adolescent medicine, internal medicine, pediatrics and pediatric internal medicine, obstetrics and gynecology, general preventative medicine, and urgent care. The largest category within primary care is family practice specialty followed by internal medicine.

Table A3.2.
Number of Practitioners by Year and Practitioner Position Held in the Practice

Position held at the practice	Year						
	2008	2009	2010	2011	2012	2013	**Total**
Nurse Practitioner	45,990	47,383	49,941	55,280	59,618	63,713	**321,925**
Physician Assistant	34,722	35,952	37,525	40,937	43,369	45,438	**237,943**
Physician	407,786	416,381	418,453	437,035	449,574	439,320	**2,568,549**
Total	**488,498**	**499,716**	**505,919**	**533,252**	**552,561**	**548,471**	**3,128,417**

[388] There are fewer specialties included and this is due to the restriction of my sample, where practice specialties that hire less than 100 NPs and PAs combined in a year are excluded. Thus, general preventative medicine and urgent care are not present in this chart.

Figure A3.2.
Primary Specialization of NPs, 2013

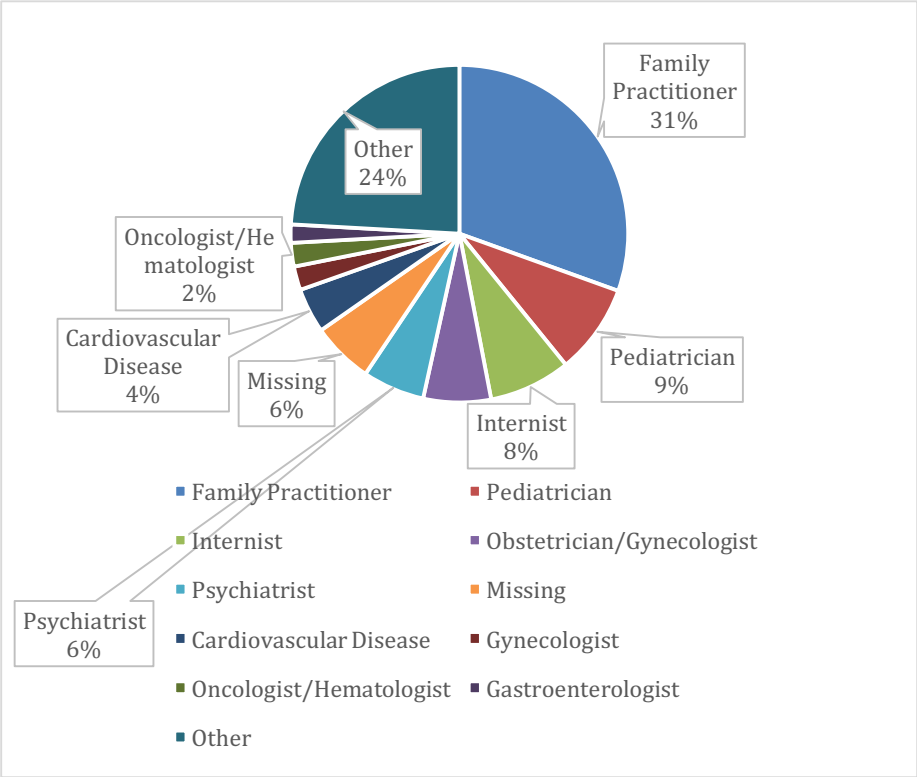


Figure A3.3.
Primary Specialization of PAs, 2013 in %

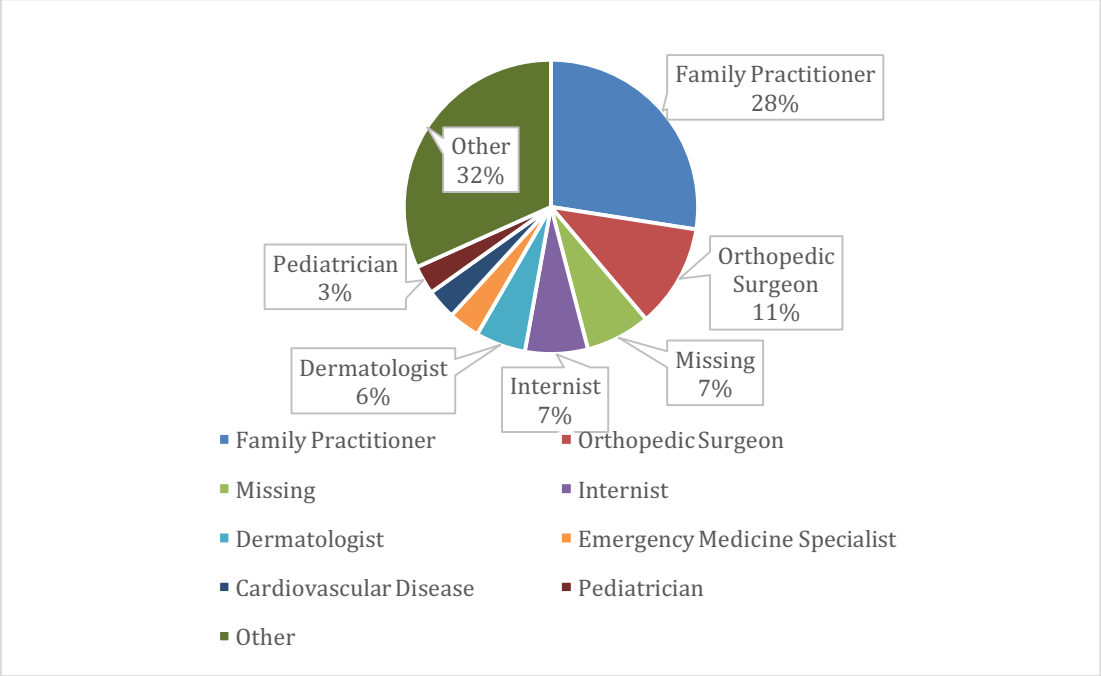


Table A3.3.
Number of Practices by NP Employment and Year

	2008	2009	2010	2011	2012	2013	**Total**
Number of practices with at least one NP	33,514	33,861	35,098	38,538	41,825	44,362	**227,198**
