The Impact of Nurse Practitioner Autonomy on Patient Sorting and Health Outcomes

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Abstract

States have expanded nurse practitioners' (NPs) autonomy from physician oversight to increase access to care, but this raises concerns about health outcomes under independent practice. I study how patients sort between NPs and physicians as primary care providers when NPs gain full practice authority, using state-level changes in NP scope of practice and data from the Medical Expenditure Panel Survey. I find that when NPs can practice independently of physicians, patients with multiple chronic conditions visit NPs more than physicians, and diagnoses of common chronic diseases increase. However, self-reported health declines, and evidence suggests limited adherence to antibiotic prescribing guidelines by NPs following the policy change. These results suggest that full NP practice authority enhances utilization of care among higher-risk patients and increases detection of chronic diseases, but improvements in overall health are limited.

JEL codes: I11, J44

Keywords: Health care providers, Occupational licensing, Primary care

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Disclaimer: This research uses the confidential version of the Medical Expenditure Panel Survey provided by the Agency for Healthcare Research and Quality (AHRQ). The content is solely the responsibility of the author and does not reflect the official views of AHRQ.

1 Introduction

To mitigate the shortage of physicians in primary care, healthcare systems utilize mid-level providers, such as nurse practitioners (NPs). However, because NPs receive less training than physicians, regulations often restrict their scope of practice, with requirements varying across states.[1] Although NPs now nearly outnumber physicians,[2] little is known about what patient characteristics influence provider choice under full autonomy and how such autonomy affects NP practice, including diagnosis and prescription behavior. Understanding the determinant of provider choice is critical for designing workforce policies that balance access and quality of care as primary care shortages grow and health disparities persist.

Given the rapid growth of NPs and the changing practice environment, existing research shows that removing physician supervision requirements for NPs increases access to care and improves health outcomes, such as mortality and self-reported health, although debates about NP productivity are ongoing. Yet two key questions remain unanswered. First, how does granting NPs full practice authority affect patient sorting between NPs and physicians and health outcomes? Second, how does granting NPs full practice authority affect clinical-decision making?[3] This paper addresses these gaps by combining state-level policy variation between 2010 and 2019 with patient data from the Medical Expenditure Panel Survey, to examine both determinants of patient sorting and clinical activities. I use states' legislative reforms expanding NP practice authority at different times between 2010 and 2019 and a stacked difference-in-differences event study design.

The measure of sorting in this paper is whether patients see NPs or physicians. Patient sorting following NP autonomy can occur through multiple, non-mutually-exclusive mechanisms. First is patient demand self-selecting a provider type. Although NPs typically require less wait times (Tinkler et al., 2017), patients expect less clinical expertise from NPs than from physicians since NPs have less formal medical training. Patients will weigh such trade-off between expertise and availability when they can, constructing their demand curves for NPs. In Section 3, I describe how the levels of expertise and availability are selected by a patient using a Constant Elasticity of Substitution (CES) utility function of a patient. Second, changes in NP use may occur through the supply of NP care. NPs

[1] By 2024, 30 states have adopted full practice autonomy for NPs to practice without physician supervision

[2] The National Center for Health Workforce 2024

[3] Alexander and Schnell (2019) find NPs with full prescribing authority increases antipsychotic use among disadvantaged populations, focusing on mental health outcomes.

may offer a broader range of care after the state grants the full practice autonomy. States with full autonomy may also attract more NPs, although evidence suggests relocation effects are limited.[4] Third supply channel relates to cost-minimizing efforts within practices. Medical organizations employ NPs to provide routine and accessible care at lower cost than physicians. Clinics can assign NPs more low-acuity patients or routine care of chronic patients, increasing NP services (Plath et al., 2019; McMichael, 2025). Assuming the market demand curve for NPs is fixed, the increased NP supply will cause a change in the quantity demanded for NPs, so the overall effect of the policy on NP utilization is positive.

Focusing on the net effects of potential sorting mechanisms, I document three main findings. First, I find that patients with three or more chronic conditions visit NPs more frequently than physicians after states expand NP practice authority. Second, I show that diagnoses of common chronic conditions increase, particularly arthritis among patients without a prior chronic disease diagnosis before NPs gained full autonomy. However, self-reported health declines. Lastly, I find NPs prescribe more medications, with limited evidence that NPs follow prescribing guidelines more closely after states grant NP practice autonomy.

A main contribution of this paper is to examine the role of patients' underlying health risks in driving patients to different providers. This paper also shows that NPs provide more care for both acute chronic conditions, suggesting potential comparative advantages of NPs in expanding access for higher-risk patients who often require timely care.

One identification challenge in using the state-level changes as exogenous variations is that policies are naturally outcomes of care needs and nonrandom. I address this by controlling for differences across states and common time effects. My assumption is that there should be no anticipation of the exact timing of state law implementation in order to use the variations in timing as exogenous shocks. I show pre-treatment trends of office-based visits and disease diagnoses evolve similarly between states that adopted the law later and those never adopted.

The first part of this paper examines the visit frequencies for NPs versus primary care physicians. I separate the analysis by patients' level of underlying health risks. I measure health risks by the number of chronic conditions diagnosed prior to NP practice autonomy to avoid endogeneity in disease diagnoses, based on existing work showing that

[4] In Appendix D, I find NP-led clinics increase, but do not find evidence that NPs relocate to full-practice states (Martsolf et al., 2023).

comorbidity predicts mortality and increases care costs (Charlson et al., 1987; Danesh et al., 2024). I find that patients with three or more chronic conditions visit NPs more frequently while visiting primary care physicians less frequently after NPs gain full practice authority. I do not find evidence that people with lower health risks use NPs more than primary care physicians. These findings suggest that a patient's underlying health condition plays a role in determining which provider type is matched to the patient.

Next, I move on to impact of practice autonomy of NPs on self-reported health scores and critical health events, such as emergency department (ER) visits and hospitalizations. The health scores decline after the reforms, though not clinically substantially, while ER use increases among the highest-risk patients and hospitalizations remain unaffected. I also show that NP autonomy leads to more diagnoses of common chronic diseases, such as high blood pressure, diabetes mellitus, and arthritis.

Several mechanisms could explain declining health scores, more health events, and increases in chronic condition diagnoses. One possibility is improved detection of previously undiagnosed conditions by NPs. Alternatively, the increased diagnoses may reflect overdiagnosis. A further concern is that inadequate treatment by NPs could worsen health. I find NPs prescribe more medications after states grant NPs full practice authority, but there is limited evidence that NPs follow antibiotics prescribing guidelines after the policy change. Overall, improvements in measured health outcomes from increased NP utilization following full NP autonomy may be limited. Although mechanisms such as overdiagnosis and limited adherence to treatment guidelines could offset benefits, increased NP utilization may still improve detection of chronic diseases for patients.

My paper is the first to examine the impact of NPs practice reforms on provider choice and suggest patients' underlying health conditions as a potential sorting mechanism. Using the same legislative changes that define the level of NP autonomy, existing papers find that the reforms increase healthcare utilization and improve health outcomes, without increasing costs substantially (Kuo et al., 2015; Muench et al., 2019; Perloff et al., 2016; Harrison et al., 2023). Benefits of NP practice autonomy include decreases in amenable deaths (McMichael, 2023), C-section rates (Markowitz et al., 2017), and emergency department visits (Traczynski and Udalova, 2018), and better mental health (Alexander and Schnell, 2019) and management chronic conditions (Hughes et al., 2022), increases in office visits and routine checkups (Traczynski and Udalova, 2018; Stange, 2014), and vaccinations (Stange, 2014). Based on these papers, this paper focuses on patient-provider type match outcomes depending on patients' underlying health risks.

The finding that sicker patients see NPs more is related to literature on the relationship between worker's autonomy and job allocation. In personal economics, granting higher work autonomy leads to better management of overall risks by workers (Stern et al., 2008; Rasul and Rogger, 2018; Banerjee et al., 2021; Dambaur et al., 2022). Following the NP full practice, NPs accept higher risks patients more, without evidence on reduced managing efforts to treat those patients.

The rest of the paper is organized as follows. In Section 2, I present the role and scope of practice of NPs in the context of the United States, including practice agreements and prescription authority. Section 3 introduces a simple utility function of a patient choosing her healthcare provider based on provider skill and wait time. Section 4 demonstrates the Medical Expenditure Panel Survey data. Section 5 explains the event-study research design, including how I define treatment and control states. Section 6 presents the impact of full NP practice on healthcare utilization, health outcomes, and treatment behavior of NPs, in comparison to physicians. Section 7 summurizes the findings and concludes the paper.

2 Nurse practitioners and scope of practice

Nurse practitioners (NPs), or advanced practice registered nurses (APRNs), in the United States are a group of healthcare providers who are registered nurses (RNs) and have a Master's degree in nursing. They work in a variety of healthcare settings, such as physicians' offices, clinics, hospitals, and emergency rooms. Autonomously or in collaboration with other health care professionals, NPs provide a wide range of primary, acute and specialty health care services, including ordering and interpreting diagnostic tests, diagnosing and treating acute and chronic conditions, prescribing medications and other treatments, managing patients' overall care, counseling, and educating patients on disease prevention (AANP).

NPs practice at a similar or lower cost (Kuo et al., 2015; Muench et al., 2019; Perloff et al., 2016; Harrison et al., 2023). Their role is especially critical in communities with historically limited access to physicians (Larson et al., 2003; Everett et al., 2009; Coombs et al., 2019; Xue et al., 2019; Auerbach et al., 2020). Despite this importance, physicians have long expressed concerns that unsupervised NP practice could increase the risk of misdiagnosis and prescription errors, which may be particularly harmful for severely ill patients who would benefit from more advanced providers (Robeznieks, 2020; Henry,

2024).

The amount of care provided by NPs as primary care providers, however, has increased steadily. Figure 1 shows the number of Medicare beneficiaries making office visits by provider type (physicians, nurse practitioners, physician assistants) and year.[5] Physicians are limited to family practice, general practice, and internal medicine. The share of beneficiaries treated by NPs has consistently increased since 2013.

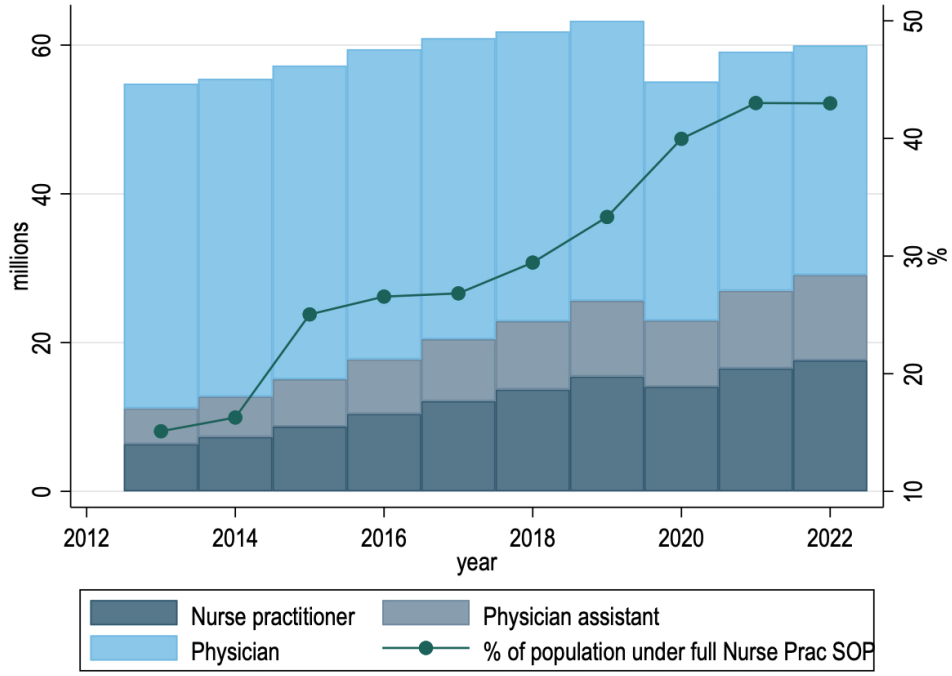


Figure 1: Number of Medicare beneficiaries by provider type and percentage of population in full-practice states

Notes: Bar graph displays the total number of Medicare beneficiaries treated under CPT codes 99201–99205 and 99211–99215 each year, aggregated at the provider level. Line graph displays that percentage of population in states that have full practice scope of NPs.
Source: Medicare Physician & Other Practitioners by Provider and Service by Centers for Medicare & Medicaid Services (CMS)

In the United States, nurse practitioners (NPs) are regulated by the laws of the state in which they practice. These regulations, outlined in state statutes and administrative codes, primarily address two areas: clinical supervision and prescribing authority. Clinical supervision rules require physician oversight of NP care in various forms, such as chart

[5]The Current Procedural Terminology (CPT) codes for new patient visits are 99201–99205 and 99211–99215 for established patient visits.

reviews, on-site supervision, or written practice protocols specifying the conditions NPs may treat (Markowitz and Adams, 2022).

The prescriptive authority involves two components. First, state regulations determine whether NPs must have physician supervision or oversight to prescribe medications. Second, they specify whether NPs are permitted to prescribe drugs with a high potential for psychological or physical dependence. Drugs or substances to make drugs are classified into five categories or schedules depending on their potential to incur abuse and dependence, where Schedule V drugs represents the least potential for abuse and Schedule I drugs are not currently accepted for medical use.[6] States may allow NPs to prescribe lower-risk drugs, such as Schedule III, IV, and V drugs, without physician involvement, but often impose stricter rules on prescribing Schedule II drugs. However, in some states, the regulations governing Schedule II drugs are no stricter than those applied to Schedule III–V drugs.

Following McMichael and Markowitz (2023) and McMichael (2023) I also define full practice status as the absence of both a required practice agreement with a physician and physician supervision for prescribing, according to state statutes and administrative codes. Independent prescriptive authority is the ability to prescribe medications without physician supervision, not necessarily the ability to prescribe Schedule II drugs.[7] 13 out of 14 states that granted the full practice authority between 2010 and 2019 allow NPs to prescribe controlled substances.[8] This is to avoid errors arising from the use of different secondary sources and inconsistent interpretations in existing literature.

Table 1 presents which component(s) of practice authority was relaxed when a state granted full practice authority to NPs according to my definition. I further describe more details on how prescriptive authority vary across states in Appendix A.

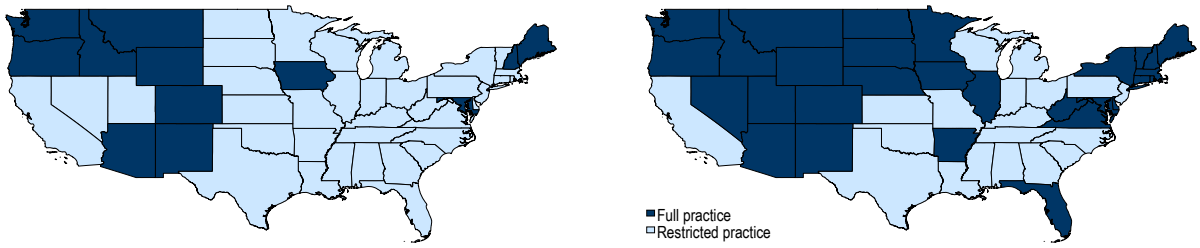
3 Conceptual framework

How can broadening the practice autonomy of nurse practitioners affect the utilization of NPs by patients with differential health risks? To illustrate the trade-off between provider skill and accessibility, I present a simple model of healthcare services demand. In choosing

[6] United States Drug Enforcement Administration

[7] Only West Virginia prohibits NPs from prescribing Schedule II or controlled substances

[8] I do not consider experience requirements as restrictive prescription authority. For example, Utah statue allows only experienced NPs can prescribe the controlled substances without supervision, but I consider that Utah has a full prescriptive authority.



