The impact of the nurse licensure compact on labor mobility before and during the COVID-19 pandemic*

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Abstract

In the wake of the COVID-19 pandemic, 50 states introduced emergency licensing reforms for healthcare professionals, liberalizing occupational licensing requirements to permit the freer movement of nurses nationwide. Before the pandemic, the Nurse Licensure Compact (NLC) was implemented by 32 states allowing nurses to work across all its members under a single license. Similarly to pandemic-era licensing policies, the NLC was designed to increase labor market flexibility by reducing licensure-related barriers to interstate mobility. Using data from over 200,000 nurses, I find that between 2015-2019, once a nurse has worked in an NLC state, their yearly rate of interstate migration is 2.6 times that of those that have never worked in the NLC (significant at 5%). Conversely, during the pandemic years of 2020-2023, the estimate of this relationship was insignificant. Throughout the pandemic, neither liberal policy reforms nor increasing labor demand, proxied by COVID-19 cases and deaths, affected interstate mobility to states with acute need. Exploiting the NLC's staggered state-level adoption, an event study design finds no effect of the NLC on nurse labor flows. These results show that the NLC has some influence on individual mobility decisions but does not induce a large enough reduction in the cost of interstate practice to create aggregate labor supply effects. These results also suggest that licensure costs and labor demand became less important migration components during the pandemic.

JEL codes: J1, J21, J44, J61, J68
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1 Introduction

There are over 3 million Registered Nurses (RNs) and 600,000 Licensed Practical/Vocational Nurses (LP/VNs) working across the country to provide essential care to millions of patients [1]. Nurses must typically obtain separate licenses for each state they practice in. In general, applicants must have graduated from a certified program, pass the National Council Licensure Examination (NCLEX), pass a criminal background check, and pay application fees to become a licensed provider [2]. State-level occupational licensing policies grant each state the power to verify that its nurses work with a minimum level of competence by its standards, potentially boosting the quality and safety of care [2]. There is some variation in the cost of licensure via application fees, renewal fees, application processing times, educational costs, and licensing requirements. This heterogeneity can suppress labor mobility by increasing the cost of interstate work, deterring nurses from seeking jobs across state lines, even in the case of high out-of-state demand for their services. Such barriers may exacerbate labor shortages, adding unsustainable workloads to nurses in understaffed facilities, and increase burnout [3, 4]. If individuals view licensing costs as a small fraction of the inevitable price of migration, however, then such barriers may have little effect on decision-making. Furthermore, some evidence suggests that consumer safety is not improved by requiring practitioners to obtain individual licensure in every state they work in [5]. Thus, the realized benefits of state-level occupational licenses are unclear for both provider and patient.

The Nurse Licensure Compact (NLC), first implemented in January 2000 by Maryland, Texas, Utah, and Wisconsin, was designed by the National Council of State Boards of Nursing (NCSBN) to lower licensure-related barriers to interstate practice among RNs and LP/VNs. Nurses with primary residence in an NLC state can obtain a "multi-state license" allowing them to work across all member states without obtaining an additional "single-state license". As of January 2023, 36 states have fully implemented the NLC, with 56% of all employed RNs and LP/VNs working in an NLC state [1, 6]. The remaining non-NLC states oppose its implementation, citing a loss of sovereignty and earnings to the Interstate Commission of

Nurse Licensure Compact Administrators (ICNLCA), and worries about how to "effectively identify and discipline nurses" who pose a threat to patient safety and could exploit the NLC by moving around quickly to evade consequences [7, 8]. Additionally, some unions fear a loss of bargaining power if healthcare facilities replace striking nurses with out-of-state NLC nurses [9, 10]. This article examines the efficacy of the NLC in achieving its purpose of increased interstate mobility and finds it caused a sizable gain in the monthly migration rate from 0.03% to 0.32% between 2015 and 2023, equivalent to the yearly migration rate increasing from 0.36% to 3.84% (significant at 5%), but had no aggregate effect on state-level nurse labor flows.

Low labor mobility can translate into the inelasticity of national nurse supply to market shocks [11]. For example, during public health emergencies, stringent licensing requirements may delay or discourage nurses from migrating to work in sites of acute need. The cost of such nursing shortages can be millions of lives. During the most recent national public health emergency, the COVID-19 pandemic, 50 states introduced temporary licensing reforms for healthcare professionals. These reforms were a liberalization of existing licensure policy, created to allow out-of-state nurses to more easily provide their services via temporary or permanent migration. The variation in the occupational licensing infrastructure that existed before or was implemented alongside the temporary pandemic-era licensing reforms may have influenced the extent of these policies' effect. For example, if pandemic-era policies provide a similar reduction in licensing barriers as joining the NLC, then becoming a compact member during the pandemic may have had muted mobility effects. Additionally, if mobility decisions during the pandemic were dictated by non-market factors, such as individual health priorities or proximity to family, then licensing reforms may have played a minor role in labor market flexibility. This study finds that the adoption of the multi-state license through the implementation of the NLC did not better equip its member states to respond to the national labor market shock of the COVID-19 pandemic. A pre-pandemic analysis suggests that once a nurse has worked in a NLC state, their rate of interstate migration is 2.6 times

that of those outside of the NLC at either the monthly or yearly level (significant at 5%), whilst the pandemic-era estimate of this relationship is insignificant. This implies that non-licensure-related factors became more important to mobility decisions during the pandemic. Additionally, this study concludes that pandemic-era licensing policies had no detectable effect on the individual likelihood of interstate mobility irrespective of compact membership.

