Occupational Autonomy and Human Capital Investment: Evidence from Nurse Practitioner Practice Authority Reforms

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Abstract

This paper examines whether individuals increase human capital investment when occupational autonomy expands. To answer this question, I exploit full practice authority (FPA) reforms for nurse practitioners (NPs) across U.S. states. These reforms allow NPs to practice and prescribe independently of physicians, thereby durably increasing occupational autonomy and expected returns to NP training in graduate programs. I find that FPA increases advanced nursing degrees by 18 percent, with substitution toward shorter master's-level programs from longer doctoral-level programs. The results suggest that educational investment responds to regulatory reforms that expand occupational autonomy, with implications for long-run labor supply.

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Keywords: human capital, occupational autonomy, professional training, scope-of-practice, healthcare workforce, nurse practitioners

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I. Introduction

Do individuals increase human capital investment when occupational autonomy expands? Standard models treat education as a forward-looking investment in expected lifetime earnings and nonpecuniary job attributes (Becker 1964, Card 1999), and a large literature shows that expected returns influence schooling and major choice (Berger 1988, Kirkeboen, Leuven and Mogstad 2016). However, much of the existing evidence relies on belief updating through informational interventions (Jensen 2010, Zafar 2011, Wiswall and Zafar 2015) or responses to contemporaneous labor market conditions (Black, McKinnish and Sanders 2005, Long, Goldhaber and Huntington-Klein 2015, Blom, Cadena and Keys 2021). It is rare to observe a plausibly exogenous shock that durably shifts occupational autonomy and expected earnings for a well-defined group of prospective entrants, and to examine whether human capital investment adjusts in response.

I study this question in the context of scope-of-practice (SOP) reforms for nurse practitioners (NPs) in the United States. Since 2010, twenty states have adopted full practice authority (FPA) laws allowing NPs to diagnose, prescribe, and practice independently of physicians (McMichael and Markowitz 2023). These reforms generate legally defined and persistent changes in occupational autonomy and have been shown to increase NP demand, wages, and self-employment (Dillender, Sasso, et al. 2024, Kleiner, et al. 2016, Markowitz and Adams 2022). This setting offers several features that sharpen identification of forward-looking investment responses. First, FPA reform alters institutional practice authority in a durable and objective manner, rather than shifting subjective perceptions of job attributes. Second, entry into NP practice requires standardized graduate training and licensure, creating a transparent mapping between educational investment and occupational outcomes.[1] Third, prospective entrants are registered nurses (RNs), who typically work alongside NPs and observe practice arrangements directly, which may facilitate the formation of expectations about the reform's effects. Finally, the choice set is relatively structured—remaining an RN, enrolling in a Master of Science in Nursing (MSN) program, or enrolling in a Doctor of Nursing Practice (DNP) program—allowing clear trade-offs between training duration and expected returns. These institutional features

[1] Studies documents substantial labor market returns to professional degrees, including medicine, law, pharmacy, and nursing (Altonji and Zhong 2021, Altonji and Zhu 2025). All four fields require standardized graduate training and licensing procedures that prepare individuals for professional practice (Bae, Kleiner, et al. 2025).

reduce ambiguity in expected outcomes relative to settings where educational choices span heterogeneous fields with uncertain career trajectories. Together, they provide a quasi-experimental setting to study how regulatory institutions shape the accumulation of specialized human capital through professional training decisions.

I examine whether NP FPA generates forward-looking labor supply responses by altering the expected returns to graduate nursing education. Becoming an NP requires costly investment in graduate education in addition to prior RN licensure and clinical experience. I develop a simple model in which individuals choose among remaining an RN, enrolling in a shorter MSN program, or enrolling in a longer DNP program. The model yields two predictions. First, by increasing post-training earnings and autonomy, FPA increases enrollment in and completion of advanced nursing programs. Second, when the incremental earnings premium for DNP training is not sufficiently larger than that for MSN training, individuals substitute toward the shorter track.

To test these predictions, I exploit staggered adoptions of FPA across 20 states between 2010 and 2024. I merge policy adoption data from McMichael and Markowitz (2023) with institution-level degree completions from the Integrated Postsecondary Education Data System (IPEDS). I use advanced nursing degree completions to approximate NP training completions given that about 60% of advanced nursing programs are relevant to NP training.[2] I focus primarily on intensive-margin responses within institutions that awarded at least one advanced nursing degree in every year of the sample period and estimate staggered difference-in-differences models with institution and year fixed effects, comparing completions in treated and never-treated states before and after reform. I then examine extensive-margin responses using analogous state-year models in which the outcome is the number of institutions awarding advanced nursing degrees. Identification relies on parallel trends between treated and never-treated states. Event-study estimates show no evidence of differential pre-trends and trace the dynamic evolution of effects following adoption. To address potential confounding from broader health-sector shocks, I conduct placebo tests using advanced non-nursing health degree

[2] For example, 39,000 new NPs completed their academic programs in 2021-2022 (U.S. Health Resources & Services Administration 2025), which corresponds to 59% of advanced nursing degree completions in the IPEDS. To be clear, NP training completions are not distinguishable from other advanced nursing degree completions in the dataset.

completions and estimate triple-difference specifications comparing nursing to non-nursing health programs within the same institutions.

I find that FPA substantially increases the training pipeline of new nurse practitioners. Institutions in treated states experience an 18 percent increase in master's or doctoral nursing degrees relative to similar institutions in never-treated states following reform. Event-study estimates show no evidence of differential pre-trends and indicate that effects emerge shortly after adoption and grow over time. Consistent with the model's second prediction, I document substitution across degree tracks: master's nursing degree completions increase significantly after reform, while doctoral nursing degree completions decline, implying a shift toward the shorter MSN pathway when the incremental returns to DNP training are limited. I find no comparable effects for advanced non-nursing health degree programs, supporting the interpretation that the response is specific to NP-related training. Results are robust to alternative staggered adoption estimators. I also find evidence of modest and delayed spillovers to the RN pipeline.

In contrast, I find little evidence of an increase in new NP programs after FPA, implying that the primary pipeline responses operate within continuing programs. At the aggregate level, I find no association between FPA and total county- or state-level advanced nursing degree completions, reflecting offsetting extensive-margin changes in program entry across states.[3] This compositional masking helps reconcile my findings with prior studies using aggregated data that report limited changes in NP workforce stock following FPA (Kandrack, Barnes and Martsolf 2021, Dillender, Sasso, et al. 2024).

The paper contributes to the literature on human capital investment and skilled labor supply by providing empirical evidence on how durable, quasi-experimental changes in occupational autonomy affect costly educational investment for career development. In the standard framework (Becker 1964, Card 1999), a large body of observational studies show that schooling decisions and college major choices are associated with predicted future earnings (Berger 1988), opportunity costs (Black, McKinnish and Sanders 2005, Emery, Ferrer and Green 2012), contemporaneous returns (Long, Goldhaber and Huntington-Klein 2015, Han and Winters

[3] I observe that treated states experienced a relative decline in the number of institutions granting advanced degrees in general—regardless of nursing or non-nursing degrees—after FPA because of an increase in new institutions granting advanced degrees in never-treated states. See Section V.4. for more details on extensive margin changes and aggregation effects.

2020), and economic downturns (Ersoy 2020, Blom, Cadena and Keys 2021). Experimental studies confirm the role of perceived returns but also reveal the prevalence of heterogeneous tastes for non-pecuniary job attributes (Jensen 2010, Wiswall and Zafar 2015, Hastings, Neilson and Zimmerman 2015). However, most existing evidence reflects responses to transitory earnings shocks or belief updating about uncertain returns. By exploiting regulatory reforms that durably alter legally defined job autonomy and expected earnings within a well-defined profession, this paper identifies forward-looking human capital investment responses to persistent changes in occupational autonomy. In doing so, it also extends the literature beyond undergraduate major selection to costly graduate education for career advancement within an established profession.

The paper also adds to the literature on the responsiveness of higher education to labor market conditions. Prior work shows that program completions at four-year colleges, for-profit institutions, and community colleges respond to occupation-specific demand shifts (Conzelmann, et al. 2024, Gilpin, Saunders and Stoddard 2015, Grosz 2022). I provide evidence that graduate education responds strongly to regulatory shocks that reshape occupational autonomy and subsequently demand for professional training. Additionally, combining my estimates with those of Dillender, Sasso, et al. (2024), the implied elasticity of NP training completions with respect to NP job postings is higher than recent estimates for major-specific degree completions in four-year institutions (Conzelmann, et al. 2024).

Finally, the paper contributes to the literature on occupational regulation and public health by identifying a dynamic workforce pipeline mechanism through which regulatory reform affects provider availability. Previous research documents that NP autonomy increases NP earnings and labor demand (Kleiner, et al. 2016, Dillender, Sasso, et al. 2024, Bhai and Mitchell 2025) and access to care (Stange 2014, Traczynski and Udalova 2018, Alexander and Schnell 2019, Guo, Kilby and Marks 2024, Ryskina, et al. 2024), yet evidence on contemporaneous changes in NP stock is weak (McMichael 2018, Kandrack, Barnes and Martsolf 2021, Dillender, Sasso, et al. 2024). By focusing on graduate degree completions—the primary margin of entry into the profession—this paper documents a forward-looking supply response that may be obscured in aggregate stock measures. The results highlight two distinct channels through which regulatory reform shapes provider supply: an immediate channel, through expanded practice authority for existing providers, and a dynamic channel, through increased entry into the

profession via the education pipeline. Most existing studies do not separately identify these channels, making it difficult to distinguish short-run service expansions from long-run supply adjustments. A simple accounting framework suggests that the observed increase in annual degree completions could translate into a substantial cumulative increase in NP stock over a decade, even under conservative assumptions about entry and attrition. More broadly, the findings indicate that occupational regulation may influence not only the allocation of existing practitioners, but also the accumulation of professional human capital.[4]

II. Backgrounds: NP SOP and Pipeline

The first NP programs were developed in the mid-1960s to train RNs to deliver expanded clinical services in primary care settings. The introduction of Medicare and Medicaid in 1965 sharply increased demand for outpatient and primary care services, policymakers repeatedly confronted the tension between maintaining professional standards and ensuring adequate access to care. Against this backdrop, NPs emerged as a new profession to mitigate shortages of primary care physicians. Over time, NPs became an increasingly important component of the health care workforce, particularly in family medicine, pediatrics, geriatrics, and mental health. Despite this growth, states historically limited NP autonomy by requiring physician supervision or collaborative agreements. Beginning in the 1990s, however, states progressively expanded NP SOP through FPA laws that allow NPs to evaluate patients, diagnose conditions, order tests, treat diseases, and prescribe medications without physician oversight (McMichael and Markowitz 2023, Dunlap 2024). Today, NPs are granted FPA in more than half of U.S. states.

Becoming an NP typically involves a multi-stage training and licensure process that is nationally standardized. The usual pathway begins with RN licensure. Individuals first complete an undergraduate nursing degree (either associate's or bachelor's degree) and pass the National Council Licensure Examination for Registered Nurses (NCLEX-RN). Most NP programs require applicants to hold an active RN license and possess prior clinical experience. NP training then occurs in an advanced nursing degree program, mostly through a Master of Science in Nursing (MSN) and increasingly through a Doctor of Nursing Practice (DNP). These programs are

[4] This implication extends beyond NPs to other regulated health professions whose practice authority has expanded in many states (Bae and Timmons 2022), including nurse midwives (Markowitz, et al. 2017), pharmacists (Shakya, et al. 2025), psychologists (Choudhury and Plemmons 2023), and optometrists (Bae and Sigaud 2026).

nationally accredited, primarily by the Commission on Collegiate Nursing Education or the Accreditation Commission for Education in Nursing. Training combines didactic coursework with extensive clinical education, typically completed under the supervision of licensed preceptors, who may be physicians or experienced NPs. Securing adequate preceptors and clinical placement sites can constrain NP program capacity.