Number of practices with no NPs	165,018	167,721	156,648	162,365	173,323	178,351	**1,003,426**

Table A3.4.
Number of Practices by PA Employment and Year

	2008	2009	2010	2011	2012	2013	**Total**
Number of practices with at least one PA	25,253	25,680	26,204	28,264	30,094	31,337	166,832
Number of practices with no PA	173,279	175,902	165,542	172,639	185,054	191,376	1,063,792

Table A3.5.
Number of Practices that Employ NPs and/or PAs by NP SOP and Specialty of a Practice, Aggregated Through 2008-2013

	Indicator variable for NP employed		
Indicator variable for PA	No PA	≥ 1	**Total**

	Indicator variable for NP employed		
Indicator variable for PA	No NP	≥ 1	**Total**

Restricted NP SOP and non-PC			
No NP	486,737	63,186	**549,923**
One or more NPs	74,975	22,877	**97,852**
Total	**561,712**	**86,063**	**647,775**

Restricted NP SOP and PC			
No NP	308,767	38,480	**347,247**
One or more NPs	82,624	14,372	**96,996**
Total	**391,391**	**52,852**	**444,243**

Liberal NP SOP and non-PC			
No NP	56,847	11,583	**68,430**
One or more NPs	11,345	5,119	**16,464**
Total	**68,192**	**16,702**	**84,894**

Liberal NP SOP and PC			
No NP	30,513	7,313	**37,826**
One or more NPs	11,984	3,902	**15,886**
Total	**42,497**	**11,215**	**53,712**

Table A3.6.
Number of Practices by NP and PA Employment and Specialty of a Practice, Aggregated Through 2008-2013