(a) 2010 (b) 2024

Figure 2: Scope of practice by state

Notes: Alaska and Hawaii were full practice states in 2010.
Source: McMichael (2023)

her healthcare service, a patient demands the skill s and immediacy (or negative wait time) a from the provider as represented by a Constant Elasticity of Substitution (CES) utility function.

$$\text{Max} \quad U(s,a) = \left(\delta s^{\rho} + (1-\delta)a^{\rho}\right)^{1/\rho}, \quad \text{with } \rho < 1, \rho \neq 0 \tag{1}$$

The utility function has two features: (1) the relative preference of skill over accessibility, as represented by the chronic illness burden (δ), and (2) limited substitutability between s and a, parameterized by $\rho < 1$. The patient then demands a bundle (s,a) to maximize her utility subject to budget constraint

$$p_s s + p_a a = I \tag{2}$$

where p_s is the financial cost of high-skill healthcare, and p_a can be interpreted as the opportunity cost of wait time.

To attain first order conditions, I define:

$$\mathcal{L}(s,a,\lambda) = \left(\delta s^{\rho} + (1-\delta)a^{\rho}\right)^{1/\rho} + \lambda\left(I - p_s s - p_a a\right),$$

Year	State	
Never (19)	Alabama California Georgia Indiana Kansas Kentucky Louisiana Michigan Mississippi	Missouri New Jersey North Carolina Ohio Oklahoma Pennsylvania South Carolina Tennessee Texas Wisconsin
Before 2006 (11)	Alaska Arizona District of Columbia Iowa Maine	Idaho Montana New Hampshire New Mexico Oregon Wyoming
2006 (1)	Washington	
2009 (1)	Hawaii	
2010 (2)	Colorado(WR)[a]	Maryland(WR,RX)
2011 (2)	North Dakota(RX)	Vermont(WR, RX)
2013 (2)	Nevada(WR, RX)[b]	Rhode Island(RX)
2014 (1)	Connecticut(WR, RX)	
2015 (4)	Delaware(WR, RX) Minnesota(WR, RX)	Nebraska(WR, RX) New York (WR, RX)
2016 (2)	Utah(RX)	West Virginia(WR,RX Limited to C.III)
2017 (1)	South Dakota(WR,RX)	
2018 (1)	Virginia(WR,RX) [c]	
2019 (1)	Illinois(RX)	
2020 (1)	Florida(WR,RX)	
2021 (2)	Arkansas(RX)	Massachusetts(WR,RX)

WR: Removal of the requirement for a written agreement
RX: Full authorization of prescribing medicines

Table 1: Years when NPs received full practice authority

[a] After 3600 hours of mentorship either with a physician or an advanced practice registered nurse who has experience (Colo. Rev. Stat. 12 – 255 – 112) The effect of law was debatable because it was highly restrictive. 90% of APNs specializing in primary care in Colorado had prescriptive authority in 2011.

[b] For schedule II drugs, NPs should have completed at least two years or 2000 hours of practice or signed a protocol with a collaborating physician (NRS 632.237)

[c] NPs with at least five years of full-time clinical experience may practice without a written agreement. The new law also adds that a nurse practitioner who has completed the equivalent of at least three years of experience may practice or prescribe without a practice agreement upon receipt by the nurse practitioner of an attestation from either (i) the patient care team physician or (ii) an attesting nurse practitioner who assumed management and leadership of a nurse practitioner pursuant to subsection G and has met the requirements of this subsection for at least three years(VA Code § 54.1-2957.01)

Source: McMichael (2023)

Then the first order conditions are:

$$\frac{\partial \mathcal{L}}{\partial s} = \left(\delta s^{\rho} + (1-\delta)a^{\rho}\right)^{\frac{1}{\rho}-1} \delta\, s^{\rho-1} - \lambda p_s \;=\; 0, \tag{3}$$

$$\frac{\partial \mathcal{L}}{\partial a} = \left(\delta s^{\rho} + (1-\delta)a^{\rho}\right)^{\frac{1}{\rho}-1} (1-\delta)\, a^{\rho-1} - \lambda p_a \;=\; 0, \tag{4}$$

$$\frac{\partial \mathcal{L}}{\partial \lambda} = I - p_s s - p_a a \;=\; 0. \tag{5}$$

Dividing (3) by (4) leads to the optimal level of skill of the provider, $s*$, as follows:

$$\frac{\delta\, s^{\rho-1}}{(1-\delta)\, a^{\rho-1}} = \frac{p_s}{p_a},$$

$$s^* = \left(\frac{\delta\, p_a}{(1-\delta)\, p_s}\right)^{\frac{1}{1-\rho}} a^*.$$

Plugging s^* into (5) leads to the optimal level of immediacy or wait time a^*:

$$a^* = a(p_s, p_a, I) = \frac{I \cdot (1-\delta) \cdot p_a^{-\sigma}}{\delta p_s^{1-\sigma} + (1-\delta) p_a^{1-\sigma}}$$
$$\text{where} \quad \sigma = \frac{1}{1-\rho}.$$

Now, I show how immediacy choice (a^*) responds to a one-unit increase in the opportunity cost of wait time ($\frac{da}{dp_a}$). The scenario that the cost of wait time decreases corresponds to an increase in the supply of independent NPs following expanded scope of practice, which reduces NP wait times. For simplicity, I redefine a^* using N and D:

$$N = I \cdot (1-\delta) \cdot p_a^{-\sigma}, \quad D = \delta p_s^{1-\sigma} + (1-\delta) p_a^{1-\sigma}$$
$$a^* = \frac{N}{D}.$$

To derive $\frac{da}{dp_a}$, I first take the derivatives of N and D with respect to p_a.

$$\frac{dN}{dp_a} = -I \cdot (1-\delta) \cdot \sigma \cdot p_a^{-\sigma-1}$$
$$\frac{dD}{dp_a} = (1-\delta) \cdot (1-\sigma) \cdot p_a^{-\sigma}$$

Plugging $\frac{dN}{dp_a}$ and $\frac{dD}{dp_a}$ into the derivative of a^* with respect to p_a results in

$$\frac{da^*}{dp_a} = \frac{dN/dp_a \cdot D - N \cdot dD/dp_a}{D^2}$$

$$= \frac{-I(1-\delta)\sigma p_a^{-\sigma-1} \cdot D - I(1-\delta)p_a^{-\sigma} \cdot (1-\delta)(1-\sigma)p_a^{-\sigma}}{D^2}$$

$$= \frac{I(1-\delta)p_a^{-\sigma}}{D^2}\left[-\sigma \cdot \frac{D}{p_a} - (1-\delta)(1-\sigma)p_a^{-\sigma}\right].$$

$\frac{da^*}{dp_a}$ is the change in a^* in response to a one-unit increase in p_a. Alternatively, the change in a in response to a one-unit decrease in p_a, or $-\frac{da^*}{dp_a}$ is

$$\frac{I(1-\delta)p_a^{-\sigma}}{D^2}\left[\sigma \cdot \frac{D}{p_a} + (1-\delta)(1-\sigma)p_a^{-\sigma}\right]. \tag{6}$$

If a patient's weight on provider skill, δ, is relatively high and weight on immediacy is low, the derivative of a with respect to p_a is lower than that of a patient with lower weight on skill. In other words, patients who have a relatively low weight on immediacy are less likely to choose an NP even if accessibility improves due to NP ability to practice independently, because patients place greater weight on provider skill and have lower values from immediacy of providers.

Suppose δ is related to chronic illness burden and higher chronic illness burden decreases δ relative to patients with lower chronic illness burden, in other words, high risk people put less weight on skill and more value on immediacy. To illustrate, people with diabetes are two times more likely to die from influenza than people with no underlying medical condition and the Center for Diseases Control and Prevention (CDC) recommends diabetes patients experiencing influenza symptoms to contact healthcare providers on the onset of symptoms (Marshall et al., 2020).

If high risk people put less weight on skill and more value on immediacy, the increase in use of more available providers, NPs, following the price drop ($-\frac{da^*}{dp_a}$) will be large relative to those with lower-risk health. At the same time, healthier people will not increase their use of NPs because of lower weight on immediacy. Increasing the number of available providers and lowering barriers to those providers will impact healthier people. Therefore, whether NPs serve more high-risk or low-risk patients following the practice law reforms

depends on how patients of different risk weighs trade off accessibility against provider skill.

4 Medical Expenditure Panel Survey data

I use the confidential Medical Expenditure Panel Survey (MEPS) by the Agency for Healthcare Research and Quality (AHRQ). The confidential MEPS includes state of residence, which is not available in the public version.

Individuals surveyed in the MEPS are collected from a nationally representative subsample of households that participated in the National Health Interview Survey. Each year, a subset of households is drawn to participate in the MEPS, and is interviewed five times over two years. In each survey round, the MEPS collects information pertaining to a period between the last time interviewed and this time. These five rounds span a maximum of 2 years.[9]

My primary source of information on healthcare utilization is the MEPS's office visit files because office-based care is the most utilized healthcare setting in the United States (Ashman et al., 2021). These files provide information on utilization, including the type of provider, such as physicians, nurses, and nurse practitioners,[10] and the type of care, including general check-ups, diagnosis and treatment, emergency care, post-operative or follow-up visits, immunizations, mental health counseling, pregnancy-related care, well-child exams, and other services, at the visit level.

MEPS provides person-level information such as demographics, income, marital status, provider type of usual source of care, insurance status. I use insurance status in each round, distinguishing between any insurance, Medicaid, and Medicare. All other person-level variables are measured annually. In addition to individual characteristics, I control for county-level factors, including the percentage of the urban population as of 2010 and the number of physicians per 100,000 residents, provided by AHRQ's Area Health Resources Files.

[9]Exceptions are households in panels 23 and 24 to compensate for the decrease in surveyed cases during the COVID-19 pandemic.

[10]Since MEPS does not isolate NPs from registered nurses, the classification here may overestimate the NPs. To address this, I exclude the cases where a patient is expected to see a registered nurse only, such as immunization shots, dialysis, and chemotherapy. The count of NPs can be also underestimated though because respondents tend to consider an NP as a doctor when the provider is in the office-based setting (Stange, 2014). In this case, the estimates on NP utilization may provide the lower bound of the effects.

Since each household is interviewed for two years, there is a limitation in tracking long-term changes in healthcare utilization of the same households.

I examine the impact of nurse practitioners' autonomy on healthcare utilization using MEPS data from 2010 to 2019. Therefore, I restrict the range of NP practice reform years to 2011–2019 in the analysis. The reason why I do not use years prior to 2010 is that 14 practice authority reforms occurred occasionally from 1973 to 2010 and data availability is limited for those periods. I exclude 2020 and afterwards to rule out the possibility the healthcare utilization is heavily impacted by the Covid pandemic.

Table 2 summarizes population characteristics in different groups of states: states with full NP practice authority before 2010, states adopting full practice authority between 2011 and 2019, and states retaining restricted authority through 2019. The percentage of population having a usual source of care of the later-adopting states between 2011 and 2019 is similar to earliest-adopting states but higher than never-adopting states through 2019.

The number of visits to NPs does not differ across states with varying timings of full practice reforms. In contrast, visits to physicians are higher in states that adopted full practice authority between 2011 and 2019 than in states that maintained restrictions on NP practice.

States that retained restrictions also have lower insurance coverage, higher Medicaid enrollment, lower rates of having a usual source of care, and fewer diagnosed chronic conditions than earlier-adopting states. These states also have lower physician and NP supply in 2010. Although there are differences in the level of provider supply between states with different reform timings, Figure A.2 shows that trends in the number of physicians and NPs evolve in parallel prior to the reforms.

5 Research design

I use an event-study design to study the impact of full practice authorization of NPs at the state level on individuals' choice of a healthcare provider. One key assumption to use the timing of full practice authorization of NP by law at the state level as a valid source variation in outcomes is there should be no anticipation in the exact timing of state laws implementations.

I show the timing does not correlate with state-wise socioeconomic conditions in several ways. First, the reforms are often outcomes of a decade of political battles of

Full NP Autonomy status	Full in 2010	Expanded 2011-2019		Restricted before 2020	
in state of residence	Mean or %	Mean or %	P-value	Mean or %	P-value
% of Female	50.5	52.6	(0.048)	52.3	(0.039)
% of Hispanic	24.7	22.9	(0.037)	29.2	(0.000)
% of Bachelor's degree	18.4	19.0	(0.416)	15.0	(0.000)
% of Insured	83.8	83.3	(0.561)	79.1	(0.000)
% of Medicare	14.2	14.4	(0.773)	13.3	(0.128)
% of Medicaid	22.4	25.6	(0.000)	25.9	(0.000)
% of Employed	66.3	62.0	(0.000)	61.5	(0.000)
% of Having a usual source of care	80.6	80.6	(0.993)	74.7	(0.000)
Mean family income in $100	680.1	700.0	(0.112)	605.0	(0.000)
Age	36.2	35.9	(0.626)	34.8	(0.001)
Number of chronic conditions	1.67	1.61	(0.209)	1.58	(0.027)
Occupation (%)					
Management, business, finance	6.1	5.8	(0.527)	5.4	(0.087)
Professional and related	9.9	9.1	(0.192)	7.7	(0.000)
Service	8.2	8.7	(0.390)	8.4	(0.782)
Sales and related	3.9	3.8	(0.789)	4.2	(0.424)
Office and administration	5.8	5.0	(0.063)	5.1	(0.089)
Farming, fishing, forestry	1.3	0.2	(0.000)	0.4	(0.000)
Construction, maintenance	4.1	2.7	(0.000)	3.6	(0.123)
Production, transportation	5.2	5.3	(0.741)	5.4	(0.507)
Military	0.3	0.2	(0.477)	0.2	(0.106)
Unclassified	0.3	0.7	(0.012)	0.5	(0.052)
Occupation not reported	55.0	58.6	(0.000)	59.1	(0.000)
Time to a usual source of care (%)					
<15 minutes	49.4	50.2	(0.515)	49.5	(0.907)
15 to 30 minutes	40.1	39.2	(0.415)	41.1	(0.305)
31 to 60 minutes	9.2	9.3	(0.893)	7.9	(0.021)
61 to 90 minutes	0.9	1.0	(0.577)	0.9	(0.939)
91 to 120 minutes	0.2	0.3	(0.584)	0.4	(0.143)
More than 2 hours	0.2	0.1	(0.188)	0.2	(0.835)
Annual office visits to any provider	4.1	4.0	(0.685)	3.2	(0.000)
All doctors	2.5	2.7	(0.033)	2.3	(0.035)
Primary care	1.4	1.5	(0.393)	1.3	(0.003)
Specialty	1.0	1.2	(0.022)	1.0	(0.475)
Nurse/NP	0.1	0.1	(0.815)	0.1	(0.531)
Other providers	1.4	1.2	(0.021)	0.8	(0.000)
Annual emergency room visit	0.2	0.2	(0.296)	0.2	(0.921)
Annual home health visit	1.7	1.4	(0.519)	1.6	(0.843)
Annual inpatient days	0.4	0.6	(0.084)	0.4	(0.640)
County level (per 100K)					
Number of primary care doctors	0.789	0.762	(0.000)	0.709	(0.000)
Number of NPs	0.475	0.574	(0.000)	0.473	(0.704)
Observations	3891	5999		22449	

Table 2: Summary statistics at individual level as of 2010

Notes: This table summarizes characteristics of individuals and county-level providers in three groups of states: States that have full NP practice authority as of 2010, states that granted full NP practice authority from 2011 to 2019, and states that have restricted practice authority through 2019. Two-sided p-values when compared to individuals in the states of full NP autonomy in 2010 are provided.
Source: Medical Expenditure Panel Survey (MEPS) and Area Health Resources File (AHRF)

stakeholders (Carollo et al., 2025), so the precise timing may be a result of political factors (Iglehart, 2013; Stange, 2014), as also found in state-wise cases (Rapsilber, 2015; Hinkins, 2016).