After completing graduate training, prospective NPs must obtain national certification from organizations such as the American Academy of Nurse Practitioners Certification Board (AANPCB) or the American Nurses Credentialing Center (ANCC). State licensure requires both graduate education and national certification, typically along with licensing fees and background checks. Although SOP regulations vary across states, NP training programs and licensure requirements are largely uniform nationwide and do not systematically differ between full-practice and restricted-practice states. Thus, FPA primarily affects labor supply incentives rather than the structure of NP education or licensure standards.

III. A Model for NP Training

Prior to empirical analysis, I present a simple model to clarify theoretical predictions regarding the effects of FPA on graduate nursing training. I model NP training as a costly investment in the spirit of standard human capital models (Becker 1964, Card 1999).

Consider a population of individuals indexed by i. Each individual chooses one of three paths indexed by $k \in \{0, M, D\}$: (i) the outside occupation ($k = 0$, no NP training), (ii) an MSN program ($k = M$, shorter NP training), or (iii) a DNP program ($k = D$, longer NP training). Let $T_M < T_D$ denote program lengths. Let the post-training working horizon be L after the DNP track and $L + T_D - T_M$ after the MSN track. Individuals discount future payoffs at rate $\beta \in (0,1)$.

Individuals differ in earnings. Let $w_{0,i}$ denote per-period earnings in the outside option (e.g., RN earnings), $w_{e,i}$ denote per-period earnings while enrolled (e.g., part-time earnings during training), and $w_{k,i}(s)$ denote per-period post-training earnings as an NP after completion of track $k \in \{M, D\}$ under SOP regime s. Let c denote per-period monetary cost of training costs, assumed to be identical across NP tracks.

The present value of the outside option is

$$V_{0,i} = \sum_{t=0}^{T+L-1} \beta^t w_{0,i}.$$

If the individual enrolls in the MSN program, the present value is

$$V_{M,i}(s) = \sum_{t=0}^{T_M-1} \beta^t \, (w_{e,i} - c) + \sum_{t=T_M}^{T_D+L-1} \beta^t \, w_{M,i}(s).$$

Similarly, for the DNP program,

$$V_{D,i}(s) = \sum_{t=0}^{T_D-1} \beta^t \, (w_{e,i} - c) + \sum_{t=T_D}^{T_D+L-1} \beta^t \, w_{D,i}(s).$$

Each individual chooses the option that maximizes present value. Define net benefits relative to the outside option as

$$\Delta_{k,i}(s) = V_{k,i}(s) - V_{0,i}, \qquad k \in \{M, D\}.$$

An individual enrolls in NP training if and only if $\Delta_{k,i}(s) \geq 0$ for at least one $k \in \{M, D\}$. This condition can be rewritten as

$$\sum_{t=T_k}^{T_D+L-1} \beta^t \, (w_{k,i}(s) - w_{0,i}) \geq \sum_{t=0}^{T_k-1} \beta^t \left(c + w_{0,i} - w_{e,i}\right).$$

Thus, enrollment requires that the discounted post-training earnings gain exceed monetary training costs and the opportunity cost of foregone earnings.

Define the net benefit of the MSN track relative to the DNP track as

$$\Gamma_i(s) = V_{M,i}(s) - V_{D,i}(s).$$

Conditional on enrollment in NP training, individuals choose the MSN track if $\Gamma_i(s) \geq 0$, which is equivalent to

$$\sum_{t=T_M}^{T_D-1} \beta^t \left(c + w_{M,i}(s) - w_{e,i}\right) \geq \sum_{t=T_D}^{T_D+L-1} \beta^t \left(w_{D,i}(s) - w_{M,i}(s)\right).$$

The DNP track must therefore compensate for additional training time and foregone MSN-level earnings during $[T_M, T_D - 1]$ through a sufficient post-training earnings premium.

Enrolled students at time τ ($\in \{1, \dots, T_k - 1\}$) continue training if the continuation value from completing the program exceeds the value of dropping out. The completion decision is analogous to the enrollment decision and can be characterized using value functions defined from period τ.

I model FPA as an exogenous regime change from s to s' that weakly increases post-training earnings in both NP tracks while leaving outside earnings, costs, and program lengths fixed:

$$w_{M,i}(s') \geq w_{M,i}(s),\ w_{D,i}(s') \geq w_{D,i}(s) \text{ for all } i.$$

Earnings gains under FPA arise from the removal of physician supervision or collaborative agreement requirements. Under restricted SOP, NPs may share revenue with supervising physicians or face constraints on the quantity and types of services they can independently provide. FPA relaxes these constraints, increasing the effective marginal revenue product of NP labor and allowing NPs to capture a larger share of the value they generate. In addition, FPA may confer non-pecuniary benefits through increased job autonomy, which are incorporated into post-training returns in the model. For parsimony, I do not model these components separately.

Proposition 1 (Enrollment and Completion Effects)

If FPA weakly increases expected post-training earnings in both MSN and DNP tracks and leave training costs unchanged, then: (1) The set of individuals who choose NP training (MSN or DNP) weakly increases relative to the outside option. (2) Within each track, the completion set weakly increases (and dropout weakly decreases) at every stage τ.

Sketch of proof: For each track k, $V_{k,i}(s)$ increases in $w_{k,i}(s)$, while $V_{0,i}$ is unchanged. Hence $\Delta_{k,i}(s)$ shifts upward, increasing the set of individuals for whom NP training dominates the outside option and strengthening incentives to complete training once enrolled.[5]

[5] See the appendix for formal proofs of Propositions 1 and 2.

Proposition 1 predicts that FPA increases NP training completions. Empirically, I test whether advanced nursing degree completions (master's or doctoral) increases after FPA reform. This outcome captures effects on both new enrollments (with longer lags) and completion decisions among existing students (with shorter lags). Due to data limitations, I do not separately observe new enrollments.

Proposition 2 (Substitution toward MSN)

Suppose FPA increases per-period post-training earnings by g_M for MSN and g_D for DNP. Then the relative attractiveness of MSN increases (i.e., $\Gamma_i(s') > \Gamma_i(s)$) whenever

$$g_D - g_M < \gamma g_M, \qquad \gamma = \frac{\sum_{t=T_M}^{T_D-1} \beta^t}{\sum_{t=T_D}^{T_D+L-1} \beta^t}.$$

Sketch of proof: The change in relative value is

$$\Gamma_i(s') - \Gamma_i(s) = \sum_{t=T_M}^{T_D-1} \beta^t g_M - \sum_{t=T_D}^{T_D+L-1} \beta^t \, (g_D - g_M) \geq 0.$$

If the additional DNP earnings gain is insufficient relative to the earlier gains under MSN, substitution toward MSN occurs.

Proposition 2 implies that FPA may have differential effects across training tracks. If FPA raises earnings similarly across MSN and DNP (i.e., $g_D = g_M$), substitution toward the shorter MSN track is sufficient. This case is plausible because FPA grants independent practice and prescribing authority regardless of degree track. Empirically, I test whether master's completions increase relative to doctoral completions following FPA reform.

IV. Empirical Methodology

1. Data

The study utilizes data from multiple sources. First, I obtain institution-level program completions data from the Integrated Postsecondary Education Data System (IPEDS) for 2010-2024 (U.S. Department of Education 2025). IPEDS reports the number of completions by 6-digit Classification of Instruction Program (CIP) codes and award level for each institution-year. I construct the number of advanced nursing degree completions for each institution-year and use it

as a proxy for NP training completions. I define master's and doctoral degrees as advanced degrees. Nursing programs are identified using 4-digit CIP codes 51.38 (Registered Nursing, Nursing Administration, Nursing Research and Clinical Nursing) or 51.39 (Practical Nursing, Vocational Nursing and Nursing Assistants) under the 2010 CIP classification.[6] Although nursing education programs were reclassified outside these categories in the 2020 CIP revision, I include them for consistency across years.[7] To avoid double-counting students who received dual degrees, I count completions only when nursing is listed as the first major. NP programs are not separately identified in IPEDS; however, approximately two-thirds of advanced nursing degree completions correspond to NP training programs.[8]

From IPEDS, I also obtain several pre-treatment covariates for estimation. I define indicators for private institutions and for institutions located in urban areas as of 2010. Following IPEDS locale definition, I classify institutions as urban if they are located within an urbanized area and inside a principal city; all others are classified as non-urban.

I also calculate the share of associate degree in nursing (ADN) completions among undergraduate nursing completions in an institution's county in 2010 as a proxy for baseline intensity of NP training demand. ADN-trained RNs typically have lower baseline earnings and may face stronger incentives to pursue additional education for upward mobility along the RN-to-NP career ladder. A higher local ADN share therefore reflects a larger pool of RNs with relatively higher incentives to upgrade to advanced practice training, making it a meaningful proxy for underlying demand for NP education in the locality.

Second, I use county-level data from the Area Health Resource Files (AHRF) to compute NP density in each institution's county in 2010 (U.S. Department of Health and Human Services 2022). The number of NPs per 100,000 residents in an institution's county captures baseline provider supply and local exposure to advanced practice roles. Higher NP density reflects stronger local demand for NP services and greater integration of NPs into the healthcare system,

[6] Advanced degree completions are almost entirely from programs under 51.38 (Registered Nursing, Nursing Administration, Nursing Research and Clinical Nursing), and there are few advanced degree completions from programs under 51.39 (Practical Nursing, Vocational Nursing and Nursing Assistants). All findings in this paper are not almost unchanged if I exclude programs under 51.39 from the sample.

[7] Crosswalks on CIP codes are available on the website of the National Center for Education Statistics as of July 22, 2024: https://nces.ed.gov/ipeds/cipcode/resources.aspx?y=56

[8] For example, 39,000 new NPs completed their academic programs in 2021-2022 (U.S. Health Resources & Services Administration 2025), which corresponds to 59% of advanced nursing degree completions in the IPEDS.

which may influence both expected returns to NP education and training capacity. Similarly, I calculate primary care physicians (PCP) density for use in heterogeneity and robustness analyses.

Third, I use regulatory data on state-level adoption of FPA from McMichael and Markowitz (2023). FPA is defined based on state statutes and administrative codes indicating whether NPs are permitted to practice and prescribe independently from physician supervision or collaborative agreements. I focus on FPA because both independent practice and prescribing authority are likely to affect professional training decisions. Between 2010 and 2023, 20 states newly adopted FPA ("treated states"; listed in Table 1), while 18 states had not adopted FPA by the end of 2024 ("never-treated states"), forming the control group.

At the national level, there is a strong time-series association between FPA adoption and advanced nursing degree completions (Figure 1). From 2010 to 2024, advanced nursing degree completions increased from approximately 25,000 to 65,000 in 2024, while the number of states granting increased from 13 to 33. Over the same period, medical degree completions rose more modestly, from about 20,000 to 30,000.