Practice's specialty	Indicator variable		Indicator variable		Total number of practices in a specialty
	No NP	One or more NP	No PA	One or more PA	
Family Practice	137,628	48,552	148,031	38,149	186,180
Multi Specialty	96,207	41,959	103,749	34,417	138,166
Obstetrics/Gynecology	57,272	22,080	73,836	5,516	79,352
Pediatrics	54,972	19,642	68,236	6,378	74,614
Internal Medicine	119,890	19,073	127,037	11,926	138,963
Psychiatric	59,382	13,655	70,756	2,281	73,037
Cardiology	30,485	8,796	34,113	5,168	39,281
Oncology/Hematology	13,248	5,236	16,222	2,262	18,484
Gastroenterology	21,754	4,431	22,681	3,504	26,185
Dermatology	30,306	3,434	24,931	8,809	33,740
Nephrology	12,328	3,326	14,296	1,358	15,654
Orthopedic Surgery	40,697	2,763	30,993	12,467	43,460
Neurology	22,345	2,728	23,563	1,510	25,073
Emergency Medicine	12,589	2,625	11,376	3,838	15,214
Urology	21,402	2,572	20,648	3,326	23,974
Allergy/Immunology	13,492	2,411	13,754	2,149	15,903
Pulmonology	11,863	2,409	13,127	1,145	14,272
General Surgery	35,236	2,310	34,895	2,651	37,546
Endocrinology	7,607	2,280	8,915	972	9,887
General Practice	11,843	2,264	12,549	1,558	14,107
Otolaryngology	23,226	1,645	22,165	2,706	24,871
Occupational Medicine	5,935	1,527	5,429	2,033	7,462
Neurological Surgery	6,709	1,285	5,856	2,138	7,994
Pain Management	5,844	1,172	5,901	1,115	7,016
Anesthesiology	12,770	1,100	12,676	1,194	13,870
Infectious Disease	4,887	1,059	5,448	498	5,946
Other	133,509	6,864	132,609	7,764	140,373
Total	**1,003,426**	**227,198**	**1,063,792**	**166,832**	**1,230,624**

Figure A3.4.
Proportion of Primary Care Practices by Practice Specialty, Aggregated Through 2008-2013

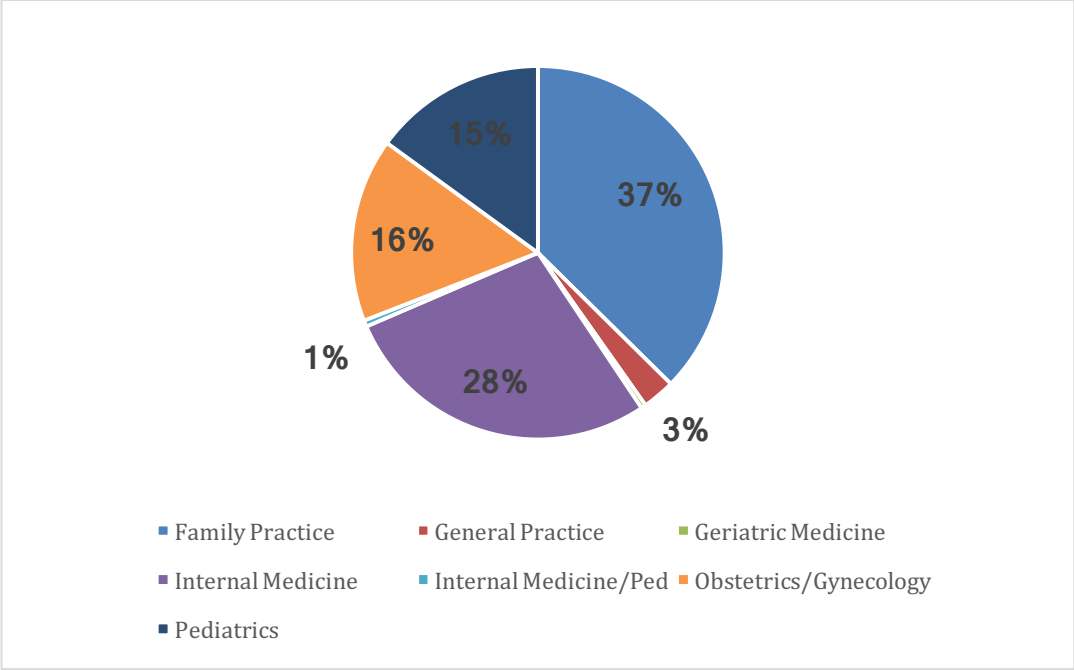


Table A3.7.
Number of Practices by Practice's Size Categories and NP Employment, NP SOP, Practice Specialty, Aggregated Through 2008-2013

Categories for practice size by number of physicians in a practice	Indicator variable		
	No NP	One or more NPs	**Total**
Restricted NP SOP and non-PC			
Solo: One MD	270,209	19,219	**289,428**
Small: 2-4 MDs	199,595	39,286	**238,881**
Medium: 5-9 MDs	58,874	24,149	**83,023**
Large: 10-20 MDs	17,203	11,276	**28,479**
Very large: 21+ MDs	4,042	3,922	**7,964**
Total	**549,923**	**97,852**	**647,775**
Liberal NP SOP and non-PC			
Solo: One MD	31,869	3,026	**34,895**
Small: 2-4 MDs	24,927	6,455	**31,382**
Medium: 5-9 MDs	8,244	4,329	**12,573**
Large: 10-20 MDs	2,780	1,936	**4,716**
Very large: 21+ MDs	610	718	**1,328**
Total	**68,430**	**16,464**	**84,894**