I also demonstrate that the implementation of these laws at the state level is not correlated with local socioeconomic characteristics in Appendix Table A.1. While some factors predict whether a state adopts the reforms, no observable economic or health characteristic predicts the timing of implementation conditional on future adoption.

I test the impact of states' grating full practice authority of nurse practitioners at different timing on healthcare visits of the entire population in the MEPS from 2010 to 2019. During this time period, there have been 14 states that fully authorized the practice authority of NPs in different years. In this staggered adoption setting, conceptually, we end up comparing a later-adopting unit (for example, 2019 Illinois) to an early-adopting unit (for example, 2015 New York), which can generate a biased estimator unless the treatment effects are constant over time (De Chaisemartin and D'Haultfœuille, 2020; Sun and Abraham, 2021; Goodman-Bacon, 2021; Borusyak et al., 2024). Therefore, I adopt a block-wise comparison to estimate the treatment effects over time (Callison and Kaestner, 2014; Deshpande and Li, 2019; Butters et al., 2022).

I define a block as follows: I include all individuals in a reforming state up to four years after adoption of full NP practice authority. Individuals from never-adopting states in the same census region and within the same time window are added as controls.[11] Each block thus consists of individuals in a treated state and corresponding control group. The 14 blocks are then stacked to form the full analysis sample.[12]

Figure 3 demonstrates how control states and a treatment state are defined within a block, using the example of New York. New York authorized the full scope of practice of NPs in 2015. In the Northeast census region, Pennsylvania, New Jersey, and Massachusetts remained as restricted NP states until the end of 2020. Excluded states in the same census region include Maryland (2010), Rhode Island (2013), Connecticut (2014), Delaware (2015), and Maine (prior to 2006).

In addition to NP autonomy laws as a major variation, I suggest that patient's health risks play a role in matching patients to different types of providers. The presence of multiple chronic conditions is a strong predictor of mortality (Lee et al., 2007; Gagne et al.,

[11] A minimum of five years is required for a treatment state to serve as a control for earlier-treated states; for example, a state treated in 2019 or later can serve as a control for states treated in 2013 or earlier.

[12] Alternatively to building a separate block for each reforming state, I simply used just all states together, and the results are robust in Appendix K.

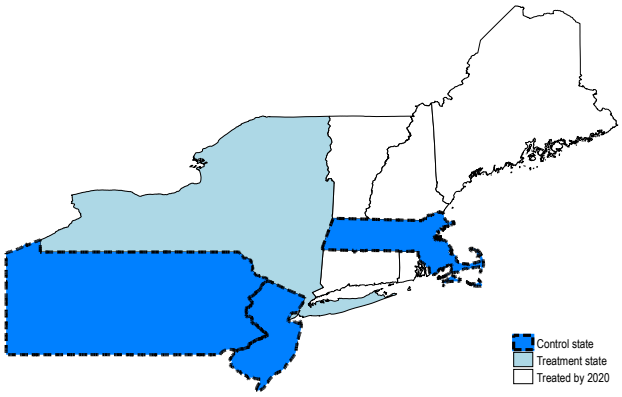


Figure 3: Illustration of a block for New York (treated in 2015)

2011; Divo et al., 2012; Danesh et al., 2024). I take the number of chronic diseases reported by respondents[13], categorized into 0-2 condition(s) and 3 or more conditions, as this measure. I base this measure on literature on the relationship between multimorbidity and healthcare utilization and costs (Zulman et al., 2015; Soley-Bori et al., 2021) and mortality (Nunes et al., 2016; Willadsen et al., 2018). Willadsen et al. (2018) find any combinations increase mortality rates.[14] In the Appendix F, I show that the effects are consistent across different combinations of diseases.

In Equation (7), I estimate the effect of NP practice autonomy on annual visits to each provider, NPs and primary care physicians, respectively, by individual i in state s in block b in year t. I remove individuals who move between states. To focus on primary care, I exclude visits for dialysis, radiation/chemotherapy, visual exams, immunization shots, and laser eye surgery.

$$\text{Visit}_{isbt} = \alpha_{sbt} + i_s + \sum_{\tau=-5,\, \tau\neq -1}^{4} \left(\beta_\tau + \gamma_\tau d_i\right) \mathbf{1}\left[\text{year}_{sbt} = \tau\right] + X_{it}'\delta + \varepsilon_{isbt} \tag{7}$$

[13]For example, a respondent is questioned "whether the person had ever been diagnosed as having high blood pressure" and the age of when diagnosed. This way of questioning may increase both false-negative (lower "yes") and false-positive (more "yes" though not being diagnosed) (Baker et al., 2004), but it is a reliable measure to know the person's pre-treatment health condition since the age of diagnosis is also answered.

[14]There is no unified standard to define comorbidity or multi-morbidity (Willadsen et al., 2018). The number of chronic diseases as a cutoff in this paper follows DuGoff et al. (2014). They find that life expectancy falls significantly with people living with 3 or more chronic diseases using 2008 Medicare beneficiary data.

Visit$_{isbt}$ denotes the annual visits to each provider type. The term α_{sbt} captures block-time fixed effects, and i_s is individual i's state fixed-effects. d_i equals 1 if a person had 3 or more chronic diseases prior to the law change, 0 otherwise.[15] year$_{sbt} = \tau$ is an indicator equal to 1 if, in year t, state s in block b is τ years after (or before, if τ is negative) the year of the reform. The vector X_{it} includes individual-level controls such as insurance status, Medicare and Medicaid coverage, Hispanic ethnicity, bachelor's degree attainment, sex, age, wage, household size, occupation, and an indicator for having three or more chronic conditions (d_i), the percentage of the population living in urban areas as of 2010, and the number of physicians per capita. Lastly, ε_{isbt} denotes the error term, which is clustered at the block level.

To ensure sufficient data coverage, I restrict the post-reform sample to four years, as Appendix Figure A.1 shows that observations relative to the reform mainly range from -5 to +4, with a steep drop in the number of observations in the fifth year.

6 Results

6.1 Office visits

Figure 4 plots the effects of state-level NP full authority law changes on annual visits to nurse practitioners (NPs). Individuals with three or more chronic conditions in states with full NP practice authority have 0.29 more visits annually over the course of four years following implementation. These increases in the number of visits represent a 46% increase relative to their baseline mean of 0.64 visits per year. Individuals with up to two chronic conditions show smaller significant change in annual visits (-0.04 times a year), with a mean visit frequency of 0.19 times a year, but statistically not significant.

I next examine whether individuals with different health risks change their use of primary care physicians following the adoption of full NP practice authority. Figure 5 shows the effects over time. Patients with three or more chronic conditions reduce their visits by 0.02 per year. For this higher-risk group, the initial responses are positive, but the effect turns negative with a lag. I show visits exhibit a declining trend over a longer horizon in the extended event study in Appendix Figure A.7. Lower-risk individuals increase their visits by 0.04 per year, not statistically significant.

[15]For individuals in the control group, $d_i = 1$ represents the largest number of chronic diseases ever reported is three or above

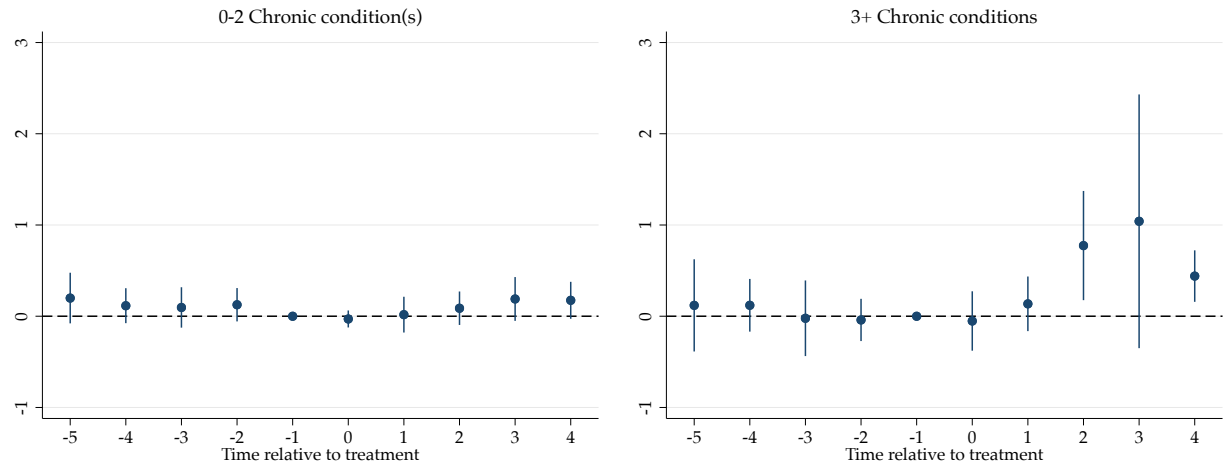


Figure 4: Effect of NP autonomy on annual visits to NP

Notes: The figure shows the effects of state-level NP full practice authority on annual NP visits by patients' pre-reform chronic conditions. Point estimates with 90% confidence intervals are reported by treatment year. Standard errors are clustered at the block level.

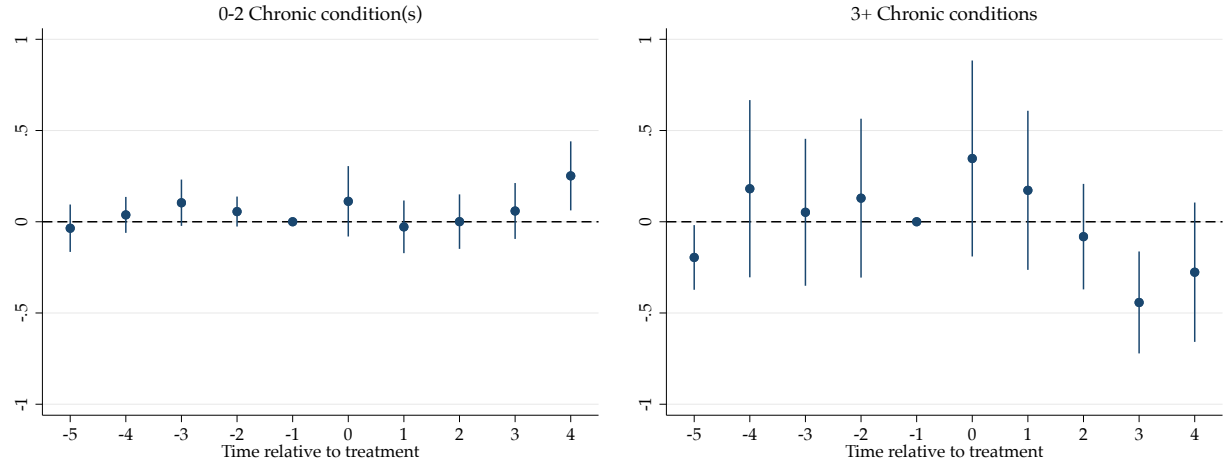


Figure 5: Effect of NP autonomy on annual visits to primary care physician

Notes: The figure shows the effects of state-level NP full practice authority on annual primary care physician visits by patients' pre-reform chronic conditions. Point estimates with 90% confidence intervals are reported by treatment year. Standard errors are clustered at the block level.

Additionally, I test each group's utilization of specialists in Appendix Figure A.13. Both groups do not show statistically significant changes in their annual visits to specialist physicians.

6.2 Health measures

In this section, I examine several health-related outcomes of NP's full practice authority. I first investigate if more diagnoses are detected as a result of NP autonomy. Next, I analyze self-assessed health status and critical events, such as emergency department visits and hospitalizations.

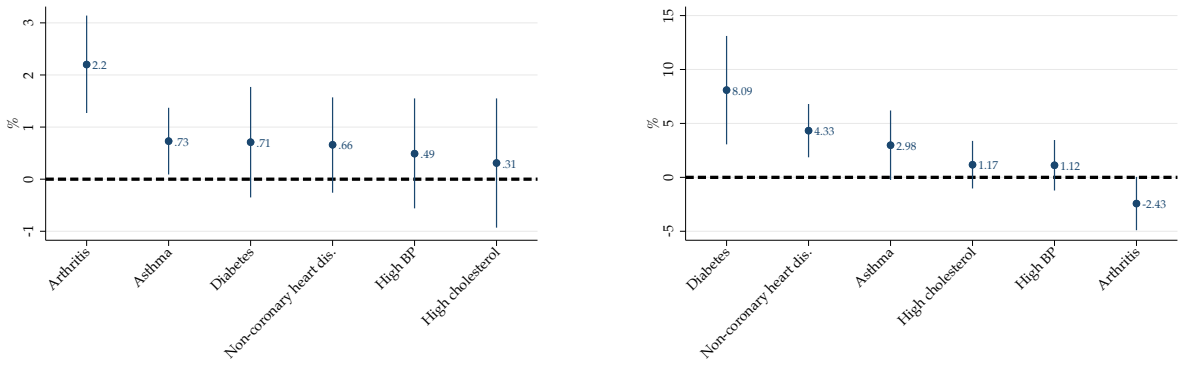
6.2.1 Diagnosis of diseases

I first examine whether NP authority affects the number of diseases diagnosed differently across patients with varying health risks prior to the law change. There are six diseases I measure, high blood pressure, heart disease (other than coronary heart disease such as stroke), high cholesterol, diabetes, arthritis, and asthma.[16] I construct an indicator variable, Ever diagnosed$_{isbt}$, equal to 1 if individual i in state s, block b, and year t, has ever been diagnosed with one of these conditions, 0 if not. Instead of showing event study analysis results for the full set of outcome variables, I summarize year 0 to 4 effects in Post$_{sbt}$ in Equation (8).

$$\text{Ever diagnosed}_{isbt} = \alpha_{sbt} + i_s + \delta_0 d_i + \delta_1 \text{Post}_{sbt} + \delta_2 d_i \times \text{Post}_{sbt} + X_{it}\delta_3 + \varepsilon_{isbt} \quad (8)$$

Individuals who had 0 or 2 chronic diseases prior to the NP practice law change are 2.2 percentage points more likely to be diagnosed with arthritis and 0.73 percentage points more likely to be diagnosed with asthma following NP practice autonomy. Individuals who had 3 or more chronic diseases prior to the law change are 8.1 percentage points more likely to be diagnosed with diabetes and 4.3 percentage points more likely to be diagnosed with non-coronary heart disease, but 2.4 percentage points less likely to be diagnosed with arthritis. These results suggest that lower-risk individuals are most likely to newly discover arthritis, while higher-risk individuals are more likely to discover diabetes and heart disease but are less likely to discover arthritis compared with those who had fewer chronic diseases.

[16] These conditions are observed in more than 10% of the population in the 2010–2019 MEPS.



(a) δ_1 (b) δ_2

Figure 6: Effect of NP autonomy on probability of diagnosis

Notes: The figure shows estimates on δ_1 (left) and δ_2 (right), the effects of state-level NP full practice authority on the probability of being diagnosed of each disease in the x-axis among those who had 0-2 pre-existing condition(s) on the left and 3 or more conditions on the right, prior to the full practice authorization. Point estimates with 90% confidence intervals are reported by disease. Standard errors are clustered at the block level.

6.2.2 Health summary scores

Second, I investigate subjective health outcomes in response to the NP's full practice authority laws. The MEPS provide the Physical Component Summary (PCS) and Mental Component Summary (MCS), which are based on respondents' self-assessments of their current health status. These summary scores range from 0 to 100 and are comparable across years, allowing for consistent numerical interpretation. Each score is a weighted average of various health questions that measure of quality of life and functional status.[17] (Mittal et al., 2001). A higher score means better health status.

$$\text{Score}_{isbt} = \alpha_{sbt} + i_s + \sum_{\tau=-5,\, \tau\neq -1}^{4} \left(\beta_\tau + \gamma_\tau d_i\right) \mathbf{1}\left[\text{year}_{sbt} = \tau\right] + X_{it}'\delta + \varepsilon_{isbt} \tag{9}$$

Figure 7 shows that in all groups, there is a decreasing trend in PCS after the law's implementation. Among individuals with 0–2 conditions, PCS decreases by 0.61 points and MCS by 0.50 points annually. However, for individuals with 3 or more chronic conditions, the effects on PCS and MCS return to zero in year 4.[18]

[17] An example question that is highly weighted for calculating PCS is "During a typical day, limitations in moderate activities" where a possible response is "limit a lot", "limit a little", "not limited".