For the causal analysis, I construct a balanced panel of 373 institutions that awarded at least one advanced nursing degree in every year from 2010 to 2024 and are located in either treated or never-treated states. This sample includes 5,595 institution-year observations. As shown in Table 2, Column 1, 46% of institutions are private, and 62% are located in urban areas as of 2010. In counties where these institutions are located, the average share of ADN among undergraduate nursing completions is 34%, and the average number of NPs per 100, 000 residents is 52 in 2010. The mean number of advanced nursing degree completions per institution-year is 91, with a standard deviation of 232. The distribution is highly right-skewed (Appendix Figure A1), so I use the logarithm of completions as the main outcome in the staggered adoption analysis. Among advanced nursing degree completions, 85% (77 out of 91) are master's degrees and 15% (14 out of 91) are doctoral degrees.

Table 2, Columns 2 and 3 compare pre-treatment covariates and outcomes between treated and never-treated states. Institutions in treated states are more likely to be private and located in urban areas and situated in counties with a higher ADN share and more NPs. They also have higher average advanced nursing degree completions—particularly master's degree completions. These differences motivate the inclusion of institution fixed effects and pre-treatment covariates in the empirical analysis.

2. Econometric Method

I estimate the effects of FPA using staggered difference-in-differences methods. The primary analysis focuses on intensive-margin responses within institutions that awarded at least one advanced nursing degree in every year of the sample period. This design isolates changes in completions within continuing programs and mitigates confounding from idiosyncratic supply shocks such as new program openings.

My baseline specification compares within-institution changes in completions between institutions in treated states and institutions in never-treated states before and after FPA adoption. I implement the Callaway and Sant'anna (2021) estimator, including institution and year fixed effects. Institution fixed effects absorb time-invariant institutional characteristics, while year fixed effects capture common shocks across states. In an event-study framework, I estimate dynamic treatment effects and assess pre-treatment trends.

For expositional clarity, consider two-way fixed effects (TWFE) event-study regression:

$$Y_{ist} = \alpha_i + \beta_t + \sum_h \tau_h \, 1[t - E_s = h] + \epsilon_{ist}$$

where i indexes an institution, s indexes a state, and t indexes a year. Y_{ist} denotes the outcome, α_i institution fixed effects, and β_t year fixed effects. E_s is the year state s first adopts FPA, and h indexes event time relative to adoption. The indicator $1[\cdot]$ identifies event years, and ϵ_{ist} is an error term.

The outcome variable is the logarithm of advanced nursing degree completions. The treatment is the first year in which a state adopts FPA. None of the treated states repeal FPA during the sample period. Because IPEDS academic years from July 1 of year $t-1$ to June 30 of year t, an institution is coded as treated in year t if FPA took effect during that interval.

If treatment effects are homogenous across states, the TWFE event-study estimates τ_h are unbiased and efficient. However, with staggered adoption and heterogeneous effects, TWFE may be biased because early-treated units serve as controls for later-treated units.[9] To address this

[9] For more details, see Borusyak, Jaravel, and Speiss (2024). For a comprehensive survey on alternative methods to address the issue, see de Chaisemartin and d'Haultfœuille (2023).

issue, I use the Callaway and Sant'anna (2021) estimator, which compares treated units only to never-treated units.

Specifically, for each treatment cohort e and relative period h, I estimate the cohort-specific treatment effect τ_{eh} as the difference in outcomes between cohort e and the never-treated group in period $e + h$, relative to the same difference in the pre-treatment year $e - 1$. I then aggregate cohort-period effects to obtain event-time effects τ_h and an overall average treatment effect τ.

Identification relies on two assumptions: no anticipation and parallel trends. The no anticipation assumption is plausible because FPA laws typically take effect shortly after enactment.[10] Parallel trends may be more restrictive, given observable differences between treated and control institutions. To improve comparability, I balance institutional characteristics between treated and control states by implementing inverse probability weighting based on pre-treatment characteristics, including indicators for public institutions and for urban institutions and baseline county-level NP density and ADN share measured in 2010, when no state in the sample adopted FPA.[11] These covariates account for persistent differences in program capacity, resources, and demand conditions that may influence advanced nursing degree completions between treated and control states.

A further concern is confounding from contemporaneous health policy changes, such as Medicaid expansions, which may affect demand for health care training more broadly. To address this, I conduct placebo tests using advanced non-nursing health degree completions, defined as CIP 51 programs excluding nursing (51.3801-51.3999) and medicine programs (51.1201, 51.1901) under the 2010 CIP classification. Because state-level health reforms other than FPA plausibly affect nursing and non-nursing health programs similarly, differential responses strengthen a causal interpretation. I also estimate triple-difference specifications comparing nursing to other health completions within the same institutions that awarded at least one advanced nursing degree and one advanced non-nursing health degree in every year of the

[10] An exception is California, where the law passed in September 2020 and became effective in January 2023, but a recode of its treatment cohort from 2023 to 2021 makes little change in the estimation result.

[11] Specifically, I use Sant'Anna and Zhao (2020) doubly robust difference-in-differences estimator based on stabilized inverse probability weighting and ordinary least squares. The estimation procedure is implemented with Stata command *csdid* with *dripw* (default option) estimation method.

sample period. This approach differences out institution-year and state-year shocks that broadly affect health education demand.

Finally, I examine extensive-margin responses using an analogous staggered adoption model at the state-year level, where the outcome is the number of institutions awarding at least one advanced nursing degree. This specification assesses whether FPA affects institutional entry into or exit from advanced nursing education. I also examine potential spillovers to undergraduate nursing programs (the RN pipeline), particularly within institutions offering both undergraduate and graduate nursing education, to evaluate whether FPA influences earlier stages of the nursing training pathway.

V. Results

1. Main Results

(1) Overall Effects

I find that FPA increases advanced nursing degree completions. Figure 2, Panel A shows that institutions in treated states experienced a 0.111 log-point increase in advanced nursing degree completions relative to institutions in never-treated states following FPA adoption. The event-study estimates show no evidence of differential pre-trends. Effects emerge shortly after adoption and increase over time. There is a temporary dip in event year 4, which may reflect substitution from doctoral to master's programs, as discussed below.

Accounting for pre-treatment institutional characteristics yields larger and more precisely estimated effects. Figure 2, Panel B shows that the overall treatment effect is 0.198 log points, approximately 18% increase in advanced nursing degree completions. The dynamic pattern remains similar. Effects become statistically significant about two years after adoption, consistent with the typical duration of a master's program, and continue to grow thereafter. The estimated effect reaches roughly 30% in event years 7 and 8, when the estimates stabilize.

These findings are consistent with Proposition 1 of the model. By increasing post-training earnings and occupational autonomy, FPA raises the net present value of NP training and expands the set of individuals for whom graduate nursing education dominates the outside option. The magnitude of the response is economically meaningful. For comparison, Dillender,

Sasso, et al. (2024) document a 24% increase in NP job postings two or more years after FPA reform. Combining their estimates with mine implies that NP training completions are highly responsive to the demand shock induced by FPA. The implied elasticity is larger than recent estimates for major-specific degree completions in four-year institutions (Conzelmann, et al. 2024).[12]

(2) Degree-Track Substitution

I next examine whether FPA affects master's and doctoral nursing programs differentially. Figure 3 presents event-study estimates separately for master's and doctoral completions. Panel A shows that doctoral nursing degree completions decline following FPA adoption. Among institutions that awarded at least one doctoral nursing degree throughout the sample period, doctoral completions decreased by 0.368 log points. The decline becomes visible in event year 1 and fully materializes in event year 4, consistent with the typical three- to four-year duration of DNP programs.

By contrast, master's nursing degree completions increase following reform. In the sample of institutions offering master's programs, master's completions increased by 0.165 log points. Because master's programs are roughly five to six times larger than doctoral programs, percentage changes in master's completions are mechanically smaller in magnitude.

To more directly assess substitution between degree tracks, Panel B restricts the sample to institutions offering both master's and doctoral nursing programs throughout the period. In this subsample, doctoral completions declined by 0.524 log points, while master's completions increased by 0.211 log points.

These patterns are consistent with Proposition 2 of the model. If FPA raises post-training earnings similarly for MSN- and DNP-trained NPs, the shorter MSN track becomes relatively more attractive, as it allows students to capture earnings gains earlier and involves lower foregone earnings during training. The observed increase in master's completions alongside a decline in doctoral completions therefore suggests substitution toward the shorter training path

[12] I find that advanced nursing degree completions increased by about 19% in a similar time frame (two to six years after reform) to Dillender, Sasso, et al. (2024)'s analysis. The estimate implies a 32 to 38% increase in NP training completions given that NP training completions are about 50 to 60% of all advanced nursing degree program completions. Based on these estimates, an implied elasticity of NP training completions with respect to NP job postings is 1.3 (=32%/24%) to 1.6 (=38%/24%). This range is above the elasticity of four-year degree completions with respect to major-specific job postings of about 1 (Conzelmann, et al. 2024).

following FPA adoption. The immediate decline in doctoral completions, particularly in event years 1 and 2, is consistent with some students shifting from doctoral to master's training after reform. The larger substitution effect in institutions offering both programs further suggests that switching is more likely when both degree tracks are available within the same institution. This substitution mechanism may also help explain the temporary dip in overall completions observed in Figure 2 around event year 4.

2. Heterogeneity and Mechanism Tests

(1) MSN- vs. DNP-Intensive Institutions

To further assess the mechanisms underlying the pipeline responses, I examine heterogeneity along two dimensions closely related to the model's predictions: the structure of NP training programs and the composition of the local RN workforce.

First, I analyze heterogeneity by baseline program structure. Institutions are classified as MSN-intensive if they did not award any doctoral nursing degrees in the base year 2010 and DNP-intensive if they awarded at least one doctoral nursing degree in that year. This distinction is motivated by Proposition 2 in the model, which predicts substitution toward shorter training tracks when the incremental returns to longer programs are not sufficiently larger than those of shorter programs.

Figure 4, Panel A shows that the response to FPA emerges earlier and is larger in MSN-intensive institutions. The event-study estimates show that completions in these institutions significantly increased two years after reform and grew steadily in subsequent years. In contrast, the estimates for DNP-intensive institutions exhibit smaller and more gradual responses. One interpretation is that institutions offering both master's and doctoral pathways experience offsetting margins: while FPA increases the incentive to pursue NP training, some prospective students substitute from longer doctoral programs toward shorter master's programs. Such substitution attenuates the net increase in total advanced nursing completions within these institutions. The timing pattern also aligns with typical program lengths, with responses emerging around two years after reform in MSN-intensive institutions, consistent with the duration of master's NP programs.

Overall, the results suggest that the pipeline response to FPA operates primarily through the expansion of master's-level NP training rather than through doctoral programs, consistent with the model's prediction of substitution toward shorter training pathways.

(2) High vs. Low ADN-Share Counties

Next, I examine heterogeneity by the baseline composition of the RN workforce. Counties are divided according to whether the share of associate degree in nursing (ADN) completions among undergraduate nursing completions in 2010 is above or below the median. As discussed in the data section, a higher ADN share indicates a larger pool of nurses with relatively strong incentives to pursue additional education for upward mobility along the RN-to-NP career ladder.