Categories for practice size by number of physicians in a practice	Indicator variable		
	No NP	One or more NPs	**Total**
Restricted NP SOP and PC			
Solo: One MD	233,907	44,735	**278,642**
Small: 2-4 MDs	92,560	36,497	**129,057**
Medium: 5-9 MDs	18,343	13,247	**31,590**
Large: 10-20 MDs	2,165	2,331	**4,496**
Very large: 21+ MDs	272	186	**458**
Total	**347,247**	**96,996**	**444,243**
Liberal NP SOP and PC			
Solo: One MD	23,692	6,471	**30,163**
Small: 2-4 MDs	11,287	6,268	**17,555**
Medium: 5-9 MDs	2,513	2,709	**5,222**
Large: 10-20 MDs	283	392	**675**
Very large: 21+ MDs	51	46	**97**
Total	**37,826**	**15,886**	**53,712**

Figure A3.5 shows means of patient volume, categorized by practice's size, NP employment, and NP SOP.

Table A3.8 examines the number of practices categorized by patient volume per day in a practice and NP employment, aggregated across 6 years and by NP SOP.

Table A3.9 shows how many practices are in the dataset categorized by practice specialty and patient volume categories across six years and NP SOP.

Table A3.10 examines the number of practices by size (number of MDs employed in a practice) and patient volume categories, aggregated across six years of observation and by NP SOP.

Figure A3.5.
Means of Patient Volume

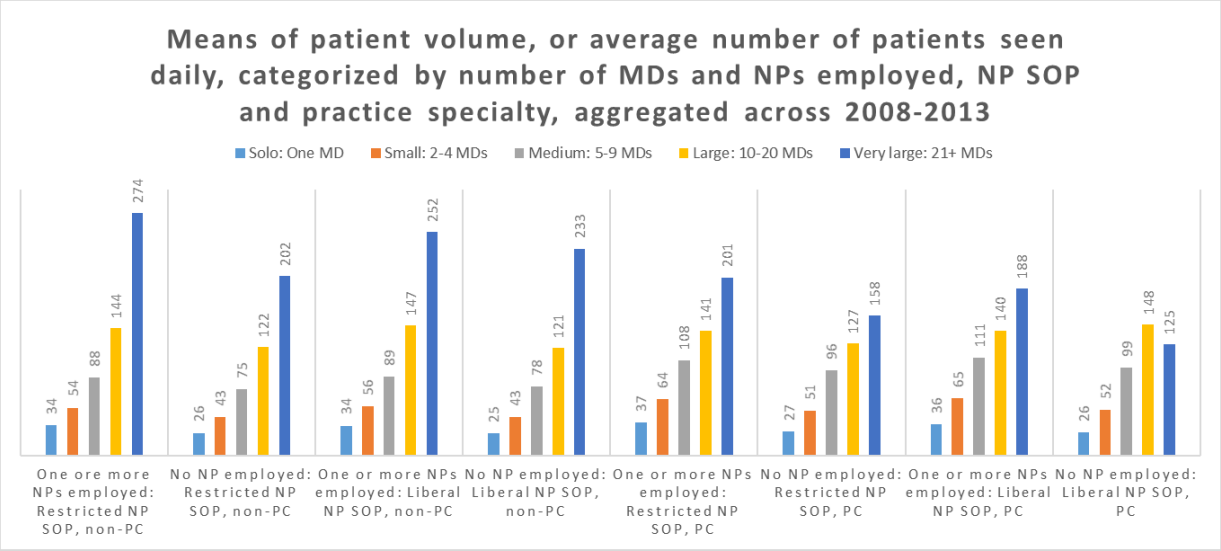


Table A3.8.
Number of Practices by NP Employment and Patient Volume Categories by NP SOP, Aggregated Through 2008-2013