[18] The rebound this group's subjective health measures may correlate with an increase in home health

In Appendix Figures A.15 and A.16, I show the distribution of PCS and MCS of patients treated by doctors and NPs, before and after the reforms, respectively. These figures show that patients' PCS slightly decline for NP visits and right for doctors, meaning that in NP's offices, we see more patients with more physical limits, compared to an average patient found in a doctor's office. However, these figures may show either treatment results or patients' underlying health prior to the reforms. The distribution of MCS remains almost unchanged.

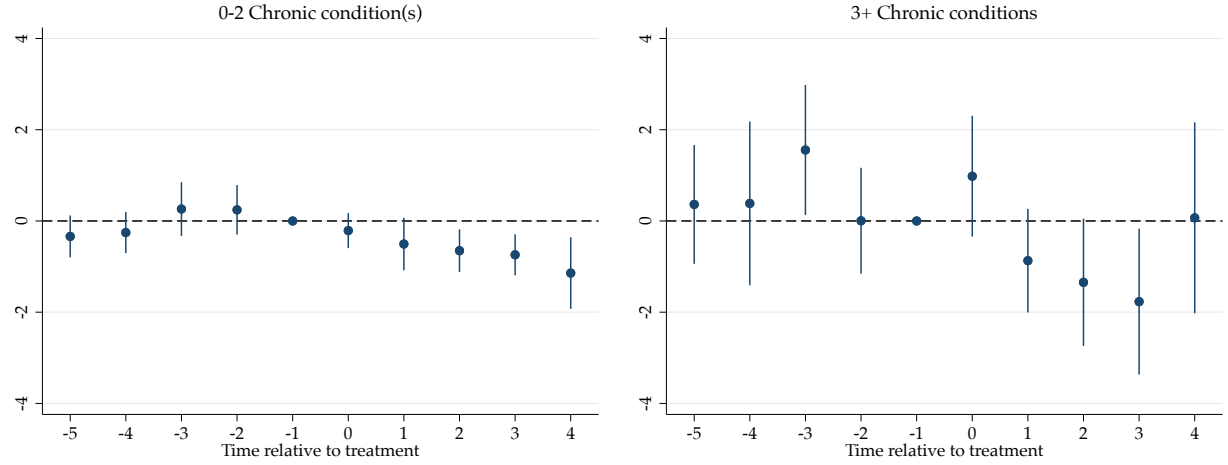


Figure 7: Effect of NP autonomy on Physical Component Summary (PCS)

Notes: The figure shows the effects of state-level NP full practice authority on the physical component summary score by patients' pre-reform chronic conditions. Point estimates with 90% confidence intervals are reported by treatment year. Standard errors are clustered at the block level.

6.2.3 ER use and hospitalizations

I examine the impact of full NP autonomy on the occurrence of critical health events by patients' underlying health risks by estimating the following equation. The variable ER visit$_{isbt}$ represents the number of emergency room visits of patient i in state s, block b, at time t.

$$\text{ER visit}_{isbt} = \alpha_{sbt} + i_s + \sum_{\tau=-5,\, \tau\neq -1}^{4} \left(\beta_\tau + \gamma_\tau d_i\right) \mathbf{1}\left[\text{year}_{sbt} = \tau\right] + X_{it}'\delta + \varepsilon_{isbt} \qquad (10)$$

visit days in the Appendix Figure A.14 (Hughes, 2000; Andreyeva et al., 2018)

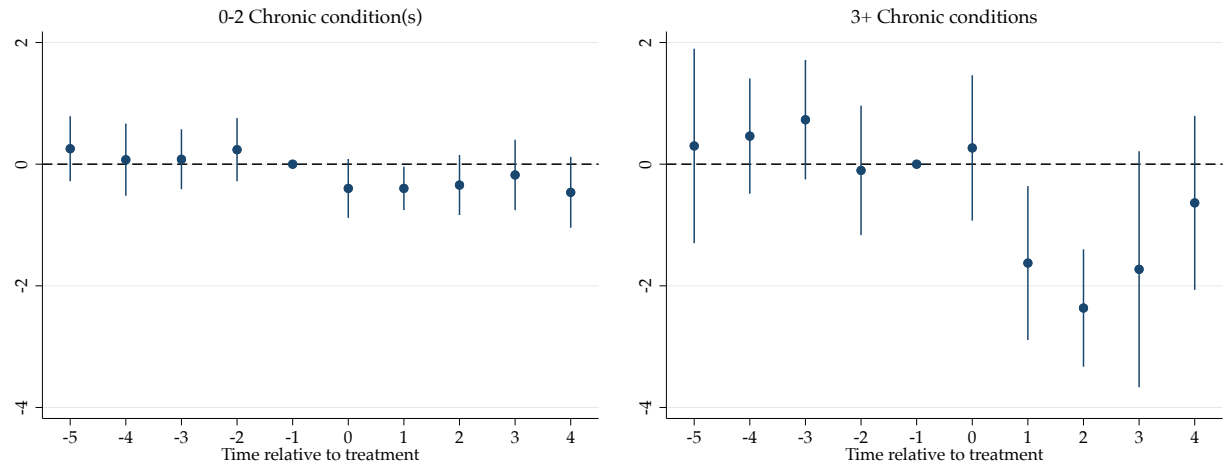


Figure 8: Effect of NP autonomy on Mental Component Summary (MCS)

Notes: The figure shows the effects of state-level NP full practice authority on the mental component summary score by patients' pre-reform chronic conditions. Point estimates with 90% confidence intervals are reported by treatment year. Standard errors are clustered at the block level.

Figure 9 shows the results from Equation 10. For patients with three or more chronic conditions, NP authority leads to an increase in annual ER visits, an average of 0.01 times per year. Those with fewer conditions show a similar increase of 0.02 visits per year.

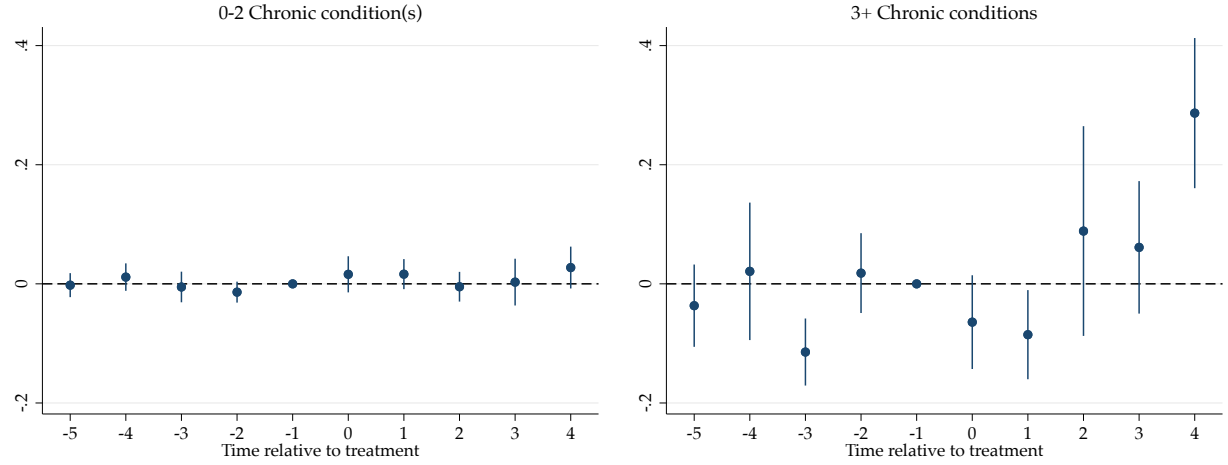


Figure 9: Effect of NP autonomy on annual ER visits

Notes: The figure shows the effects of state-level NP full practice authority on annual visits to emergency department visits by patients' pre-reform chronic conditions. Point estimates with 90% confidence intervals are reported by treatment year. Standard errors are clustered at the block level.

Next, I examine the impact of full NP autonomy on annual hospitalizations by esti-

mating:

$$\text{Hospitalization}_{isbt} = \alpha_{sbt} + i_s + \sum_{\tau=-5,\,\tau\neq-1}^{4} \left(\beta_\tau + \gamma_\tau d_i\right) \mathbf{1}\left[\text{year}_{sbt} = \tau\right] + X_{it}'\delta + \varepsilon_{isbt}. \quad (11)$$

Figure 10 shows the results for the number of hospitalizations per year. I do not find evidence that NP authority increases annual hospitalizations for any group. Individuals with 0-2 chronic conditions have 0.003 more hospitalizations per year. Individuals with 3 or more conditions have 0.02 more visits per year. For this group, the annual hospitalizations in year 4 increase by 0.1 times a year but I show this increase does not extend to a longer period in Appendix Figure A.10.

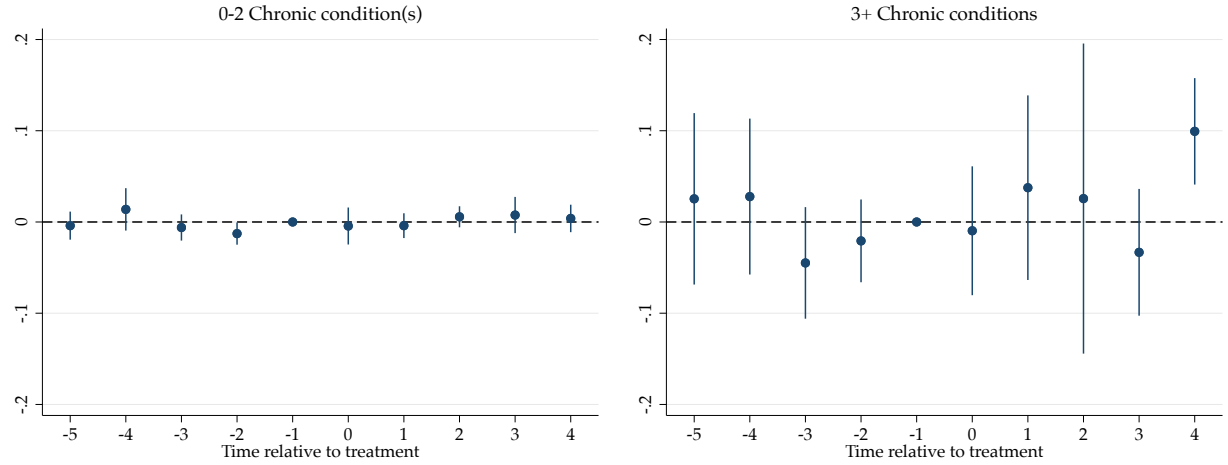


Figure 10: Effect of NP autonomy on annual hospitalizations

Notes: The figure shows the effects of state-level NP full practice authority on annual discharges by patients' pre-reform chronic conditions. Point estimates with 90% confidence intervals are reported by treatment year. Standard errors are clustered at the block level.

To summarize the findings, subjective health outcomes are slightly worsened. ER use increases among patients with higher health risk. Full NP practice authority increases diagnoses of chronic conditions.

6.3 Clinical activities

In this section, I document how full-practice NPs practice differently compared to restricted-practice NPs using physicians as benchmark during office-based visits. I focus on four

outcomes: prescribing rates, diagnostic test ordering rates, changes in visit purpose, and changes in the diseases addressed.

6.3.1 Prescriptions and diagnostic tests

First, I investigate if clinical decision making of NPs is affected by the change in the state law using two outcomes, prescriptions and diagnostic tests. To do so, I switch the unit of analysis from individual-year level to event-level. Each observation is an office-based visit to NP or doctor. I control for county-year fixed effects in addition to post-treatment dummy, NP indicator, and the interaction of the two. Briefly said, for each visit k by patient i in county c at time t, I estimate the following equation:

$$\text{Drug}_{hict} = \tau_{ct} + X'_{it}\beta + \delta_0 \text{Post}_{ct} + \delta_1 \text{NP}_h + \delta_2 \text{Post}_{ct} \times \text{NP}_h + e_{hict} \tag{12}$$

Drug_{hict} equals 1 if a certain drug class is prescribed in visit h. τ_{ct} represents county-year fixed effects. X'_{it} is a vector of individual-level characteristics for person i in year t, including insurance status, Medicare and Medicaid status, wage, race, family size, age, education, sex, occupation, and the number of underlying health conditions. The variable Post_{ct} equals 1 if the observation occurs after the state of c passed the full NP autonomy law. Finally, the variable NP_h is equal to 1 if the visit at event h (visit) is to an NP and 0 if it is to a doctor. Errors were clustered at the state level.

Table 3 shows in visits to full-practice NPs, individuals receive more prescriptions of central nerve system agents, narcotic agents, and psychotherapeutic agents, compared to their visits to restricted-practice NPs. Specifically, if an individual visits a full-practice NP, she is more likely to get any prescriptions than she visits a restricted-practice NP by 4.3 percentage points. The prescription rate of central nerve system agents by a full-practice NP increases by 1.7 percentage points compared to a restricted-practice NP. This increase takes around 40% of the net increase in total prescriptions. Also, the prescription of psychotherapeutic agents also increases within visits to NPs by 1.0 percentage points.

Next, I investigate the impact of NP autonomy on prescription rates conditional on disease, especially infectious diseases. I focus on these diseases because viral infection and bacterial infection have solid prescription guidelines–antiviral drugs for viral infection and antibiotics drugs for bacterial infection, and not vice versa.[19] Table 4 shows regression results for antibiotics and antiviral drug prescriptions respectively, conditional

[19]CDC guideline: https://www.cdc.gov/antibiotic-use/about/index.html

	Any prescription	Antibiotics	Central Nerve System	Narcotics	Psychotherapeutic
Post	-5.815***	-1.245*	-1.439	-0.026	-1.005*
	(1.815)	(0.618)	(0.939)	(0.319)	(0.586)
NP	-10.587***	-0.753**	-4.175***	-0.528***	-0.911***
	(1.102)	(0.366)	(0.392)	(0.061)	(0.109)
Post x NP	4.306***	0.659	1.726***	0.234**	0.956***
	(1.383)	(0.574)	(0.598)	(0.096)	(0.265)
N	434932	434932	434932	434932	434932
Mean (%)	27.7	5.7	8.0	0.7	2.2

Table 3: Effect of NP autonomy on prescriptions by drug class (%)
Note: * p-value < 0.1, ** p-value < 0.05, *** p-value < 0.01. Standard errors are in parenthesis. Mean is the average prescription rate in percentage.

on addressing bacterial and viral infection diseases during the visit. During a visit that addresses bacterial infection, I do not find evidence that antibiotic prescriptions increase for NP visits following NP practice autonomy. I also do not find evidence that antiviral drug prescriptions for bacterial infection change during NP visits following the policy change.

For viral infections where antiviral prescriptions are supposed and antibiotic prescriptions are not supposed, I do not find evidence that antiviral prescriptions change differently for physicians and NPs after NPs gain full practice authority. On the other hand, antibiotics prescriptions increase, although statistically insignificant, during NP visits to address virus infections.

Now I investigate how granting full scope of practice affects the rate of ordering diagnostic tests by NPs. Diagnostic tests are defined as any lab test, sonogram, and x-rays. Results are robust to inclusion of ultrasound, EEG, EKG, mammogram, and MRI. In Equation (13), outcome Test_{hict} is equal to 1 if there is any lab test, sonogram, or x-rays during the visit h of patient i in county c and year t, while 0 if there is not any test done.

$$\text{Test}_{hict} = \tau_{ct} + X'_{it}\beta + \delta_0 \text{Post}_{ct} + \delta_1 \text{NP}_h + \delta_2 \text{Post}_{ct} \times \text{NP}_h + e_{hict} \tag{13}$$

Table 5 shows we cannot reject NPs are giving more or fewer tests than an average doctor after NPs have greater authority.