Figure 4, Panel B presents that the effects of FPA emerge immediately and are substantially larger in counties with high ADN shares. In these areas, advanced nursing degree completions increased sharply following reform and continued to grow over time. In contrast, the estimated effect is smaller and imprecise. This pattern is consistent with a forward-looking human capital investment channel. If ADN-trained nurses face relatively larger gains from advancing to NP status, policy-induced increases in the expected returns to NP practice should generate stronger training responses in areas where such nurses constitute a larger share of the workforce.

Taken together, the heterogeneity results support the interpretation that FPA affects the NP workforce primarily through changes in educational investment decisions. The stronger responses observed in MSN-intensive institutions and in counties with higher ADN shares are consistent with the model's predictions regarding substitution across training tracks and heterogeneous incentives for career advancement among RNs.

(3) Contextual Heterogeneity

Additionally, I report results on contextual heterogeneity in Appendix Figure A2. These estimates examine variation in the pipeline effects across institutions located in counties with different baseline provider densities as well as across geographic and institutional characteristics. The event-study estimates suggest somewhat earlier responses in institutions located in areas with higher NP or PCP density and in urban areas, although the long-run magnitudes are broadly

similar across groups (Panels A to C). This pattern is consistent with the possibility that institutions in more developed healthcare markets adjust more quickly to changes in expected returns to NP training, while institutions in other areas gradually converge over time. I find little systematic difference in the long-run effects between private and public institutions (Panel D). Overall, these patterns suggest that the main pipeline effects are not confined to particular types of institutions or locations but instead reflect a broad-based response in NP-related training.

3. Robustness

(1) Placebo and Triple Differences

Because FPA was adopted during a period of broader health system reforms—including Medicaid expansions and insurance coverage changes—a concern is that contemporaneous demand shocks to healthcare education may confound the estimates (Dillender 2022). However, Dillender, Friedson, et al. (2019) find no effects of Medicaid expansions on overall health degree completions or on subcategories such as nursing. To further address this concern, I conduct placebo tests using advanced non-nursing health degree completions from the same institutions. State-level health reforms other than FPA would plausibly affect demand for nursing and non-nursing health training similarly, whereas FPA directly affects only NP-related training.

Figure 5, Panel A shows no detectable change in advanced non-nursing health degree completions following FPA adoption. In the same institutions, advanced nursing degree completions increased substantially. I also find no meaningful changes in medical degree completions (Appendix Figure A3), suggesting no evidence of substitution between medical education and advanced nursing education.

I further estimate triple-difference specifications that compare nursing and non-nursing health programs within institutions. The outcomes is the within-institution log difference between nursing and non-nursing advanced health degree completions. This approach differences out institution-year and state-year shocks that broadly affect demand for health education. As shown in Figure 5, Panel B, the triple differences estimate (0.129 log points) are somewhat smaller than the baseline difference-in-differences estimate (0.198 log points), but the two are not statistically different, and the dynamic patter closely mirrors the main results. These

findings reinforce the interpretation that the pipeline response is specific to NP training rather than reflecting broader shocks to healthcare education demand.

(2) Alternative Staggered Adoption Methods

I assess robustness of my key findings to alternative staggered adoption estimators. Figure 6 compares the baseline Callaway and Sant'anna (2021) estimates with covariates to four alternatives: Callaway and Sant'anna estimates without balancing covariates, Borusyak, Jaravel, and Speiss (2024) imputation-based estimates, stacked difference-in-differences estimates (Wing, et al. 2024), and TWFE OLS estimates.

Across specifications, the dynamic pattern is similar. The overall effect estimates based on alternative methods range from 8 to 10 percent, which are somewhat smaller than the baseline specification that balances pre-treatment characteristics. Because these alternative estimators do not incorporate time-invariant covariates, the baseline specification may better account for pre-treatment institutional differences between treated and never-treated states. These covariates capture persistent institutional differences in program capacity, resources, and demand conditions that may influence graduate nursing degree production.

I also find similar results when using not-yet-treated states as controls instead of never-treated states (Appendix Figure A4). Overall, the main findings are robust to the choice of staggered adoption estimator.

4. Extensive-Margin Changes and Aggregation Effects

The preceding analysis focuses on intensive-margin responses by restricting attention to institutions that awarded at least one advanced nursing degree in every year of the sample period. This design isolates changes within continuing programs. However, FPA could also affect the extensive margin by inducing entry or exit of graduate nursing programs (Gruber, et al. 2026). To examine this possibility, I estimate an analogous staggered adoption model at the state-year level, where the outcome is the number of institutions awarding at least one advanced nursing degree.

I find no evidence that FPA increases program entry. If anything, treated states experienced a relative decline in the number of institutions granting advanced nursing degrees following reform (Figure 7). Importantly, this pattern is not specific to nursing programs: similar

extensive-margin changes are observed for advanced non-nursing health programs, for which I find no intensive-margin effects (Figure 5, Panel A). Decomposition shows that the relative change reflects differential program entry across states rather than closures of existing programs in treated states (Appendix Figure A5).

These results suggest that the primary pipeline effects operate within continuing programs rather than through program entry or exit. The absence of extensive-margin expansion is consistent with institutional frictions in graduate nursing education. Faculty shortages, accreditation requirements, and clinical placement constraints likely limit the speed at which new programs can open or existing programs can expand capacity.

The extensive margin also has implications for interpretation of aggregate outcomes. Figure 8 shows that, at the state and county levels, there is no detectable association between FPA and total advanced nursing degree completions. While completions increase within continuing programs in treated states, differential program entry across states offsets these gains in aggregate measures. This compositional masking provides a potential explanation for prior studies using county- or state-level data that report limited changes in NP workforce stock following SOP reforms (Kandrack, Barnes and Martsolf 2021, Dillender, Sasso, et al. 2024). These results highlight the importance of using institution-level data to detect pipeline responses that may be obscured in aggregated state- or county-level analyses.

5. Implications for NP Workforce Stock

The intensive-margin pipeline effects imply a gradual increase in the supply of NPs. Because workforce stock adjusts slowly, pipeline responses may take years to translate into observable changes in NP supply. To assess the quantitative implications, I consider a simple accounting framework in which NP workforce stock evolves through entry and attrition.

Let C_t denote NP graduates, θ the rate at which NP graduates obtain licensure and enter practice, and δ the annual exit rate from the profession. The NP stock evolves as:

$$NP_{t+1} = (1 - \delta)NP_t + \theta C_t.$$

Consider a permanent increase in NP graduates induced by FPA. My baseline estimate τ reflects the proportional increase in advanced nursing degree completions after reform. Under the assumption that non-NP advanced nursing programs are unaffected by FPA, the estimated

increase in advanced nursing completions maps one-for-one into an increase in NP graduates of τA_0, where A_0 denotes baseline advanced nursing degree completions. The implied annual increase in new NP entrants after reform therefore equals $\theta\tau A_0$.

Under this framework, the cumulative effect on NP stock over l years is

$$\Delta NP_l = \theta\tau A_0 \sum_{j=0}^{l-1} (1-\delta)^j.$$

To calibrate magnitudes, I use conservative parameter values based on certification and workforce data: 80-90% of NP graduates obtain licensure and enter practice (AANPCB 2025, ANCC 2025) and annual attrition ranges from 1-2%. Using the 2018 national counts of advanced nursing degree completions (55,737) as baseline completions A_0, and NP stock estimates from the Area Health Resources File (257,504) and the American Community Survey (183,482) as baseline stock NP_0, an 18 percent increase in annual completions implies a 29 to 47 percent increase in NP stock over a ten-year horizon, depending on parameter assumptions.

These calculations are mechanical and intended to provide order-of-magnitude guidance rather than structural forecasts. Because workforce accumulation is gradual and attrition offsets new entry in the short run, contemporaneous changes in NP stock may appear modest even when pipeline responses are substantial. This dynamic helps reconcile prior evidence of increased NP earnings and demand with limited short-run change in observed NP workforce stock.

6. Spillovers to the RN Pipeline

Given the positive effects on graduate nursing completions, a natural question is whether FPA also affects earlier stages of the nursing education pipeline. I therefor examine whether FPA reforms generate spillovers to the RN training pipeline. For prospective undergraduate students, FPA may raise expected lifetime earnings from nursing by increasing the option value of pursuing NP training later in their careers. However, the magnitude of this spillover is likely smaller than the direct NP pipeline effect. NPs constitute roughly one-tenth of the RN workforce, implying that the option value channel affects only a small subset of nursing entrants. At the same time, undergraduate and graduate nursing programs may share instructional inputs such as faculty and clinical placements, creating complementarities that could amplify the response.

Figure 9, Panel A shows no statistically significant change in undergraduate nursing degree completions (associate's or bachelor's degree) following FPA adoption. Event-study estimates show a small uptick in the year of reform and another increase around event year 6, although these estimates are not statistically significant. Panel B focuses on institutions that offer both undergraduate and graduate nursing programs. In this subsample, undergraduate completions gradually increase following reform, particularly from event year 4 onward. The trajectory resembles that of graduate completions and becomes statistically distinguishable from zero by event year 8.

This pattern suggests that these institutions offering both undergraduate and graduate programs may expand undergraduate enrollments alongside graduate enrollments as they increase capacity for NP-related programs. However, the magnitude of these spillover effects remains substantially smaller than the direct effects on advanced nursing degree completions.

Taken together, the evidence suggests modest and delayed spillovers from FPA to RN training. While option value or complementarities in degree production may increase entry into undergraduate nursing programs, the primary labor supply response appears to operate through the graduate NP pipeline, where the effects are larger and emerge earlier.

VI. Conclusion

In this paper, I provide theoretical and empirical evidence on how changes in occupational autonomy shape forward-looking human capital investment. Using scope-of-practice expansions that grant nurse practitioners full practice authority, I document an 18 percent increase in advanced nursing degree completions following reform. I also find substitution toward shorter NP training pathways: master's degree completions increase while doctoral degree completions decline after reform. Consistent with stronger incentives for NP training among RNs with associate degrees relative to those with bachelor's degrees, the pipeline response is stronger in areas with a higher share of associate-degree nursing programs. These findings are consistent with a forward-looking human capital model of educational investment. An increase in expected post-training earnings raises the incentive to enroll in and complete graduate nursing programs. Moreover, when the earnings premium associated with longer training is not sufficiently large relative to its additional costs, individuals substitute from doctoral to master's programs. More broadly, the results illustrate how regulatory changes that

expand occupational autonomy can influence not only the allocation of existing workers but also the timing and composition of human capital investment in regulated professions.

The paper also reconciles the positive pipeline effect with prior studies that find limited changes in NP stock using county- or state-level aggregate data (Kandrack, Barnes and Martsolf 2021, Dillender, Sasso, et al. 2024). While degree completions increase within continuing programs in treated states, differential program entry across states offsets these gains in aggregate measures. In addition, workforce accumulation occurs gradually and is subject to attrition, making stock measures less responsive to pipeline responses in the short to medium run. As a result, aggregate analyses may mask forward-looking supply responses to regulatory reform.

From the perspective of healthcare workforce policy, the findings imply a substantial long-run increase in NP supply following full practice reforms. Using a simple accounting framework for NP stock evolution, I estimate that the observed increase in degree completions translates into a 29 to 47 percent cumulative increase in NP stock over ten years after reform. More broadly, SOP expansions affect access to medical care through two channels: an immediate channel, by expanding the scope of services that existing NPs can provide independently, and a dynamic channel, by increasing entry into the profession through the education pipeline. The results underscore the importance of this dynamic entry channel and suggest that evaluations based solely on contemporaneous workforce or utilization effects may understate the long-run impact of regulatory reform.