Average patient volume per day in a practice	NP Indicator: No NP	NP Indicator: One or more NPs	**Total**	Average patient volume per day in a practice	NP Indicator: No NP	NP Indicator: One or more NPs	**Total**
Restricted NP SOP; 2008 -2013				**Liberal NP SOP; 2008-2013**			
1-20 patients	285,212	23,425	**308,637**	1-20 patients	35,999	4,380	**40,379**
21-80 patients	534,560	123,024	**657,584**	21-80 patients	59,092	18,998	**78,090**
81-180 patients	65,226	38,159	**103,385**	81-180 patients	9,350	4-Mar	**16,353**
181-420	11,031	8,961	**19,992**	181-420	1,641	1,804	**3,445**
421 or more patients	1,141	1,279	**2,420**	421 or more patients	174	165	**339**
Total	**897,170**	**194,848**	**1,092,018**	**Total**	**106,256**	**32,350**	**138,606**

Table A3.9.
Number of Practices by Practice Specialty and Patient Volume Categories, Aggregated Through 2008-2013 and by NP SOP

Average patient volume per day in a practice	Primary Care Specialty: No	Primary Care Specialty: Yes	**Total**	Average patient volume per day in a practice	Primary Care Specialty: No	Primary Care Specialty: Yes	**Total**
Restricted NP SOP; 2008 -2013				**Liberal NP SOP; 2008-2013**			
1-20 patients	198,519	110,118	**308,637**	1-20 patients	26,151	14,228	**40,379**
21-80 patients	367,755	289,829	**657,584**	21-80 patients	45,807	32,283	**78,090**
81-180 patients	64,156	39,229	**103,385**	81-180 patients	10,032	6,321	**16,353**
181-420	15,118	4,874	**19,992**	181-420	2,597	848	**3,445**
421 or more patients	2,227	193	**2,420**	421 or more patients	307	32	**339**
Total	**647,775**	**444,243**	**1,092,018**	**Total**	**84,894**	**53,712**	**138,606**

Table A3.10.
Number of Practices by MD Employment Categories and Patient Volume Categories, Aggregated Through 2008-2013 and by NP SOP

Average patient volume per day in a practice	Categories for practice size by number of physicians employed in a practice					
	Solo: 1 MD	Small: 2-4 MDs	Medium: 5-9 MDs	Large: 10-20 MDs	Very large: 21 or more MDs	**Total**
Restricted NP SOP; 2008 -2013						
1-20 patients	240,445	58,692	7,646	1,553	301	**308,637**
21-80 patients	320,162	267,350	58,338	10,370	1,364	**657,584**
81-180 patients	6,617	39,311	41,285	13,534	2,638	
181-420 patients	780	2,454	7,135	6,852	2,771	**19,992**
421 or more patients	66	131	209	666	1,348	**2,420**
Total	**568,070**	**367,938**	**114,613**	**32,975**	**8,422**	**1,092,018**
Liberal NP SOP; 2008 -2013						
1-20 patients	30,711	8,329	1,053	237	49	**40,379**
21-80 patients	33,208	34,490	8,511	1,625	256	**78,090**
81-180 patients	1,012	5,651	7,039	2,247	404	**16,353**
181-420 patients	117	439	1,167	1,196	526	**3,445**
421 or more patients	10	28	25	86	190	**339**
Total	**65,058**	**48,937**	**17,795**	**5,391**	**1,425**	**138,606**

Chapter 6: Tables and Figures

Table A3.12 demonstrates the number of practices by CPCI participation and state.

Table A3.13 examines the number of practices with NPs and PAs employed by CPCI participation.

Table A3.14 and Table A3.15 explore the number of practices by size vis-à-vis number of NPs, PAs employed in a practice by CPCI participation, respectively.

Table 3.16 examines practitioner composition at each CPCI participating practice by NP SOP.

Table A3.17 shows the relationship between daily average patient visits and CPCI participation by NP SOP.

Table 3.18 examines the patient volume for CPCI participating states categorized by NP SOP and number of NPs employed at the practice.

Table A3.19 examines number of practices by primary care specialty and NP SOP, categorized by CPCI participation.

Table A3.20 examines whether there is difference in employment of NPs and PAs in a practice by NP SOP and CPCI.