One possibility is that NPs may treat more patients with known conditions as I find that there are increased NP visits by patients with 3 or more chronic conditions following

Disease	Bacterial infection		Viral infection	
Drug	Antibiotics	Antiviral	Antibiotics	Antiviral
Post	23.95**	-0.04	7.73	-24.16
	(10.23)	(0.11)	(7.84)	(17.27)
NP	-2.30	-0.39	-4.80*	4.63
	(2.92)	(0.63)	(2.59)	(4.25)
Post x NP	-6.68	0.43	20.62	-25.82*
	(10.65)	(0.61)	(14.13)	(14.97)
Observations	7,788		5,656	

Table 4: Effect of NP autonomy on antibiotics and antiviral agent prescriptions by disease(%)

Note: * p-value < 0.1, ** p-value < 0.05, *** p-value < 0.01. Standard errors are in parenthesis.

Bacterial infection: International Classification of Disease (ICD-10) of A40-A41, J01-J02, J13-J15, J36, K35, K65, L00-L08, N10, N30, N41, N70-N73, and O85. For corresponding ICD-9 codes, I use 038, 461, 034, 481-483, 475, 540, 567, 680-686, 590, 595, 601, 614-616, and 670.

Viral infection: ICD-10 codes of B00-B02 (ICD-9 codes of 052-054), B18 (070), B20 (042), B25 (078), J09-J11 (487). Detailed explanations for each code are in Appendix A.4.

NP autonomy, Therefore, a visit by a patient being under a established treatment schedule may not require further tests to detect a problem. Or NPs may order too few tests, potentially compromising patient health. My previous findings on declining self-reported health scores do not rule out the second possibility, but the increase in diagnosed chronic conditions weakens the concern that full-practice NPs systematically underuse diagnostic testing. Moreover, according to McMichael (2023), NP autonomy decreases preventable death and previous literature did not find any evidence that NP autonomy does significantly undermine patients' health.

To rule out the second possibility that NPs do not order enough tests, I need to investigate longer-term health outcomes related to late diagnosis at the individual level. The limitation of the MEPS data is such longer-term outcomes are not observable, as each respondent is observed for a maximum of two years.

6.3.2 Visit category and disease treated by doctors vs NPs

In this section, I examine if full-practice NPs are visited for different purposes than restricted-practice NPs. This analysis aims to determine whether granting full scope of practice changes the types of treatments provided and the conditions addressed by NPs. For each visit h by patient i in county c at time t, I estimate the following equation:

	Any test	Lab test	X-ray	Sonogram
Post	-2.419	-2.087	-0.765	-0.139
	(2.616)	(1.995)	(0.55)	(0.962)
NP	-4.215***	-2.685**	-1.877***	-1.473***
	(1.044)	(0.986)	(0.254)	(0.117)
Post x NP	-1.624	-1.469	0.07	0.409
	(2.025)	(1.901)	(0.733)	(0.498)
N	430958	430958	430958	430958
Mean (%)	24.4	20.7	3.5	1.7

Table 5: Effect of NP autonomy on testing (%)

Note: * p-value < 0.1, ** p-value < 0.05, *** p-value < 0.01. Standard errors are in parenthesis. Mean is the average test rate in percentage. "Any test" includes any lab test, x-rays, or sonograms.

$$\text{Visit Category}_{hict} = \tau_{ct} + X'_{it}\beta + \gamma_0 \text{Post}_{ct} + \gamma_1 \text{NP}_h + \gamma_2 \text{Post}_{ct} \times \text{NP}_h + e_{hict}. \tag{14}$$

The outcome $\text{Visit Category}_{hict}$ is an indicator equal to 1 if visit h falls into one of eight categories: routine checkup, diagnosis or treatment, post-operation/follow-up, emergency, mental health, pregnancy-related, well-child exam, or other.[20]

I compare the impact of NP autonomy on this visit is for a specific purpose, conditional on visiting a physician (γ_0) and visiting an NP(γ_2). Figure 11 shows that there are no significant changes in the categories of visits between doctors and NPs compared to pre-NP autonomy period. For all types of providers, the share of regular checkup increases and treatment or diagnosis decreases. Conditional on visiting an NP, the probability that this visit was for mental counseling increases by 1.7 percentage points, whereas the corresponding probability for physicians remains unchanged relative to the pre-NP autonomy period. Other major visit categories, such as regular checkup and treatment/diagnosis, do not show statistically significant changes compared to the pre-NP autonomy period.

The next equation is to estimate the effect of full NP practice authority on whether a visit h by patient i in county c at time t addresses a certain disease category.

[20]Visit categories are self-reported by respondents so there may be measurement errors. For example, a person may consider a follow-up visit as a diagnosis/treatment visit if he believes the follow-up visit is part of treatment.

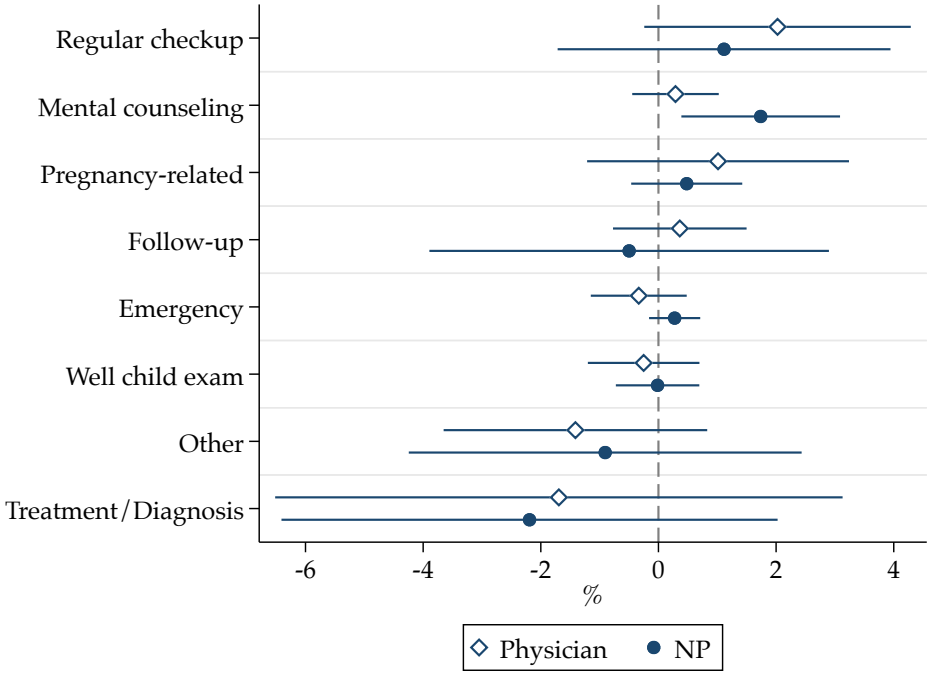


Figure 11: Effect of NP autonomy on visit category by provider type

Note: The figure shows the effects of state-level NP full practice authority on the probability that an office-based visit falls into each disease category, separately for physician-treated (γ_0) and NP-treated (γ_2) visits. Point estimates with 90% confidence intervals are reported by each visit category. Standard errors are clustered at the state level.

$$\text{Disease Category}_{hict} = \tau_{ct} + X'_{it}\beta + \gamma_0 \text{Post}_{ct} + \gamma_1 \text{NP}_h + \gamma_2 \text{Post}_{ct} \times \text{NP}_h + e_{hict} \tag{15}$$

Disease Category$_{hict}$ equals one if the visit h addresses one of the following diseases: infectious, endocrine, mental, nervous, circulatory, respiratory, digestive, or skin and musculoskeletal diseases, reported by respondents. Multiple diseases may be addressed within one visit. The most common condition addressed by NPs and doctors is injury and poisoning in both the pre- and post-treatment periods.[21]

Figure 12 shows that the probability that an NP visit involves injury and poisoning following full NP practice authority decreases by 6.3 percentage points, while the probability for a physician visit increases by 9.3 percentage points. NP visits for infectious diseases

[21]Respondents tend to recall conditions that are highly salient, cause pain, need ongoing treatment or alter lifestyle, and/or affect daily life (recall error). Less salient conditions such as the common cold or flu may be underreported due to recall error (Mitchell et al., 2023)

increase by 2.9 percentage points, whereas physician visits for the same category remain unchanged. These results suggest that NPs' role in treating acute infections expands after the reform.

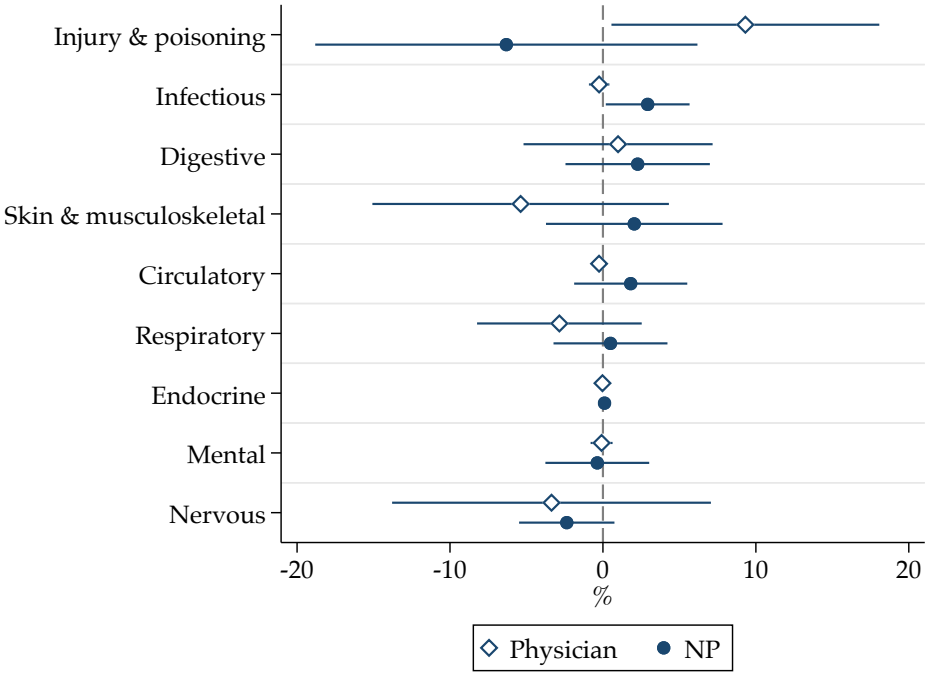


Figure 12: Effect of NP autonomy on disease category by provider type

Note: The figure shows the effects of state-level NP full practice authority on the probability that an office-based visit addresses a certain disease category, separately for physician-treated (γ_0) and NP-treated (γ_2) visits. Point estimates with 90% confidence intervals are reported by each visit category. Standard errors are clustered at the state level.

7 Conclusion

This paper studies first, how granting practice authority to nurse practitioners (NPs) affects patients' provider choice based on patients' underlying health conditions, second, how the policy change influences clinical activities at the visit level. NPs have been providing accessible primary care but their scope of practice is varied between states and expanded over time. Using state-level changes in laws granting NPs full practice authority, I demonstrate that people with more chronic conditions increase their visits to NPs, potentially for prescriptions. Diagnoses of common chronic diseases are increasingly

detected following practice reforms. Next, I find a subjective physical health summary score decreases though clinically non-meaningful (Díaz-Arribas et al., 2017; Clement et al., 2019) and emergency room visits increase within people with a higher burden of chronic conditions.

Lack of health improvement in subjective health and increased utilization of emergency room (ER) despite the increased visits to NPs may have several causes. First, higher practice authority of NP affects the quality of care, usually measured by accurate diagnosis and set up of timely proper treatment plans, and increase diseases and ER use. Second, full-practice NPs find more diseases that have not been found before, therefore decreasing self-evaluated health and use of care. The interpretation of worsening health status needs caution as more access to primary care also increases chances of revealing unknown conditions, providing opportunity for care and objective information on health (Idler et al., 2004; Jylhä, 2009; Falconer and Quesnel-Vallée, 2017).

My findings on NP autonomy increasing chronic conditions measured along with non-decreasing diagnostic test rates weaken the first concern that NPs may put insufficient effort to detect a problem. The visit level data shows full-practice NPs prescribe more medications compared to restricted-practice NPs. For diseases with well-established prescription guidelines, however, I do not find significant changes in prescription accuracy after NPs gain full practice authority. Overall, the evidence indicates that NP autonomy increases visits from patients with more complex health conditions. At the same time, NP autonomy does not affect the appropriateness of prescriptions for infectious diseases, nor does it decrease the total prescriptions.

Since the MEPS is repeated sets of 2-year panels of individual, it is hard to examine the longer-term health outcomes within a person. Second, I do not provide analysis on healthcare costs since information on price is limited in the current dataset. Using detailed price data at the visit level and longer-term data on health outcome would generate better insights over how full scope of practice of NPs affect the efficiency of health care.

Taken together, the advantages of NP autonomy include greater utilization—such as more frequent visits, more prescriptions, and a higher number of providers making diagnoses. However, granting NPs full practice autonomy does not improve antibiotic prescription adherence or overall health outcomes. These adverse effects may ultimately increase healthcare spending due to medication side effects and early interventions that fail to improve health (Alalouf et al., 2024). To fully assess the benefits of the policy, first, the analysis should account for potential gains from earlier interventions and diagnoses,

such as changes in health-related behaviors, as well as the associated costs of overdiagnosis. Second, the benefits of increased care utilization may be larger in areas facing severe shortages of healthcare professionals. Third, the analysis should investigate other important outcomes such as mortality and patient satisfaction from increased utilization (Carranza et al., 2020; McMichael, 2023). Finally, changes in physicians' time allocation in response to NP autonomy may become another channel through which the policy may affect healthcare efficiency and care outcomes.

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Appendix

A Details on NP prescriptive authority

Prior to 2020, less restrictive states in terms of nurse practitioners' prescriptive authority included Alaska, Arizona, Colorado, Idaho, Iowa, Minnesota, Montana, New Hampshire, New Mexico, North Dakota, Oregon, Rhode Island, Washington, Utah, West Virginia[22], South Dakota, Virginia, Illinois, Florida and Washington D.C. These states do not require a physician's involvement for nurse practitioners' prescriptive authority to prescribe drugs of all schedules from V to II.[23] However, prescriptive authority of schedule II substances still needs differential requirements from state to state. Colorado (3600 hours[24]), South Dakota (1020 hours), and Virginia (three years) allow a nurse practitioner to prescribe Schedule II substances without an agreement with a physician only if he or she meets a requirement for the minimum number of years of clinical experience under supervision. In West Virginia, prescribing Schedule II substances is still prohibited since the time of full practice authorization in 2016.[25]

Limited prescriptive authority means a requirement of physician supervision and may imply ability to prescribe schedule II drugs. For example in Alabama, NPs can prescribe Schedule III-IV controlled substances under monitoring of the supervising doctor. They cannot prescribe Schedule II substances, for example, less than 15 milligrams of hydrocodone, unless they have have an active Limited Purpose Schedule II Permit (LPSP) and a collaborative practice agreement with a physician (Alabama Board of Pharmacy). In Georgia, NPs meet the most strict requirements for prescriptive authority. NPs practicing in Georgia must hold a collaborative agreement with a supervising physician to have prescriptive authority, similarly to Alabama, but cannot prescribe Schedule II controlled substances regardless of a collaborative agreement with a physician.[26]

Defining the scope of practice following whether NPs can prescribe high-ranked drugs can be further complicated if states can define controlled substances on their own differently than the federal scheduling process (Gupta et al., 2023). In addition, certain drugs,

[22] An exception is Schedule II drugs.

[23] Source: 2017 AMA

[24] Later reduced to 2600 hours

[25] W. Va. Code Ann. § 9-4B-1. Id. § 30-7-15b.