Several limitations merit consideration. First, I approximate NP training using master's and doctoral nursing degree completions in IPEDS rather than directly observing NP-specific graduates. Second, I do not directly examine changes in newly licensed NPs due to the absence of cohort-level licensure data linked to institutions. Third, the analysis does not account for interstate mobility of NPs, which may weaken incentives to pursue NP training in FPA states. These limitations are more likely to bias estimates toward zero than to exaggerate them. Further research using detailed licensure and mobility data could further clarify the long-run workforce implications of scope-of-practice reforms.

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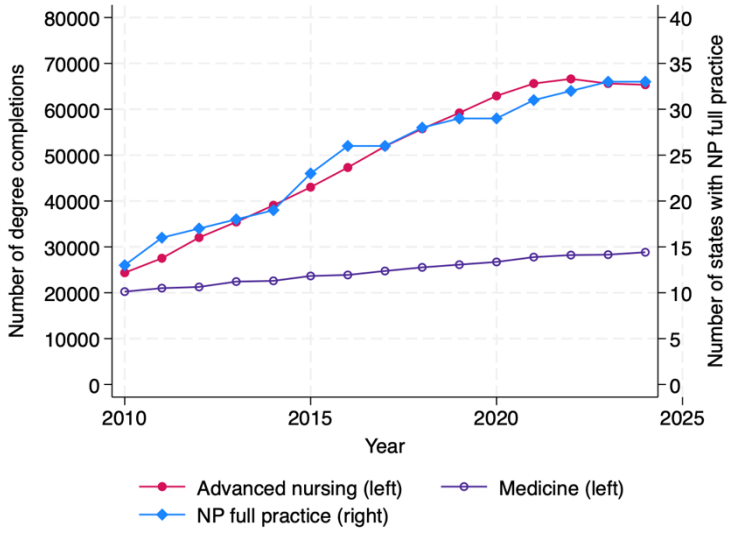
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Exhibits

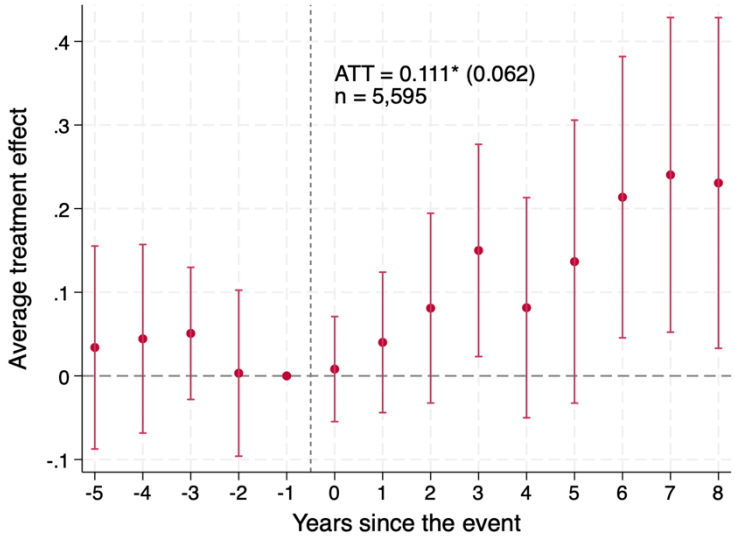
Figure 1. Trends in FPA and Number of Advanced Nursing Degree Completions



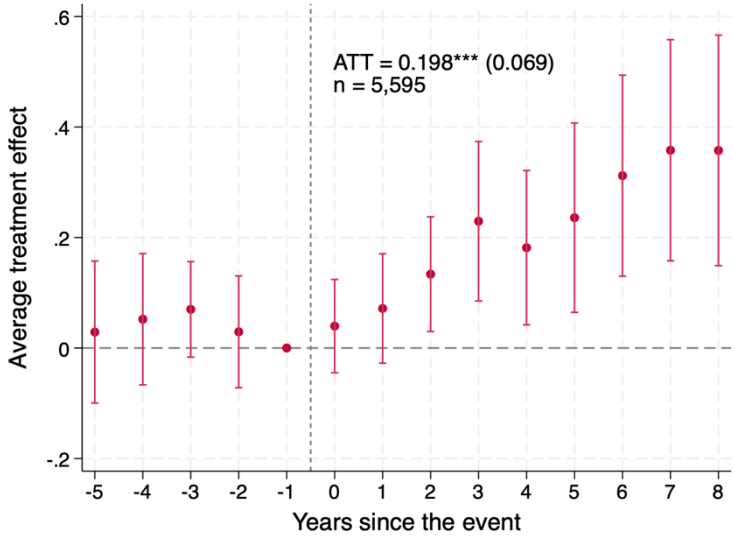
Notes: Red dots (filled) show the number of students receiving an advanced nursing degree (master's or doctoral degree in nursing) from institutions in 50 U.S. states and the District of Columbia (DC) based on the Integrated Postsecondary Education Data System (IPEDS) 2010-2024, and purple dots (hollow) present the number of students receiving a medicine degree (medical or osteopathic doctor). Blue diamonds show the number of states (counting the District of Columbia as a state) that grant FPA to nurse practitioners based on the classification by McMichael and Markowitz (2023).

Figure 2. Effects of FPA on Advanced Nursing Degree Completions

A. Without Covariates

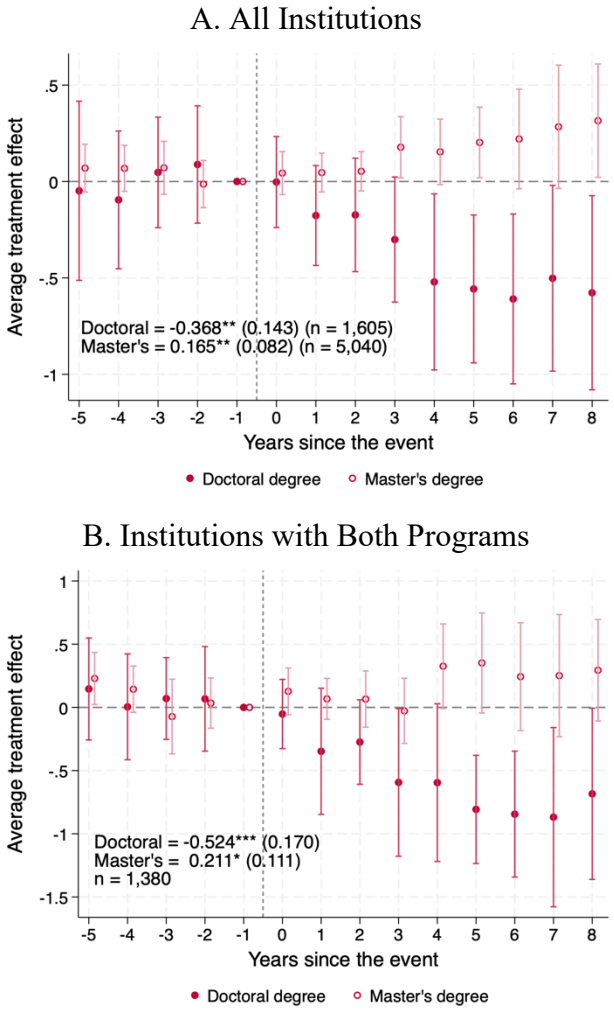


B. With Covariates



Notes: The figure presents event-study point estimates of the effect of FPA and their 95% confidence intervals based on the Callaway and Sant'anna (2021) method with institution and year fixed effects and standard errors clustered by states. The outcome is the logarithm of advance nursing degree completions. The sample is 5,595 institution-year observations on 373 institutions in 38 states that granted at least one advanced nursing degree every year in the IPEDS 2010-2024. Panel B estimates account for potential influence of pre-treatment covariates on the propensity of treatment or post-treatment outcomes. The covariates include indicators for private institutions and for institutions in urban area, NP density, and ADN share in the institution's county. See the text for variable definitions.

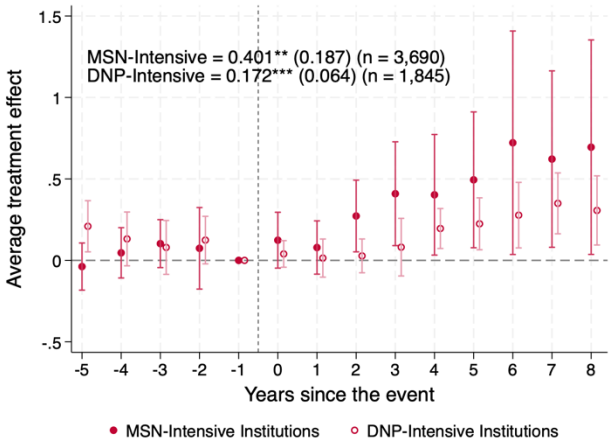
Figure 3. Substitution between Master's and Doctoral Nursing Programs



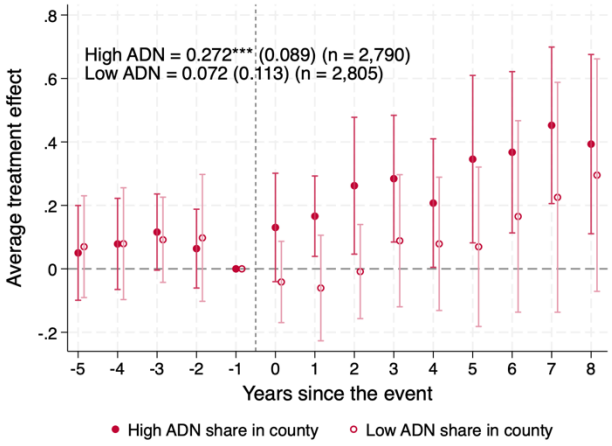
Notes: The figure presents event-study point estimates of the effect of FPA and their 95% confidence intervals based on the Callaway and Sant'anna (2021) method with institution and year fixed effects and standard errors clustered by states. In both panels, the outcome is the logarithm of doctoral nursing degree completions for estimates presented with filled dots and the logarithm of master's nursing degree completions for estimates shown with hollow dots. The sample for estimates of filled dots in Panel A is 1,605 institution-year panel observations that granted at least one doctoral nursing every year. The sample for estimates of hollow dots in Panel A is 5,040 institution-year panel observations that granted at least one master's nursing degree every year in the IPEDS 2010-2024. The sample for both sets of estimates in Panel B is 1,380 institution-year panel observations that granted at least one master's nursing degree and one doctoral nursing every year. All estimates are obtained from the Callaway and Sant'anna (2021) method after accounting for potential influence of pre-treatment covariates on the propensity of treatment or post-treatment outcomes. The covariates include indicators for private institutions and for institutions in urban area, NP density, and ADN share in the institution's county. See the text for variable definitions.