Table A3.12.
Number of Practices by CPCI Participation and State, 2013

	State								
CPCI	AR	CO	KY	NJ	NY	OH	OK	OR	**Total**
No	1,848	3,257	187	10,226	3,101	1,983	955	2,260	**23,817**
Yes	46	47	13	41	47	33	42	56	**325**
Total	**1,894**	**3,304**	**200**	**10,267**	**3,148**	**2,016**	**997**	**2,316**	**24,142**

Table A3.13.
Number of Practices with NPs and PAs Employed or Not by CPCI Participation, 2013

	Indicator variable			Indicator variable		
CPCI	No NP employed	One or more NP employed	**Total**	No PA employed	One or more PA employed	**Total**
No	20,108	3,709	**23,817**	21,272	2,545	**23,817**
Yes	211	114	**325**	231	94	**325**
Total	**20,319**	**3,823**	**24,142**	**21,503**	**2,639**	**24,142**

Table A3.14.

Number of Practices with NPs Employed or Not, by CPCI Participation and Size of a Practice

Participation in CPCI: No			
Number of physicians in a practice	Indicator variable: No NP employed	Indicator variable: One or more NP employed	Total
One MD	11,100	1,103	12,203
Two MDs	3,649	689	4,338
3 MDs	1,847	453	2,300
4 MDs	1,182	318	1,500
5 MDs	734	263	997
6-10 MDs	1,199	583	1,782
11-20 MDs	305	210	515
21-50 MDs	82	80	162
51-99 MDs	10	9	19
100 and more MDs	0	1	1
Total	**20,108**	**3,709**	**23,817**

Participation in CPCI: Yes			
Number of physicians in a practice	Indicator variable: No NP employed	Indicator variable: One or more NP employed	Total
One MD	40	23	63
Two MDs	38	18	56
3 MDs	34	17	51
4 MDs	32	10	42
5 MDs	17	4	21
6-10 MDs	37	29	66
11-20 MDs	13	11	24
21-50 MDs	0	2	2
Total	**211**	**114**	**325**

Table A3.15.
Number of Practices with PAs Employed or Not, by CPCI Participation and Size of a Practice

Participation in CPCI: No			
Number of physicians in a practice	Indicator variable: No PA employed	Indicator variable: One or more PA employed	**Total**
One MD	11,513	690	**12,203**
Two MDs	3,899	439	**4,338**
3 MDs	1,948	352	**2,300**
4 MDs	1,265	235	**1,500**
5 MDs	823	174	**997**
6-10 MDs	1,350	432	**1,782**
11-20 MDs	357	158	**515**
21-50 MDs	107	55	**162**
51-99 MDs	10	9	**19**
100 and more MDs	0	1	**1**
Total	**21,272**	**2,545**	**23,817**

Participation in CPCI: Yes			
Number of physicians in a practice	Indicator variable: No PA employed	Indicator variable: One or more PA employed	**Total**
One MD	46	17	**63**
Two MDs	42	14	**56**
3 MDs	36	15	**51**
4 MDs	30	12	**42**
5 MDs	17	4	**21**
6-10 MDs	48	18	**66**
11-20 MDs	11	13	**24**
21-50 MDs	1	1	**2**
Total	**231**	**94**	**325**

Table A3.16.
Number of CPCI Participating Practices Employing NPs or Not, Categorized by Number of Physicians in a Practice and NP SOP

NP SOP: Restricted

Number of physicians in a practice	Number of NPs employed in a practice				
	No NPs	One NP	Two NPs	Three or more NPs	**Total**
One MD	35	18	1	0	**54**
Two MDs	28	9	3	0	**40**
3 MDs	24	8	2	1	**35**
4 MDs	23	3	2	3	**31**
5 MDs	9	4	0	0	**13**
6-10 MDs	24	12	3	2	**41**
11-20 MDs	5	2	0	1	**8**
Total	**148**	**56**	**11**	**7**	**222**

NP SOP: Liberal

Number of physicians in a practice	Number of NPs employed in a practice				
	No NPs	One NP	Two NPs	Three or more NPs	**Total**
One MD	5	2	2	0	**9**
Two MDs	10	4	1	1	**16**
3 MDs	10	6	0	0	**16**
4 MDs	9	1	1	0	**11**
5 MDs	8	0	0	0	**8**
6-10 MDs	13	9	2	1	**25**
11-20 MDs	8	3	4	1	**16**
21-50 MDs	0	0	2	0	**2**
Total	**63**	**25**	**12**	**3**	**103**

Table A3.17.