[26] Effective from July 1, 2024, the General Assembly amended O.C.G.A. § 43-34-25 (concerning delegation to APRNs) and O.C.G.A. § 43-24-103 (concerning delegation to PAs) to permit the prescription of hydrocodone, oxycodone, or compounds thereof in emergency situations and if the APRN/PA meets specific requirements.

such as buprenorphine to treat opioid use disorder, requires all providers to obtain additional certifications to prescribe them (Spetz et al., 2019).

B Factors that predict the NP practice expansion

	(1) Expansion		(2) Year of Expansion	
Population density (per sq mile)	-0.000	(0.001)	0.001	(0.009)
Share of age under 5(%)	0.486	(0.367)	7.262	(5.262)
Share of age 65+(%)	0.272*	(0.133)	1.683	(2.455)
NP per physician	1.490	(1.181)	-15.360	(24.298)
NP-led clinic per physician-led clinic	-7.376	(5.872)	22.388	(123.804)
Share of uninsured (%)	-0.005	(0.047)	0.311	(0.580)
Labor force participation (%)	0.001	(0.040)	-0.518	(0.542)
Share of White (%)	0.009	(0.021)	-0.512	(0.471)
Share of Non-Hispanic (%)	-0.010	(0.025)	0.756	(0.909)
Share of Bachelor's degree (%)	0.023	(0.058)	1.062	(0.737)
Deaths per 100K (Age unadjusted)	-0.001	(0.003)	0.038	(0.043)
Deaths per 100K age under 5	-0.001	(0.008)	-0.143	(0.164)
Constant	-6.185	(4.949)	1908.422***	(77.358)
N	34		15	

Standard errors in parentheses

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

Table A.1: Predictors of NP autonomy expansion and timing

Note: This table shows OLS estimates where outcomes are whether a state adopts the reform after 2011 (Column 1) and years of adoption conditions on future adoption (Column 2). The factors are all as of 2011(pre-treatment level) but 2010 for the population density.

Source: Treatment and treatment timing: McMichael (2023), populuation density as of 2010: Census, Share of age under 5 and share of age 65+, White, Non-Hispanic, Bachelor's degree: American Community Survey 5 Years, Number of nurse practitioners and physicians and clinics: National Plan & Provider Enumeration System, share of uninsured: Small Area Health Insurance Estimates, labor force participation rate: U.S. Bureau of Labor Statistics, mortality rates: Centers for Disease Control & Prevention

C Distribution of Year Relative to Treatment

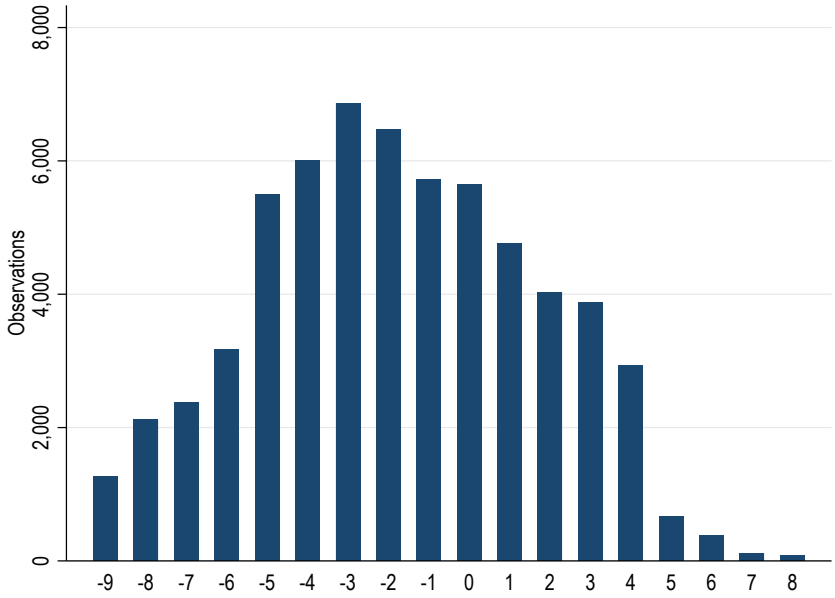

Figure A.1: Distribution of year relative to treatment

Notes: This figure shows the distribution of years relative to the adoption of full NP practice authority across states. Each observation represents an individual.

D Supply of NPs and NP clinics in rural and urban regions

To address heterogeneous supply effects between rural and urban regions, I use the National Plan and Provider Enumeration System (NPPES) 2011-2019 data which covers the entire U.S. healthcare provider population and organizations with a National Provider Identifier (NPI). The NPPES data include each provider's NPI, a unique identifier for healthcare providers in the United States, practice addresses, credentials, and specialty (taxonomy) codes for both individual providers and organizations. For organizations, the data also include the names and credentials of their authorized officials.

Outcomes are the number of NPs, physicians(MD or DO), NP-led clinics, MD-led clinics per 100K population.[27]

[27]Dillender et al. (2024) find that expanding NP SOP reallocates NPs from outpatient to self-employment using the American Community Survey 2010-2019.

Supply measure	Definition
Individual NP	Taxonomy for general NP, and NP specialty codes for adult care, family, ob/gyn, pediatrics, primary care, and women's care
Individual MD	Physician specialty taxonomy codes for family pratice, general practice, pediatrics
NP-led clinics	Authorized official's credential includes NP or equivalent
MD-led clinics	Authorized official's credential includes MD or equivalent

Table A.2: Definitions of NPs, MDs, NP- and MD- led clinics in the NPPES data

Similar to the main research design and specification, I construct a block of one treatment state and neighboring, clean states in the same census region. Then I regress the outcome variables on block-year fixed effects(α_{bst}), state-fixed effects(τ_s), event-study dummies(I_τ), and state-level controls (X_{st}=median age, median household income, unemployment rate, percentage of uninsured). Errors were clustered at the block level.

$$\text{Outcome}_{sbt} = \alpha_{bst} + \tau_s + \sum_{\tau=-5,\ \tau\neq-1}^{5} I_\tau + X_{st} + \varepsilon_{sbt} \tag{16}$$

Figure A.2 shows the response of the number of NPs and physicians registered in treatment states. The number of registered NPs and physicians do not respond following the full NP SOP in the state. However, Figure A.5 shows the number of clinics led by NPs increases with lags while the number of MD-led clinics is not affected following the law change.

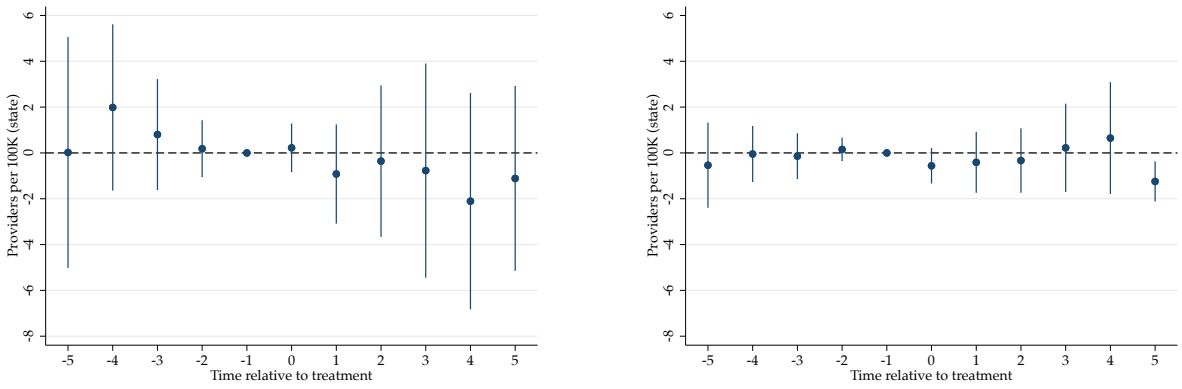

Figure A.2: The number of NPs (left) and physicians (right)

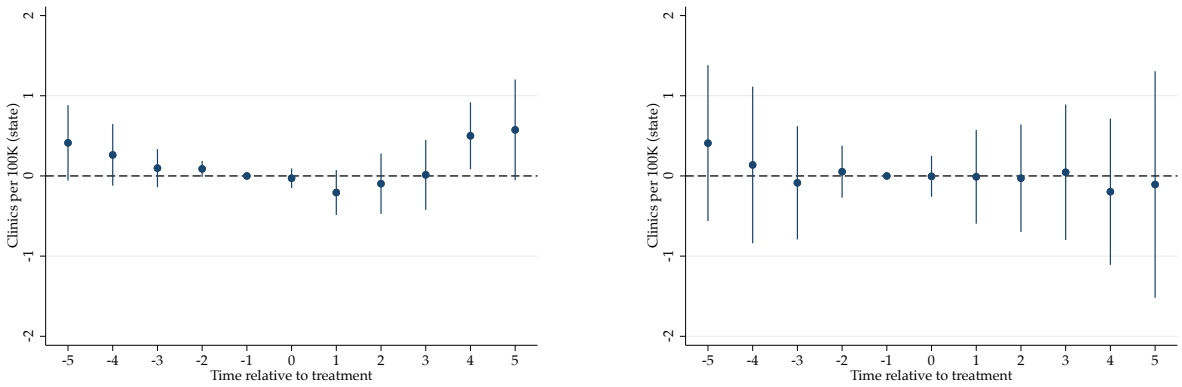

Figure A.3: The number of NP-led (left) and MD-led clinics (right)

Now I examine if there are heterogeneous policy effects between urban and rural areas. I change the unit of analysis from state to county level. I use a cutoff of 69.1% to distinguish urban and rural counties, the median percentage of urban population in the MEPS. Figure A.4 show the number of NPs (left) and physicians (right), separately in urban and rural counties following NP practice autonomy. NPs in urban counties increase while NPs in rural counties decrease. Clinics led by NPs increase both in urban and rural areas, but clinics in urban areas increase at a faster rate.

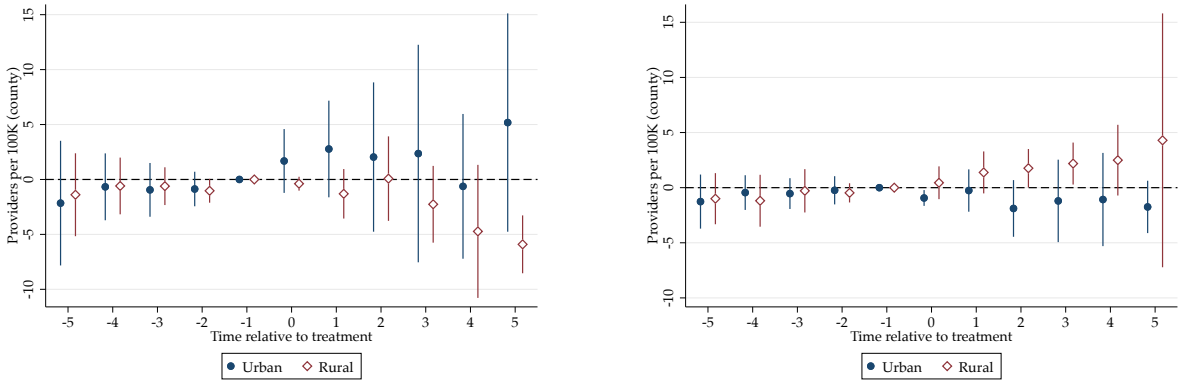

Figure A.4: The number of NPs (left) and physicians (right)

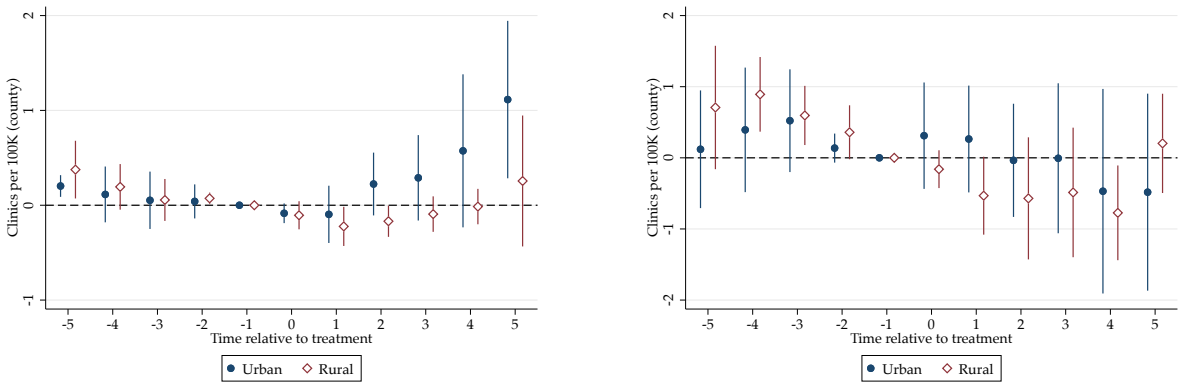

Figure A.5: The number of NP-led (left) and MD-led clinics (right)

E Robustness check: 0 chronic disease, 1 or 2 disease(s), 3 or more diseases, in extended treatment window

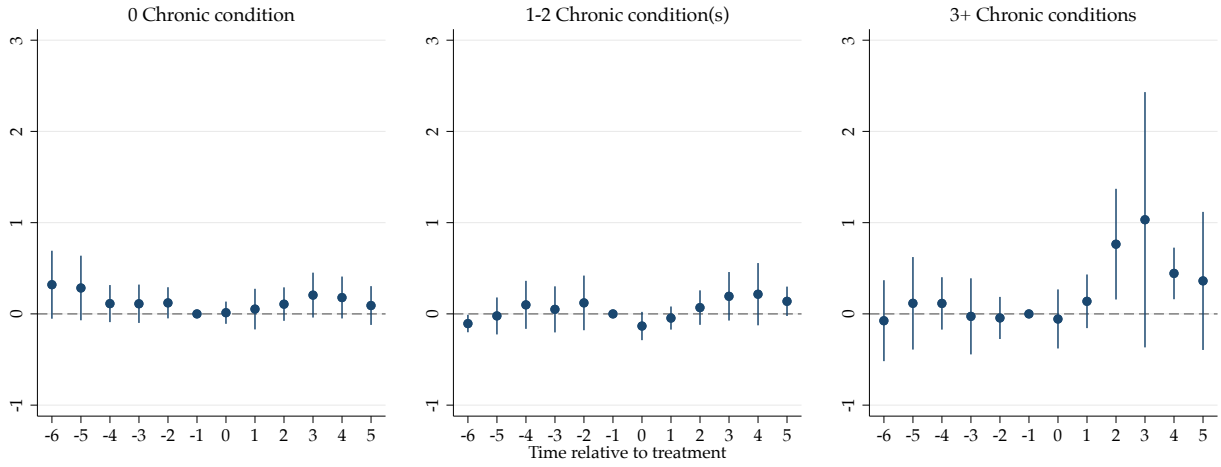

Figure A.6: Effect of NP autonomy on annual visits to NPs

Notes: The figure shows the effects of state-level NP full practice authority on annual visits to NPs by patients' pre-reform chronic conditions. Point estimates with 90% confidence intervals are reported by treatment year. Standard errors are clustered at the block level.