Figure 4. Mechanism-Driven Heterogeneity

A. MSN- vs DNP-Intensive Institutions

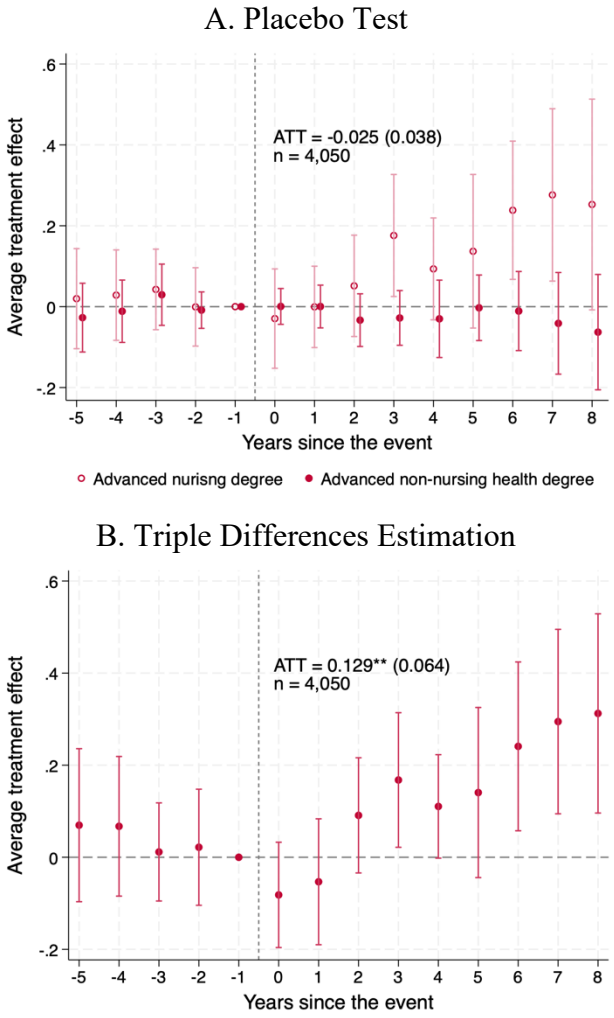


B. High vs Low ADN-Share Counties



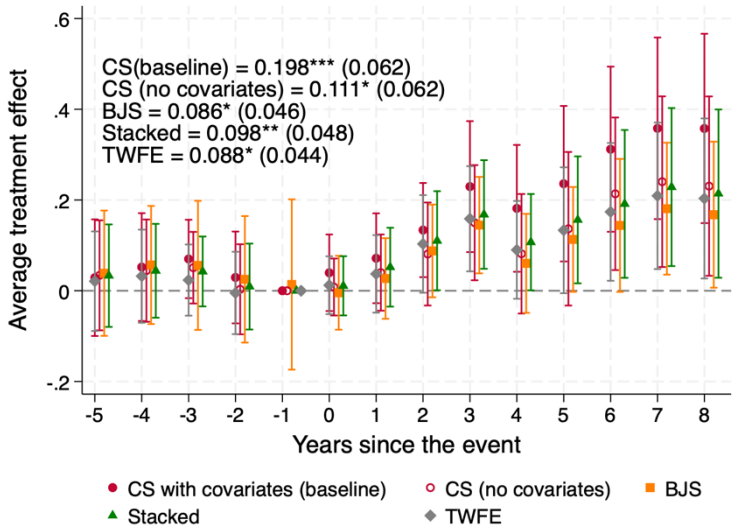
Notes: The figure presents event-study point estimates of the effect of FPA and their 95% confidence intervals based on the Callaway and Sant'anna (2021) method with institution and year fixed effects and standard errors clustered by states. In both panels, the outcome is the logarithm of advanced nursing degree completions. The full sample is 5,595 institution-year observations on 373 institutions in 38 states that granted at least one advanced nursing degree every year in the IPEDS 2010-2024. Panel A estimations use a subsample of institutions that did not award any doctoral nursing degree in 2010 ("MSN-intensive institutions") and another subsample of institutions that awarded at least one doctoral nursing degree in 2010 ("DNP-intensive institutions"). Panel B estimations use a subsample of institutions in counties whose ADN share is above the median ("High ADN share in county") and another subsample of institutions in counties whose ADN share is the same to or below the median ("Low ADN share in county"). All estimates are obtained from the Callaway and Sant'anna (2021) method after accounting for potential influence of pre-treatment covariates on the propensity of treatment or post-treatment outcomes. The covariates include indicators for private institutions and for institutions in urban area, NP density, and ADN share in the institution's county. See the text for variable definitions.

Figure 5. Robustness Results with Advanced Non-Nursing Health Programs



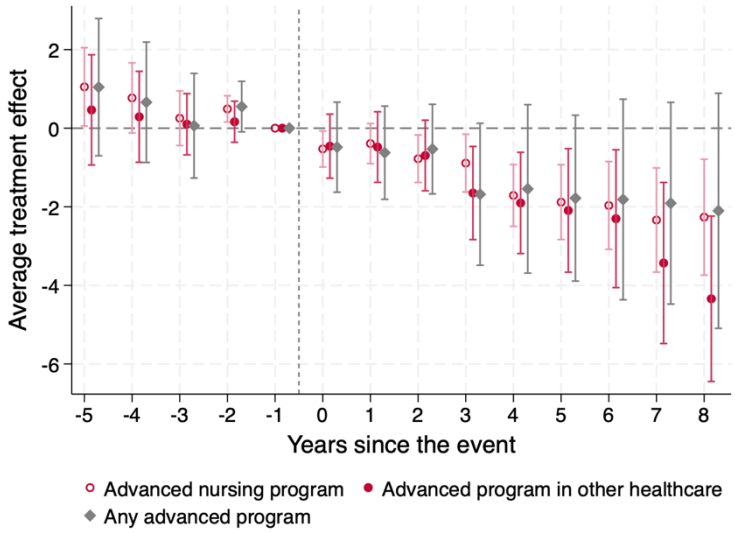
Notes: The figure presents event-study point estimates of the effect of FPA and their 95% confidence intervals based on the Callaway and Sant'anna (2021) method with institution and year fixed effects and standard errors clustered by states. The sample is 4,050 institution-year panel observations that granted at least one advanced nursing degree and one advanced degree in non-nursing healthcare programs (CIP 51.0000 to 51.9999 except nursing and medicine programs) every year in the IPEDS 2010-2024. The outcome is the logarithmic number of students receiving an advance nursing degree for estimates of hollow dots and the logarithmic number of students receiving an advanced degree in non-nursing health programs for estimates of filled dots in Panel A. In Panel B, the outcome is the log difference between the number of students receiving an advanced nursing degree and the number of students receiving an advanced non-nursing health degree. All estimates are obtained from the Callaway and Sant'anna (2021) method after accounting for potential influence of pre-treatment covariates on the propensity of treatment or post-treatment outcomes. The covariates include indicators for private institutions and for institutions in urban area, NP density, and ADN share in the institution's county. See the text for variable definitions.

Figure 6. Robustness to Alternative Staggered Adoption Methods



Notes: The figure presents event-study point estimates of the effect of FPA and their 95% confidence intervals based on various staggered adoption methods and standard errors clustered by states. The outcome is the logarithmic number of students receiving an advance nursing degree. The sample is 5,595 institution-year observations on 373 institutions in 38 states that granted at least one advanced nursing degree every year in the IPEDS 2010-2024. Baseline estimates (filled red dots) are obtained from the Callaway and Sant'anna (2021) method after accounting for potential influence of pre-treatment covariates on the propensity of treatment or post-treatment outcomes. The covariates include indicators for private institutions and for institutions in urban area, NP density, and ADN share in the institution's county. See the text for variable definitions. Estimates in hollow red dots (labeled as CS) are obtained from the Callaway and Sant'anna (2021) method without using covariates, those in orange squares (BJS) are obtained from the imputation-based method proposed by Borusyak, Jaravel, and Speiss (2024), those in green triangles (Stacked) are obtained from a stacked estimation method suggested by Wing et al. (2024), and those in gray diamonds (TWFE OLS) are obtained from the conventional OLS event-study method. The stacked estimation includes cohort-institution and cohort-year fixed effects, and all other estimations includes institution and year fixed effects. The four sets of alternative estimates do not account for pre-treatment covariates because they are time-invariant characteristics within institutions.

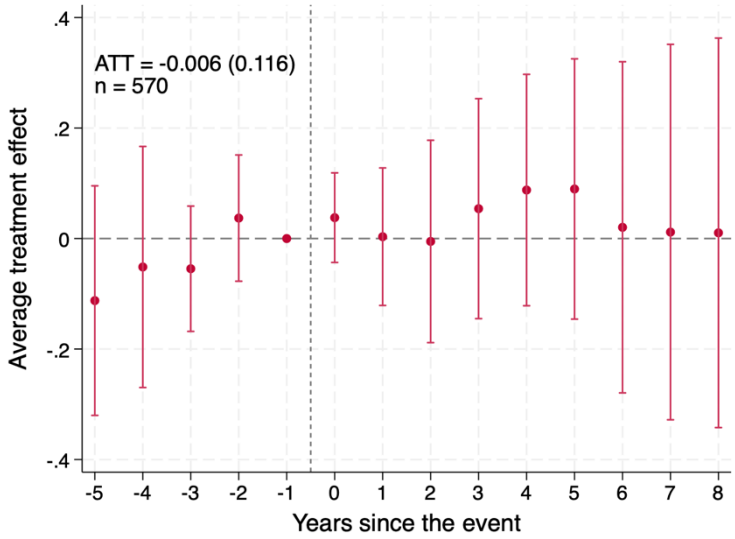
Figure 7. Association between FPA and the Number of Institutions with Advanced Nursing Degree Programs



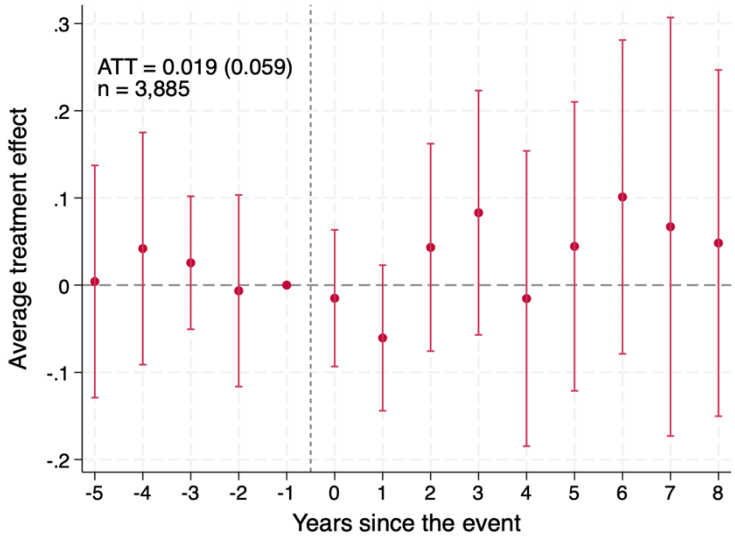
Notes: The figure presents event-study point estimates of the effect of FPA and their 95% confidence intervals based on the Callaway and Sant'anna (2021) method with state and year fixed effects and standard errors clustered by states. The outcome is the number of schools with advanced degree programs of three types: advanced nursing degree programs for estimates in hollow circle, the number of schools with advanced degree programs in non-nursing health programs for estimates in solid circle, and the number of schools with any advanced degree programs for estimates in gray diamonds. The sample is 570 state-year panel observations aggregated from the IPEDS 2010-2024.