Number of Practices by CPCI Participation and Average Daily Patient Visits, Categorized by NP SOP; 2013

NP SOP: Restricted				NP SOP: Liberal			
Average daily patient visits	CPCI Participation No	Yes	**Total**	Average daily patient visits	CPCI Participation No	Yes	**Total**
1-20 patients	5,581	15	**5,596**	1-20 patients	1,747	3	**1,750**
21-40 patients	6,964	52	**7,016**	21-40 patients	1,770	17	**1,787**
41-60 patients	2,752	43	**2,795**	41-60 patients	769	18	**787**
61-80 patients	1,197	29	**1,226**	61-80 patients	422	17	**439**
81-100 patients	923	39	**962**	81-100 patients	362	20	**382**
101-120 patients	196	13	**209**	101-120 patients	118	7	**125**
121-140 patients	128	7	**135**	121-140 patients	53	7	**60**
141-160 patients	224	9	**233**	141-160 patients	114	3	**117**
161-180 patients	35	3	**38**	161-180 patients	22	3	**25**
181- 250 patients	199	9	**208**	181- 250 patients	93	4	**97**
251-300 patients	50	3	**53**	251-300 patients	21	4	**25**
300 or more patients	51	0	**51**	300 or more patients	26	0	**26**
Total	**18,300**	**222**	**18,522**	**Total**	**5,517**	**103**	**5,620**

Table A3.18.
Number of CPCI Practices Grouped by Patient Volume and NP Employment, Categorized by NP SOP

Average daily patient visits	Number of NPs in a practice				**Total**
	No NP	One NP	Two NPs	Three or more NPs	
NP SOP: Restricted					
1-20 patients	14	1	0	0	**15**
21-40 patients	39	11	2	0	**52**
41-60 patients	25	15	3	0	**43**
61-80 patients	17	9	2	1	**29**
81-100 patients	26	8	2	3	**39**
101-120 patients	11	2	0	0	**13**
121-140 patients	3	3	0	1	**7**
141-160 patients	4	4	0	1	**9**
161-180 patients	1	1	0	1	**3**
181- 250 patients	7	1	1	0	**9**
251-300 patients	1	1	1	0	**3**
Total	**148**	**56**	**11**	**7**	**222**
NP SOP: Liberal					
1-20 patients	3	0	0	0	**3**
21-40 patients	12	4	1	0	**17**
41-60 patients	11	6	1	0	**18**
61-80 patients	10	5	1	1	**17**
81-100 patients	12	6	2	0	**20**
101-120 patients	5	1	1	0	**7**
121-140 patients	4	2	1	0	**7**
141-160 patients	2	1	0	0	**3**
161-180 patients	2	0	0	1	**3**
181- 250 patients	0	0	3	1	**4**
251-300 patients	2	0	2	0	**4**
Total	**63**	**25**	**12**	**3**	**103**

Table A3.19.
Number of Practices by Primary Care Specialty and NP SOP, Categorized by CPCI Participation

CPCI participation = No			
Indicator variables for nonprimary care specialty	NP SOP		
	Restricted	Liberal	**Total**
Yes	11,671	3,691	**15,362**
No	6,629	1,826	**8,455**
Total	**18,300**	**5,517**	**23,817**

CPCI participation = Yes			
Indicator variables for primary care specialty	NP SOP		
	Restricted	Liberal	**Total**
Yes	55	36	**91**
No	167	67	**234**
Total	**222**	**103**	**325**

Table A3.20.
Number of practices employing NPs and PAs, categorized by NP SOP and CPCI participation

NP SOP: Restricted; CPCI participation = No			
Indicator variable for NP employed	Indicator variable for PA employed One or		
	No PA	more PA	**Total**
No NP	14,771	1,019	**15,790**
One or more NP	2,193	317	**2,510**
Total	**16,964**	**1,336**	**18,300**

NP SOP: Liberal; CPCI participation = No			
Indicator variable for NP employed	Indicator variable for PA employed One or		
	No PA	more PA	**Total**
No NP	3,468	850	**4,318**
One or more NP	840	359	**1,199**
Total	**4,308**	**1,209**	**5,517**

NP SOP: Restricted; CPCI participation = Yes			
Indicator variable for NP employed	Indicator variable for PA employed One or		
	No PA	more PA	**Total**
No NP	113	35	**148**
One or more NP	58	16	**74**
Total	**171**	**51**	**222**

NP SOP: Liberal; CPCI participation = Yes			
Indicator variable for NP employed	Indicator variable for PA employed One or		
	No PA	more PA	**Total**
No NP	37	26	**63**
One or more NP	23	17	**40**
Total	**60**	**43**	**103**