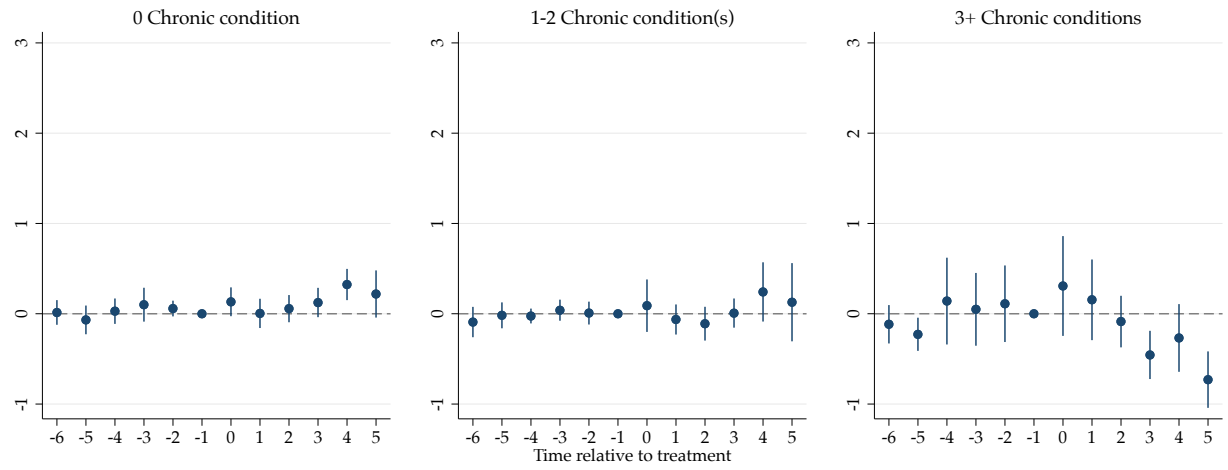

Figure A.7: Effect of NP autonomy on annual visits to primary care physicians

Notes: The figure shows the effects of state-level NP full practice authority on annual visits to primary care physicians by patients' pre-reform chronic conditions. Point estimates with 90% confidence intervals are reported by treatment year. Standard errors are clustered at the block level.

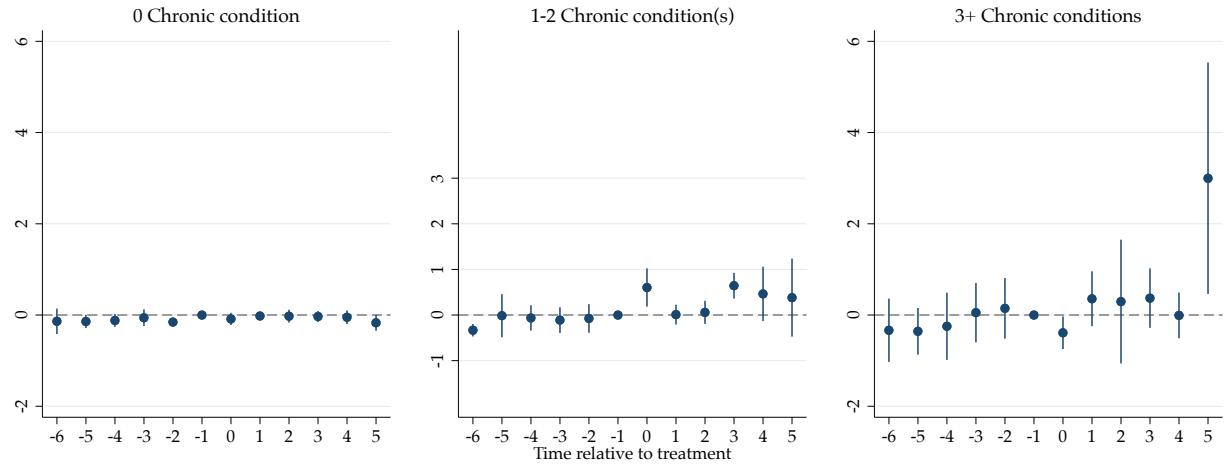

Figure A.8: Effect of NP autonomy on annual visits to specialty physicians

Notes: The figure shows the effects of state-level NP full practice authority on annual visits to primary care physicians by patients' pre-reform chronic conditions. Point estimates with 90% confidence intervals are reported by treatment year. Standard errors are clustered at the block level.

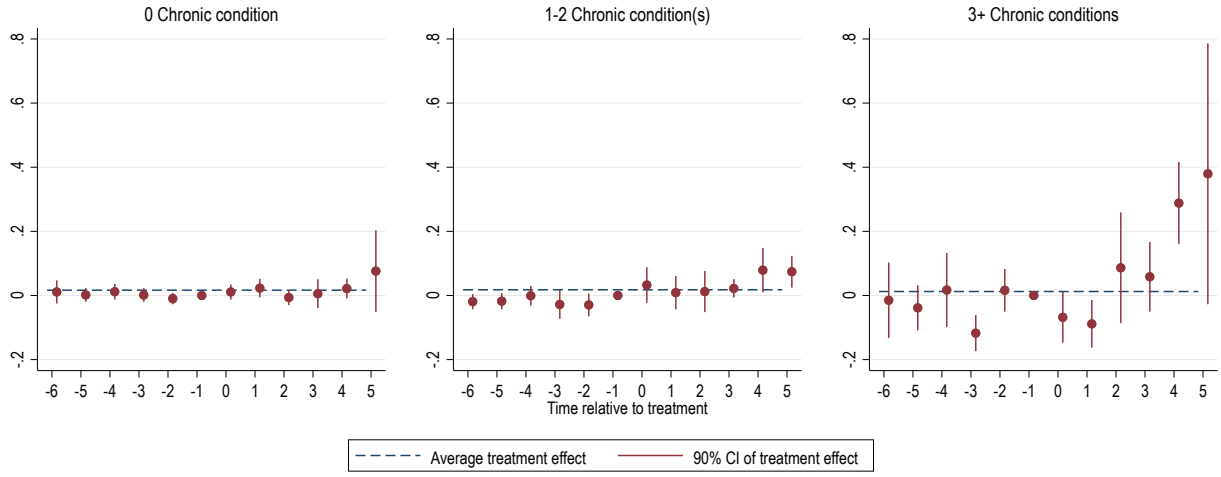

Figure A.9: Effect of NP autonomy on emergency department visits

Notes: The figure shows the effects of state-level NP full practice authority on annual emergency department visits by patients' pre-reform chronic conditions. Point estimates with 90% confidence intervals are reported by treatment year. Standard errors are clustered at the block level. Dashed lines are average treatment effects over the course of five years of treatment.

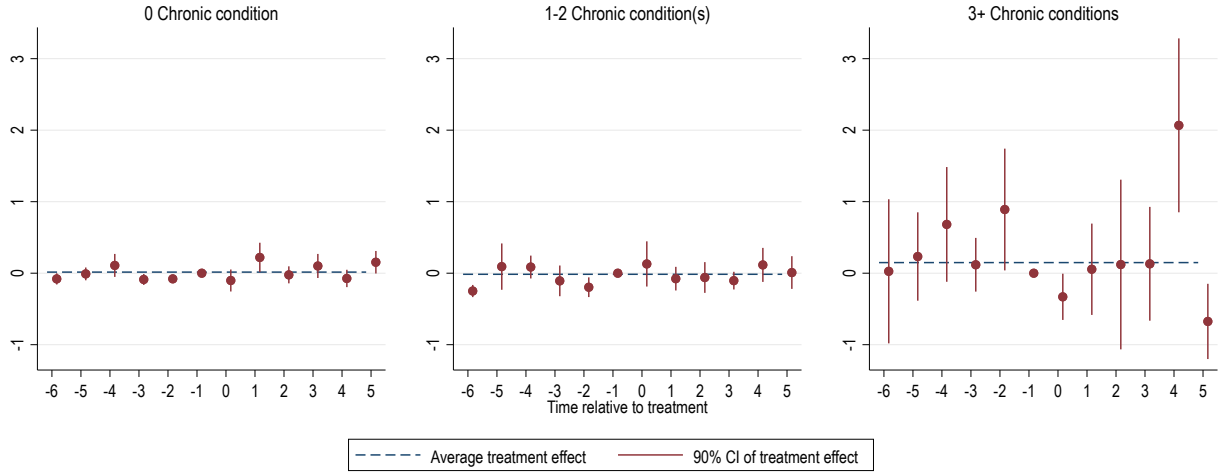

Figure A.10: Effect of NP autonomy on annual hospitalizations

Notes: The figure shows the effects of state-level NP full practice authority on annual hospitalizations by patients' pre-reform chronic conditions. Point estimates with 90% confidence intervals are reported by treatment year. Standard errors are clustered at the block level. Dashed lines are average treatment effects over the course of five years of treatment.

F Heterogeneity across combinations of diseases

In this part, I check if the results on visit outcomes are driven by a certain combination of chronic diseases. For example, a high blood pressure combined with heart disease may increase visits to NP when the patient's state allows the full-practice authority, but high blood pressure with arthritis may not increase their visits to NPs. To check if there exists heterogeneity across combinations of conditions, I estimates the following equation:

$$\text{Outcome}_{isbt} = \alpha_{sbt} + i_s + \delta_0 d_i + \delta_1 \text{Post}_{sbt} + \delta_2 d_i \times \text{Post}_{sbt} + X_{it}\delta_3 + \varepsilon_{isbt} \tag{17}$$

Where d_i is

- 1 if having high blood pressure only and 0 if no conditions
- 1 if having two conditions (high blood pressure + cancer, high bp + stroke, etc.) and 0 if condition
- 1 if having three or more conditions (high bp + cancer + something else, high bp + heart attack + something else, etc.) and 0 if no condition

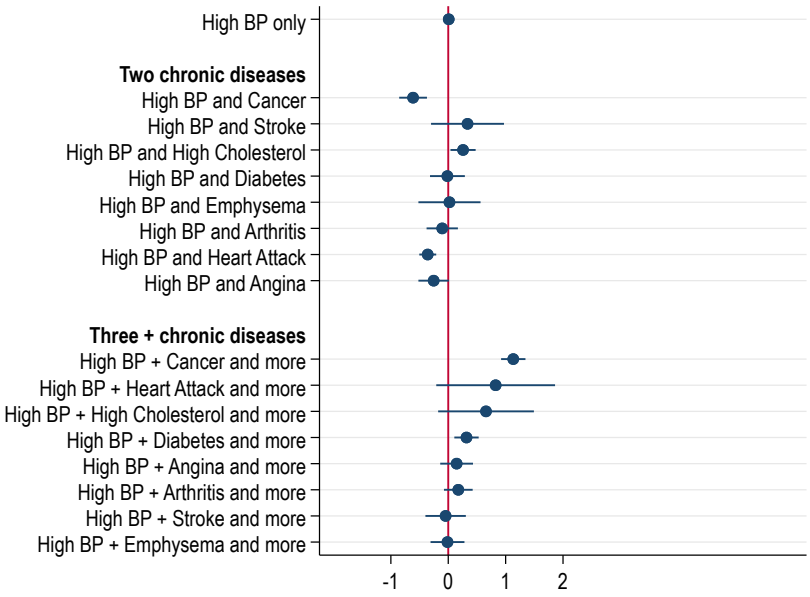

Figure A.11: Average treatment effects of NP autonomy on Annual visits to NP by disease combinations

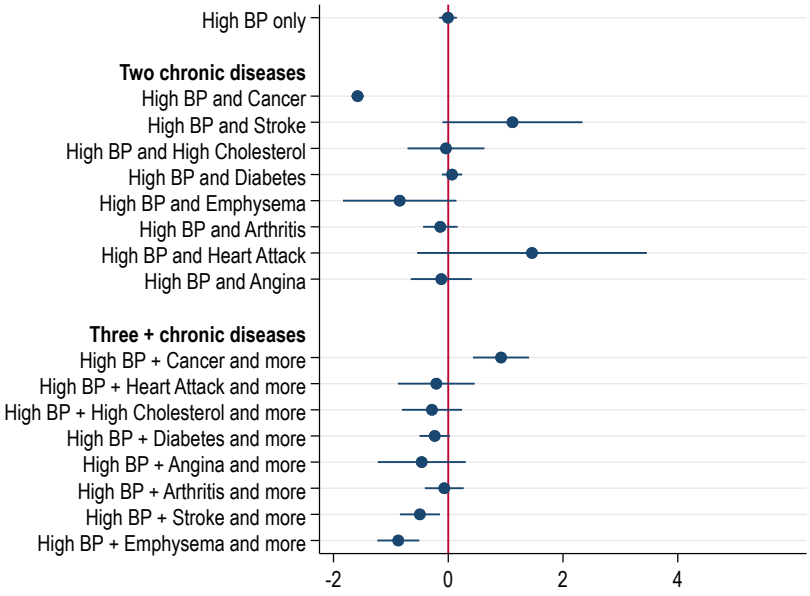

Figure A.12: Average treatment effects of NP autonomy on Annual visits to Primary Care Physician by disease combinations

G The Impact of NP autonomy on annual specialty physicians

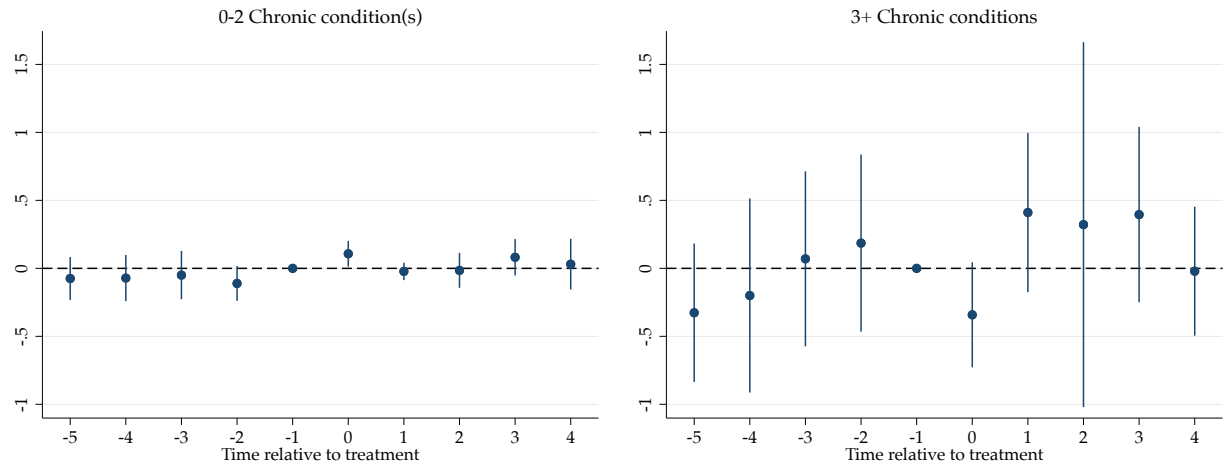

Figure A.13: Effect of NP autonomy on annual visits to specialty physicians

Notes: The figure shows the effects of state-level NP full practice authority on annual specialty physician visits by patients' pre-reform chronic conditions. Point estimates with 90% confidence intervals are reported by treatment year. Standard errors are clustered at the block level.

H Impact of NP autonomy on home health care visit days by health condition

$$\text{Days}_{isbt} = \alpha_{sbt} + i_s + \sum_{\tau=-5,\,\tau\neq-1}^{4} \left(\beta_\tau + \gamma_\tau d_i\right) \mathbf{1}\left[\text{year}_{sbt} = \tau\right] + X_{it}'\delta + \varepsilon_{isbt} \tag{18}$$

Days_{isbt} is annual home health care visit days of individual i in state s in block b in year t. α_{sbt} is block-time fixed effects. s is state-fixed effects. d_i equals 1 if a person had 3 or more chronic conditions prior to full NP autonomy. Post_{sbt} is equal to 1 if state s in block b at time t has authorized the full practice autonomy.