Figure 8. Association between FPA and County- or State-Level Aggregates

A. State-Level Analysis



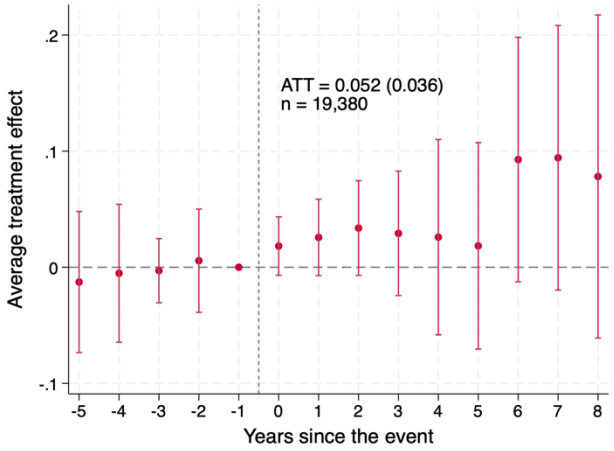
B. County-Level Analysis



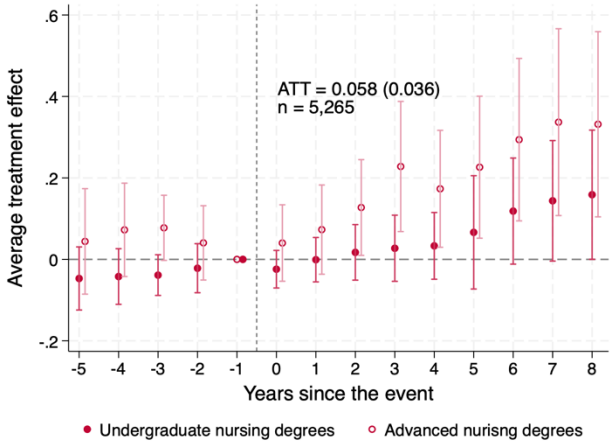
Notes: The figure presents event-study point estimates of the effect of FPA and their 95% confidence intervals based on the Callaway and Sant'anna (2021) method and standard errors clustered by states. For the Panel A analysis with state and year fixed effects, the outcome is the number of advanced nursing degree completions in a state-year, and the sample is 570 state-year panel observations aggregated from the IPEDS 2010-2024. For the Panel B analysis with county and year fixed effects, the outcome is the number of advanced nursing degree completions in a county-year, and the sample is 3,885 county-year panel observations. The county-year panel includes observations on 259 counties that have at least one advanced nursing graduate every year. Connecticut is excluded from the county-level analysis due to changes in county codes between 2021 and 2022.

Figure 9. Spillover Effects on RN Pipelines

A. All Institutions



B. Institutions with Both Undergraduate and Graduate Nursing Programs



Notes: The figure presents event-study point estimates of the effect of FPA and their 95% confidence intervals based on the Callaway and Sant'anna (2021) method with institution and year fixed effects and standard errors clustered by states. The outcome for estimates of filled dots is the logarithmic number of students receiving an bachelor's nursing degrees, and the outcome for estimates of hollow dots is the number hat of students receiving an advanced nursing degree (only in Panel B). The sample for Panel A estimation is 19,380 institution-year panel observations that granted at least one undergraduate nursing degree (either associate's or bachelor's degree) every year in the IPEDS 2010-2024. The sample for Panel B estimation is 5,265 institution-year panel observations that granted at least one undergraduate degree and one advanced nursing degree every year. All estimates are obtained from the Callaway and Sant'anna (2021) method after accounting for potential influence of pre-treatment covariates on the propensity of treatment or post-treatment outcomes. The covariates include indicators for private institutions and for institutions in urban area, NP density, and ADN share in the institution's county. See the text for variable definitions.

Table 1. List of 20 States with NP SOP Expansions in 2010-2023

State	Year and Month
Colorado	July 2010
Maryland	October 2010
Vermont	June 2011
North Dakota	October 2011
Rhode Island	June 2013
Nevada	July 2013
Connecticut	July 2014
Minnesota	January 2015
New York	January 2015
Nebraska	March 2015
Delaware	September 2015
Utah	May 2016
West Virginia	June 2016
South Dakota	July 2017
Virginia	April 2018
Illinois	June 2019
Florida	July 2020
Massachusetts	January 2021
Arkansas	July 2021
California	January 2023

Source: McMichael and Markowitz (2023).

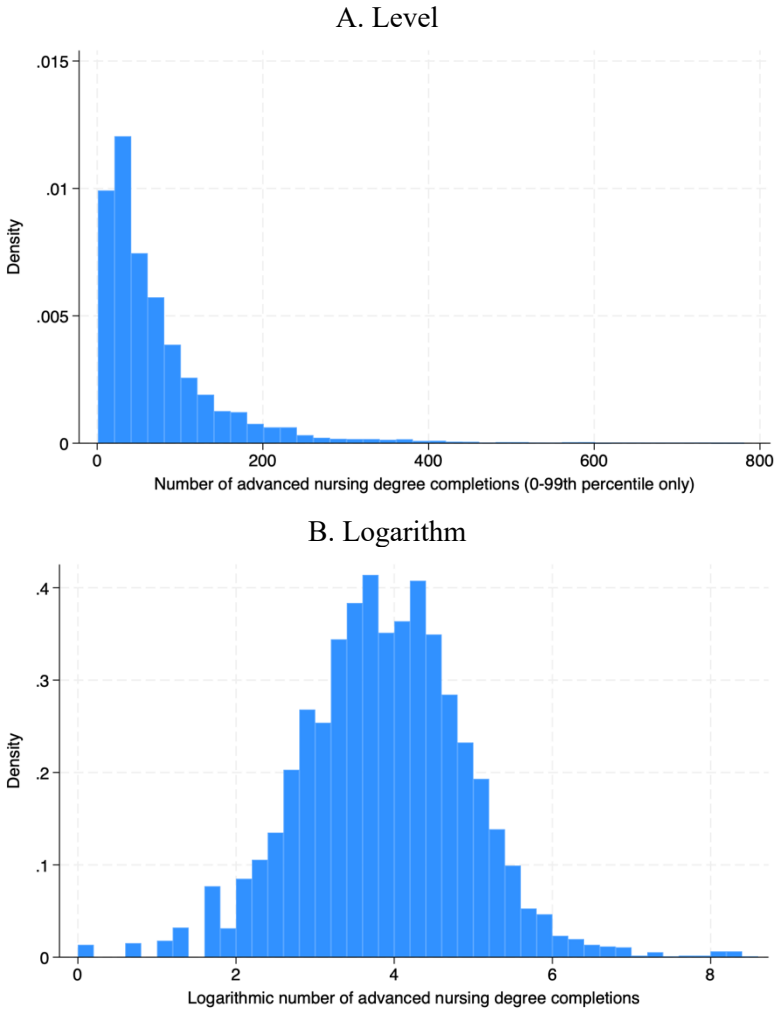
Table 2. Descriptive Statistics

Variable	(1) All	(2) Treated states	(3) Never-treated states
A. Covariates as of 2010			
Private	0.46	0.51	0.42
Urban location	0.62	0.65	0.60
ADN share in county	0.34	0.38	0.31
	(0.25)	(0.24)	(0.25)
NP density in county	52	57	48
	(34)	(40)	(26)
Observations (institutions)	373	173	200
B. Outcomes in 2010-2024			
Advanced nursing degree completions	91	105	80
	(232)	(313)	(123)
Master's degree completions	77	90	66
	(222)	(302)	(112)
Doctoral degree completions	14	15	13
	(25)	(28)	(22)
Observations (institution-year)	5,595	2,595	3,000

Notes: Unweighted means. Standard deviations are in parentheses. The sample is an institution-year panel of 373 institutions in 38 states that granted at least one advanced nursing degree every year in the IPEDS 2010-2024. The sample does not include institutions in 12 states and the District of Columbia that had adopted FPA prior to the sample period. ADN share in county is the share of associate degree in nursing (ADN) completions among undergraduate nursing completions in an institution's county in 2010, a proxy for baseline intensity of NP training demand. NP density in county means the number of NPs per 100,000 residents in the institution's county in 2010. All variables except NP density are obtained from the IPEDS. NP density is obtained from the AHRF.