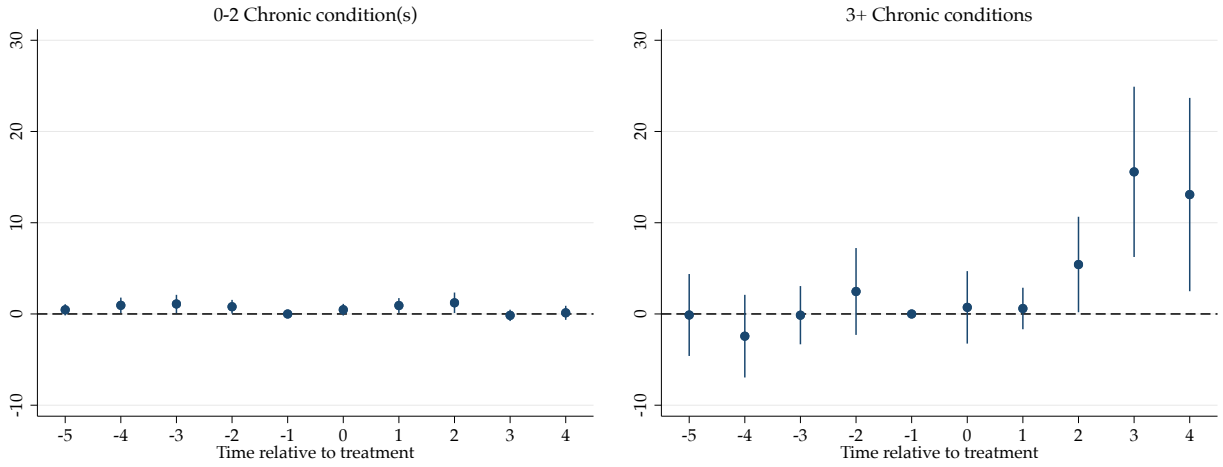

Figure A.14: Effect of NP autonomy on home health care visit days by health condition

Notes: The figure shows the effects of state-level NP full practice authority on annual home health visits by patients' pre-reform chronic conditions. Point estimates with 90% confidence intervals are reported by treatment year. Standard errors are clustered at the block level.

I Distribution of PCS and MCS by provider type and treatment status

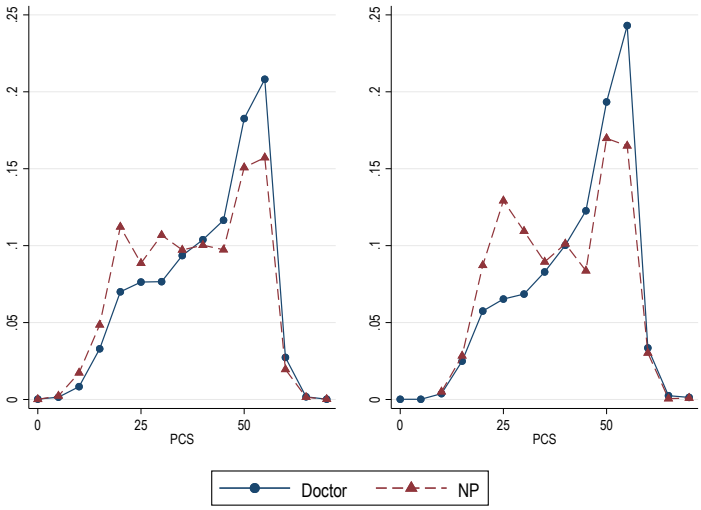

Figure A.15: Distribution of PCS (Physical Component Summary)

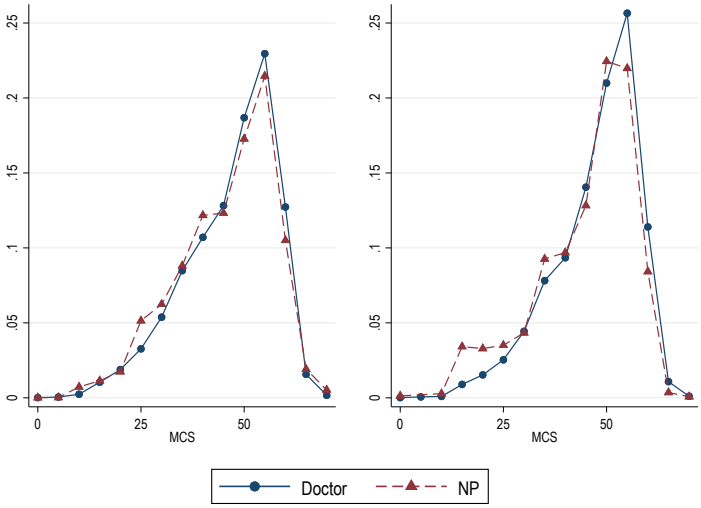

Figure A.16: Distribution of MCS (Mental Component Summary)

Notes: The figure shows the distribution of patients' physical and mental component summary scores before state-level NP full practice authority (on the left) and after the reform (on the right), by provider type.

J The effect of NP autonomy on type of conditions addressed in a visit, by provider type

$$\text{Disease Category}_{hict} = \tau_{ct} + \tau_{it} + \gamma_0 \text{Post}_{ct} + \gamma_1 \text{NP}_h + \gamma_2 \text{Post}_{ct} \times \text{NP}_h + e_{hict} \quad (15)$$

	Post		Post x NP	
Disease category	γ_0	SE	γ_s	SE
Infectious	-0.25	(0.40)	2.93	(1.62)
Neoplasm	0.22	(0.15)	-0.69	(0.61)
Endocrine	-0.03	(0.05)	0.10	(0.08)
Blood & blood-forming organ	-0.01	(0.01)	0.00	(0.01)
Mental	-0.09	(0.42)	-0.37	(2.01)
Nervous	-3.36	(6.17)	-2.36	(1.84)
Circulatory	-0.25	(0.25)	1.82	(2.19)
Respiratory	-2.85	(3.19)	0.49	(2.20)
Digestive	0.99	(3.66)	2.27	(2.79)
Genitourinary	0.26	(0.22)	-0.55	(0.33)
Complications of pregnancy	-0.13	(0.17)	-0.18	(0.23)
Skin & musculoskeletal	-5.38	(5.74)	2.05	(3.42)
Congenital	0.00	(0.02)	-0.01	(0.01)
Prenatal	0.01	(0.01)	0.01	(0.01)
Ill-defined	1.57	(4.55)	0.81	(2.40)
Injury & poisoning	9.31	(5.18)	-6.32	(7.40)
N	12746			

Table A.3: Effect of NP autonomy on the probability that a certain condition is addressed, by provider type (%)

Notes: The table reports the effect of state-level NP full practice authority on the probability that an office-based visit addresses a certain disease category, separately for physician-treated visits (γ_0) and NP-treated visits (γ_2) by estimating Equation 15. Observations are at the event level. Standard errors are shown in parentheses. Standard errors are clustered at the state level.

K The effect of NP autonomy on NP visits, physician visits, Physical and Mental Component Summary

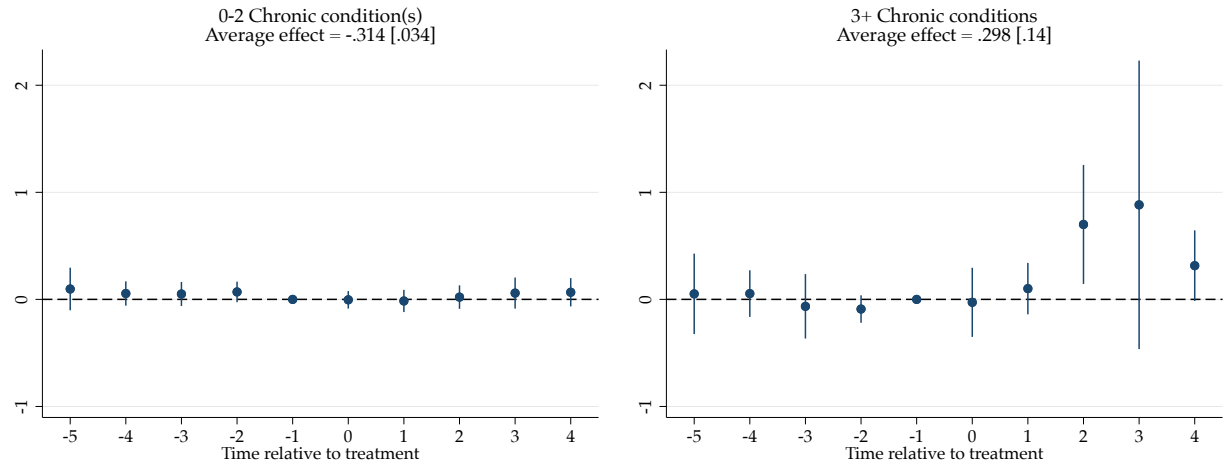

Figure A.17: Effect of NP autonomy on annual visits to NP

Notes: The figure shows the effects of state-level NP full practice authority on annual visits to NPs by patients' pre-reform chronic conditions using a simple event-study design based on individuals in expansion states and non-expansion states. Point estimates with 90% confidence intervals are reported by treatment year. Average expansion effects for 4 years are indicated below each title, with robust standard errors are in the parentheses. Standard errors are clustered at the state level.

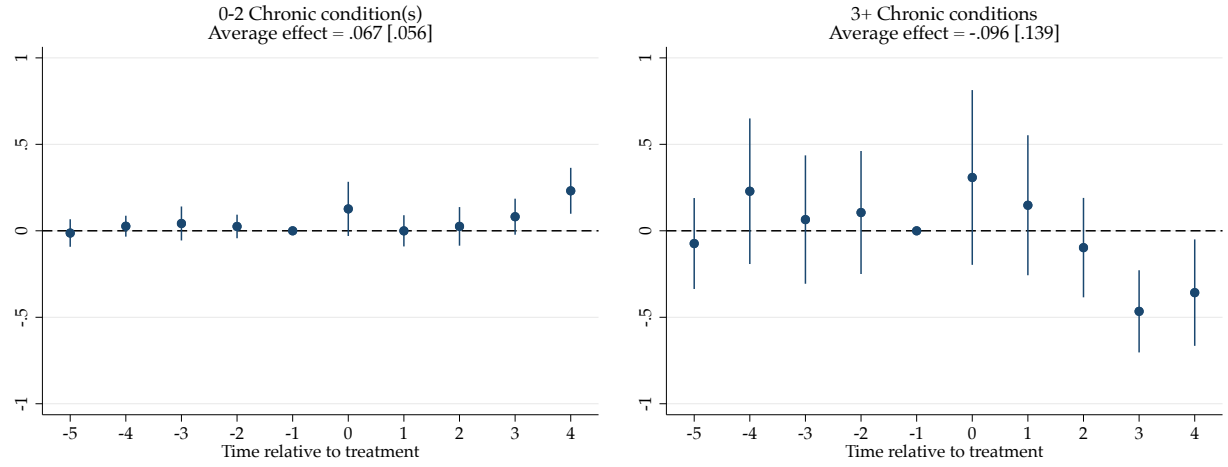

Figure A.18: Effect of NP autonomy on annual visits to PCP

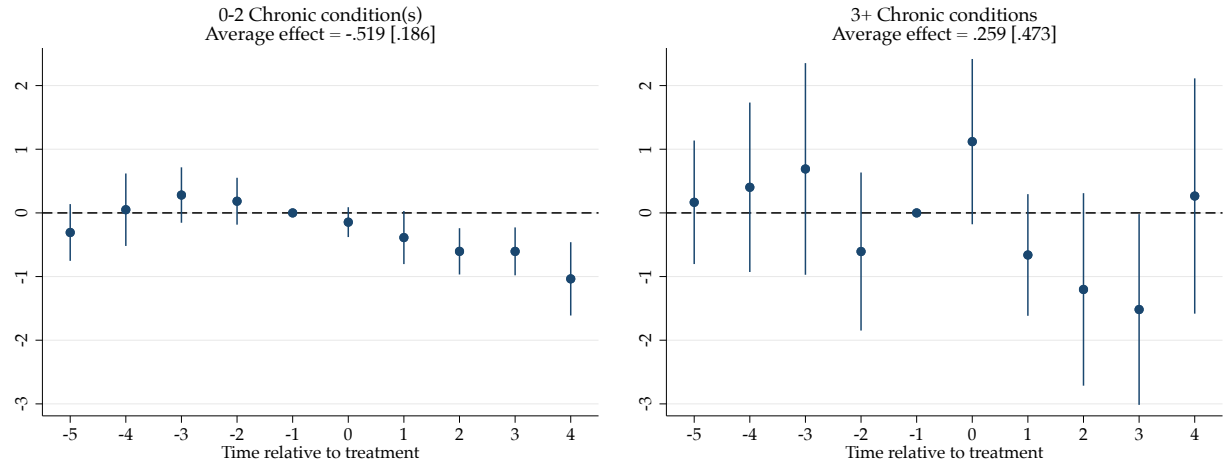

Figure A.19: Effect of NP autonomy on Physical Component Summary (PCS)

Notes: The figure shows the effects of state-level NP full practice authority on the physical component summary score by patients' pre-reform chronic conditions using a simple event-study design based on individuals in expansion states and non-expansion states. Point estimates with 90% confidence intervals are reported by treatment year. Average expansion effects for 4 years are indicated below each title, with robust standard errors are in the parentheses. Standard errors are clustered at the state level.

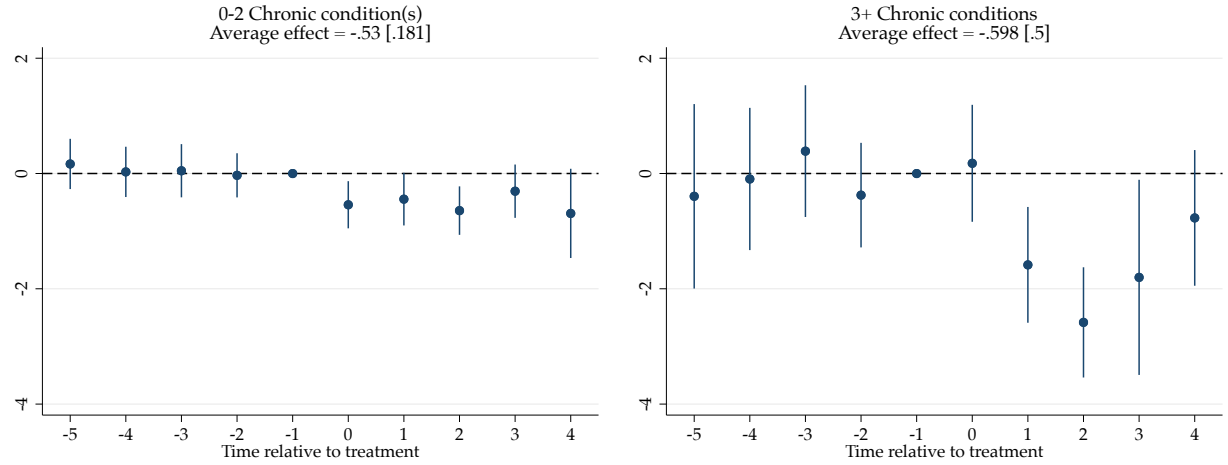

Figure A.20: Effect of NP autonomy on Mental Component Summary (MCS)

L International Classification of Diseases (ICD-10 and ICD-9) codes for bacterial and viral infections requiring antibiotic or antiviral medications

ICD-10 (3-digit)	ICD-9 (3-digit)	Condition
Bacterial infections–antibiotic therapy required		
A40	038	Streptococcal sepsis
A41	038	Other sepsis (e.g., *E. coli*, *Pseudomonas*)
J01	461	Acute bacterial sinusitis
J02	034	Streptococcal pharyngitis
J13–J15	481–483	Bacterial pneumonia (e.g., pneumococcal, staphylococcal)
J36	475	Peritonsillar abscess
K35	540	Acute appendicitis
K65	567	Peritonitis
L00–L08	680–686	Bacterial skin infections (impetigo, cellulitis, abscess)
N10	590	Acute pyelonephritis
N30	595	Acute bacterial cystitis
N41	601	Prostatitis
N70–N73	614–616	Pelvic inflammatory disease, salpingitis, endometritis
O85	670	Puerperal sepsis
Viral infections–antiviral therapy required		
B00	054	Herpes simplex infections (e.g., genital, encephalitis)
B01	052	Varicella (chickenpox)
B02	053	Herpes zoster
B18	070	Chronic viral hepatitis B or C
B20	042	HIV infection
B25	078	Cytomegalovirus disease
J09–J11	487	Influenza

Table A.4: ICD-10 and ICD-9 Codes for infection conditions