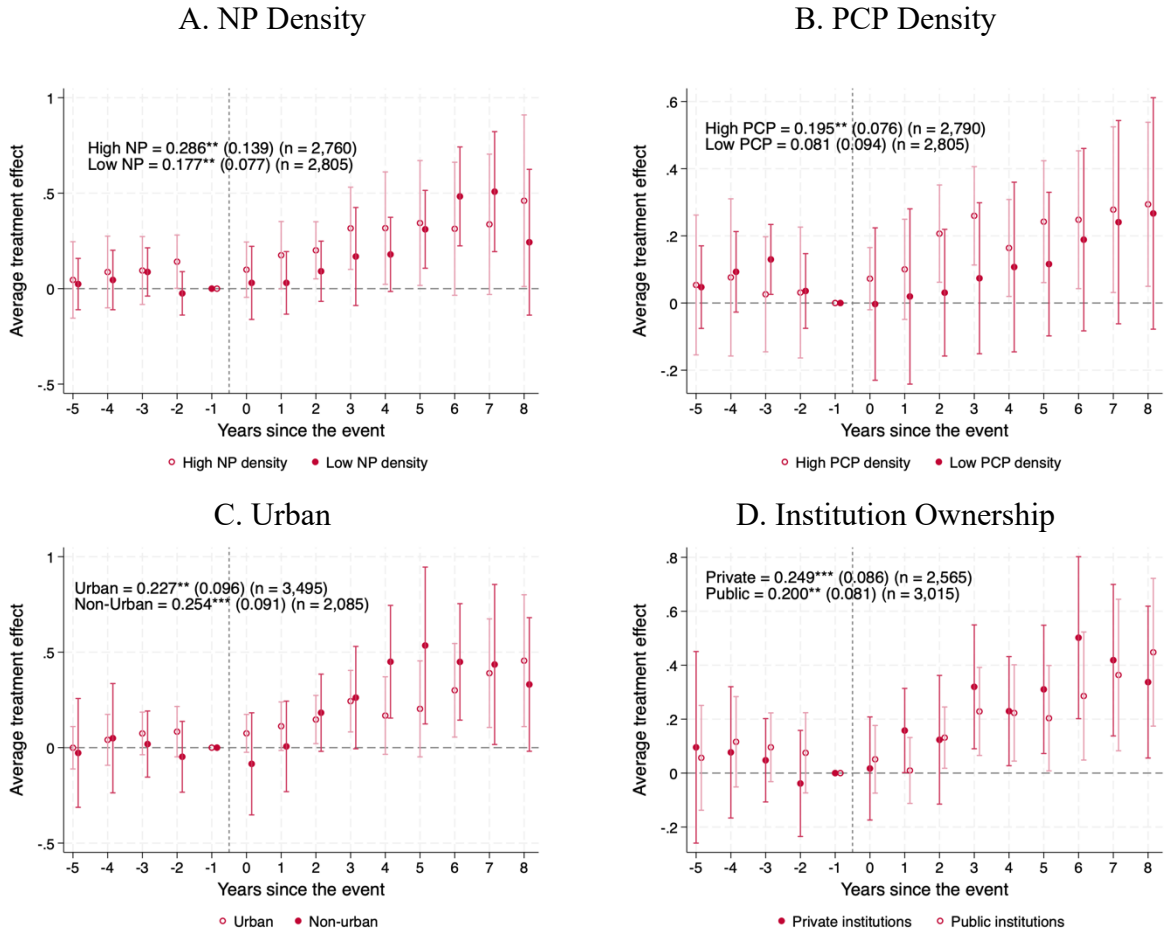
Appendix A. Additional Exhibits

Figure A1. Distribution of the Number of Advanced Nursing Degree Completions



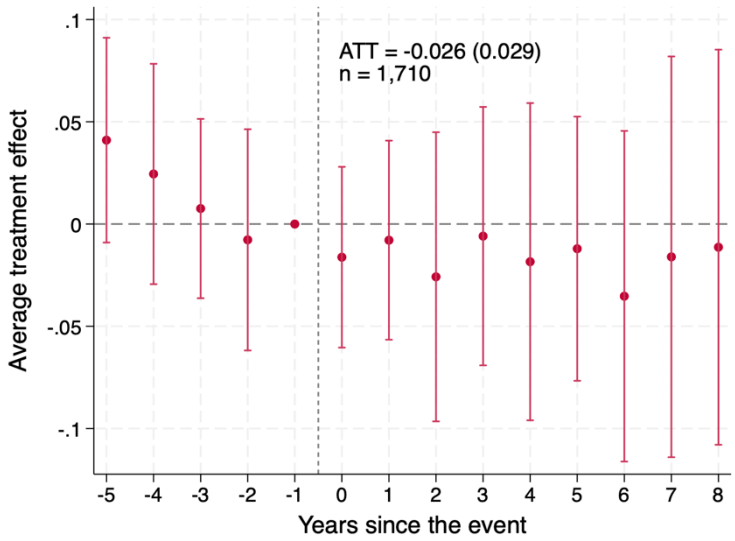
Notes: Panel A shows a histogram on the number of advanced nursing degree completions, while panel B shows a histogram on the logarithmic number of advanced nursing degree completions. The x-axis of Panel A is restricted up to the 99th percentile value in the sample. The sample is 5,595 institution-year observations for 373 institutions in 38 states that granted at least one advanced nursing degree every year in the IPEDS 2010-2024.

Figure A2. Contextual Heterogeneity



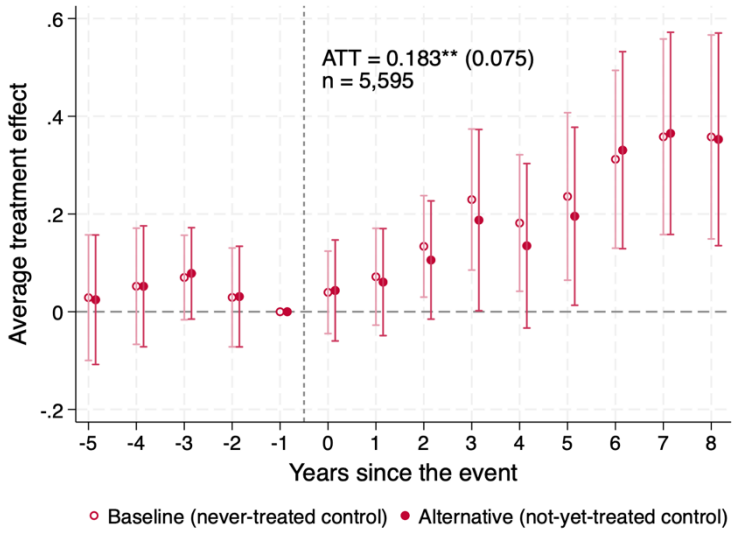
Notes: The figure presents event-study point estimates of the effect of FPA and their 95% confidence intervals based on the Callaway and Sant'anna (2021) method with institution and year fixed effects and standard errors clustered by states. The outcome is the logarithm of advanced nursing degree completions. The full sample is 5,595 institution-year observations on 373 institutions in 38 states that granted at least one advanced nursing degree every year in the IPEDS 2010-2024. Each panel uses two subsamples divided by the median NP density, the median PCP density, and indicators for institutions in urban area and for private institutions. All estimates are obtained from the Callaway and Sant'anna (2021) method after accounting for potential influence of pre-treatment covariates on the propensity of treatment or post-treatment outcomes. The covariates include indicators for private institutions and for institutions in urban area, NP density, and ADN share in the institution's county. See the text for variable definitions.

Figure A3. Effects on Medicine Degree Completions



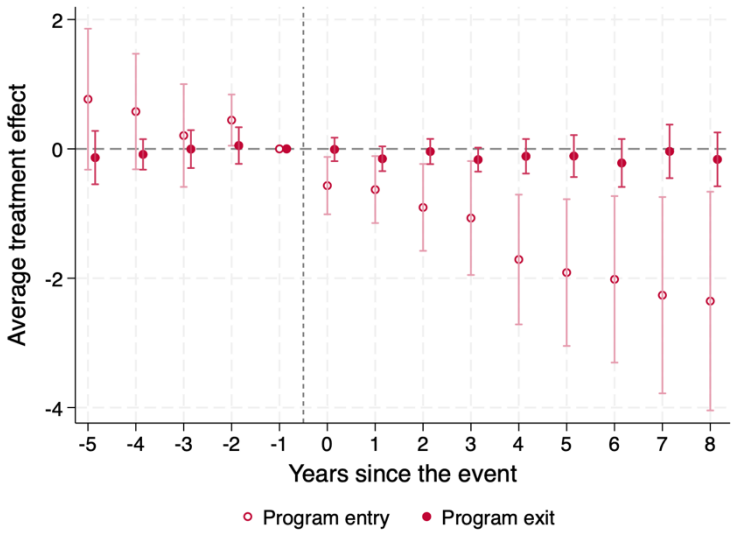
Notes: The figure presents event-study point estimates of the effect of FPA and their 95% confidence intervals based on the Callaway and Sant'anna (2021) method with institution and year fixed effects and standard errors clustered by states. The outcome is the logarithmic number of students receiving an advance nursing degree for estimates presented with hollow dots, that of students receiving a medicine degree for estimates shown with filled dots. The sample is 1,710 institution-year panel observations that granted at least one advanced nursing degree and one medicine degree (CIP 51.1201, 51.1202) every year in the IPEDS 2010-2024. All estimates are obtained from the Callaway and Sant'anna (2021) method after accounting for potential influence of pre-treatment covariates on the propensity of treatment or post-treatment outcomes. The covariates include indicators for private institutions and for institutions in urban area, NP density, and ADN share in the institution's county. See the text for variable definitions.

Figure A4. Robustness: Not-Yet-Treated Control



Notes: The figure presents event-study point estimates of the effect of FPA and their 95% confidence intervals based on the Callaway and Sant'anna (2021) method with institution and year fixed effects and standard errors clustered by states. The outcome is the logarithmic number of students receiving an advance nursing degree. The sample is 5,595 institution-year observations on 373 institutions in 38 states that granted at least one advanced nursing degree every year in the IPEDS 2010-2024. Baseline estimates (hollow dots) are obtained from a model using institutions in never-treated states as the control group for those in treated states, while alternative estimates (filled dots) are from an alternative model using institutions in not-yet-treated states as the control group. All estimates are obtained from the Callaway and Sant'anna (2021) method after accounting for potential influence of pre-treatment covariates on the propensity of treatment or post-treatment outcomes. The covariates include indicators for private institutions and for institutions in urban area, NP density, and ADN share in the institution's county. See the text for variable definitions.

Figure A5. Association between FPA and Program Entry and Exit



Notes: The figure presents event-study point estimates of the effect of FPA and their 95% confidence intervals based on the Callaway and Sant'anna (2021) method with state and year fixed effects and standard errors clustered by states. For estimates in filled dots, the outcome is the number of schools with at least one advanced nursing degree program graduate in a year that did not have any graduate in 2010 (proxying "new program openings since 2010"). For estimates in hollow dots, the outcome is the number of schools without any advanced nursing degree program graduate in a year that had at least one graduate in 2010 (approximating "program closures since 2010"). The sample is 570 state-year panel observations aggregated from the IPEDS 2010-2024.

Appendix B. Proofs of Propositions 1 and 2

Proposition 1 (Enrollment and Completion Effects)

If SOP expansion weakly increases expected post-training earnings in the MSN and DNP tracks and leave training costs fixed, then: (1) The set of individuals who choose either NP track (MSN or DNP) weakly increases relative to the outside option. (2) Within each track, the completion set weakly increases (and dropout weakly decreases) at every stage τ.

Proof: For each track $k \in \{M, D\}$, $w_{k,i}(s') \geq w_{k,i}(s)$ because SOP expansion weakly increases post-training earnings. It implies that for each track k,

$$\Delta_{k,i}(s') - \Delta_{k,i}(s) = \sum_{t=T_k}^{T_D+L-1} \beta^t \left(w_{k,i}(s') - w_{k,i}(s)\right) \geq 0.$$

Thus, the set of individuals who choose to enroll in either NP track weakly increases.

For already-enrolled students at time τ ($\in \{1, \ldots, T_k - 1\}$), let $R_i(\tau)$ denote the value from dropping out at time τ (e.g., returning immediately to the outside option):

$$R_i(\tau) = \sum_{t=\tau}^{T+L-1} \beta^{t-\tau} w_{0,i}.$$

The continuation value from completing track k under regime s is:

$$C_{k,i}(\tau; s) = \sum_{t=\tau}^{T_k-1} \beta^{t-\tau} \left(w_{e,i} - c\right) + \sum_{t=T_k}^{T_D+L-1} \beta^{t-\tau} w_{k,i}(s).$$

Let net benefits from the completion of track k relative to dropping out:

$$\Delta_{k,i}(\tau; s) = C_{k,i}(\tau; s) - R_i(\tau).$$

Then, for each track k,

$$\Delta_{k,i}(\tau; s') - \Delta_{k,i}(\tau; s) = C_{k,i}(\tau; s') - C_{k,i}(\tau; s) = \sum_{t=T_k}^{T_D+L-1} \beta^{t-\tau} \left(w_{k,i}(s') - w_{k,i}(s)\right) \geq 0.$$

Thus, the set of individuals who complete either NP track weakly increases.

Proposition 2 (Substitution toward MSN when DNP gains are not sufficiently larger)

If SOP expansion increases MSN per-period post-training earnings by g_M and DNP per-period post-training earnings by g_D, then the relative attractiveness of MSN versus DNP increases (i.e., $\Gamma_i(s') > \Gamma_i(s)$ for all i) whenever

$$g_D - g_M < g_M \frac{\sum_{t=T_M}^{T_D-1} \beta^t}{\sum_{t=T_D}^{T_D+L-1} \beta^t}.$$

Proof: Suppose the condition holds. Then,

$$\Gamma_i(s') - \Gamma_i(s) = \sum_{t=T_M}^{T_D-1} \beta^t g_M - \sum_{t=T_D}^{T_D+L-1} \beta^t \, (g_D - g_M) \geq 0.$$

Thus, new students substitute the MSN track for the DNP track. For already-enrolled students at time τ, let net benefits from the MSN track relative to those from the DNP track be:

$$\Gamma_i(\tau; s) = C_{M,i}(\tau; s) - C_{D,i}(\tau; s).$$

Then,

$$\Gamma_i(\tau; s') - \Gamma_i(\tau; s) = \sum_{t=T_M}^{T_D-1} \beta^{t-\tau} g_M - \sum_{t=T_D}^{T_D+L-1} \beta^{t-\tau} \, (g_D - g_M) \geq 0.$$

Thus, students already-enrolled in the DNP track change to the MSN track and complete a shorter NP training program.