The staggered adoption of the NLC creates a natural experiment, lending itself to quasi-experimental difference-in-difference (DiD) estimation or event study analysis. The effects of the NLC have only been estimated in three studies, all utilizing at least one of the aforementioned methods. More broadly, literature on the effects of occupational licensing on interstate migration is sparse, with much of the evidence built upon the works of Kleiner [12]. There is some evidence for a causal link between more restrictive licensing policies and dampened mobility rates [13, 14]. Kleiner et al. 1982 report an inverse relationship between the extent of licensure reciprocity and migration across 14 professions, with a caveat of lower wages [13]. Similarly, Johnson and Kleiner use migration data from over 20 professions to find occupational licensing has played a small but statistically significant role in the decline in interstate migration rates in past decades [15].

The most expansive analysis of the NLC is DePasquale and Stange's 2016 working paper using the 2001-2012 American Community Survey [16]. The authors employ a triple difference estimator with non-nurse healthcare workers as an added comparison group as they ought not to be directly affected by the NLC's implementation. This method accounts for the potential bias in difference-in-difference estimates if other policy and labor market shocks coincide with NLC adoption. They find no effect on interstate migration, commuting, labor force participation, employment, hours worked, or relative wage income. Similarly, Ghani 2019 presents a positive DiD estimate on state-level healthcare sector job-to-job flows [17]. Shakya et al. 2022 use a linear probability DiD model to find that working in a NLC state increases the probability of a nurse moving to another NLC state, moving within a NLC state, and moving across states irrespective of NLC status [18].

All previous studies ask if the adoption of the NLC affects mobility across years. For analysis at the level of the individual, DePasquale and Stange define nurses as treated if their state of residence was an NLC member in the prior year [16]. Shakya et al. 2022 modify this definition by replacing the state of residence with the state of a nurse's primary practice location [18]. For state-level analysis, both Ghani, DePasquale and Stange define treatment as the binary implementation of the NLC, with the latter study also using a continuous definition being the fraction of US states that are NLC members in a given year [16, 17].

This study adds to the literature providing empirical evidence for the relationship between occupational licensing and mobility in two ways. Firstly, I build upon three major studies by adding a monthly-level analysis of labor mobility. This more granular analysis identifies a subsample of nurses that are more likely to migrate within rather than across years to take advantage of the NLC's reduction in licensing costs [16, 18, 19]. This subgroup is likely to be migrating temporarily and to have lower relocation costs, hence the reduction in licensing barriers when working within the NLC may have greater consequences. Secondly, there is little research documenting the effect of COVID-19 and pandemic-era policies on labor mobility [20]. I explore the interaction of existing licensure policies and temporary licensing reforms to identify heterogeneous effects. This article also contributes to a wider literature on how migration flows are affected by public policies.

2 Institutional Background

2.1 The Nurse Licensure Compact

During the 19th century, US states began to formally regulate the medical profession by mandating minimum educational or work experience requirements, and competency exams [21]. The most primitive form of nurse-specific licensure policy grew out of nurse registration policies of the early 20th century [22]. Once nurses had graduated from an approved program, passed a competency exam, and registered with their state, they received a "per-

missive license" and were granted use of the official title "registered nurse" [22]. Initially, this permissive license did not prohibit those without it to work in nursing roles. Following World War II, however, licenses first became compulsory in New York through the Mandatory Licensure Practice Act, and the scopes of two types of nurses, practical and registered, were first defined [22]. By 1950, all states used the same examination to assess their nurses, becoming the first profession to do so [22]. Despite this, variations in state licensing requirements persisted through the duration and costs of recognized training programs, high school graduation requirements, and the benchmark required to pass the licensing exam [22, 23].

Such differences in the "entry-to-practice" standards required for licensure complicated the process of obtaining and maintaining multiple state licenses to work across state lines [7, 24]. In 1995, the Pew Health Professions Commission published a report arguing that this system of single-state licensure would fail to suit the needs of the 21st century market, as it caused "unreasonable barriers to interstate mobility" via licensing heterogeneity [24].[1] In 1997, the NCSBN responded to this report and to concerns on the regulation of the growing telehealth industry surrounding the Telecommunications Act of 1996 by endorsing a "mutual recognition model of licensure by endorsement" [24, 26, 27]. This laid the foundation for the introduction of the interstate licensure compact [28]. The NCSBN intended that the mutual recognition model would increase access to health care by making it easier for nurses to work across state lines [29]. First implemented in four states in January 2000, the Nurse Licensure Compact (NLC) allows any RN or LP/VN with a primary residence in one NLC state to work across all other NLC states under one multi-state license, and therefore, NLC states mutually recognize the licenses of all other members. Note that the multi-state license permits nurses to work both physically and via telehealth in all NLC states. Outside of the NLC, nurses practice under single-state licenses that are only valid in the issuing state. Perceived benefits of joining the NLC include: (1) increased mobility and flexibility through access to a larger pool of job opportunities in other compact states; (2) expanding access

[1]The Pew Commission was established in 1989 "to help health professionals, educators, and policy makers respond to the changing nature of health care in the United States" [25].

to care, in particular via telemedicine services from out-of-state nurses and during times of public health emergency; (3) and potential reductions in licensing costs [30, 31].

Figure 1 shows the number of years states have been NLC members, whilst Figure 2 shows the number of states in the NLC over time. NLC membership stagnated by 2015, some attributing this to the compact's insufficient criminal background check requirements and inconsistencies between state policies and NLC requirements [7, 32]. These concerns prompted the implementation of the revised version of the NLC, the Enhanced Nurse Licensure Compact in January 2018. Since its introduction, the NLC has gained 12 new member states [6]. Post-2018, the NLC homogenized state-level policies through 11 universal licensing requirements (URLs) such that in order to be licensed, applicants must: (1) meet the requirements for licensure in the home state (state of residency); (2) have graduated from a Board of Nursing approved education program; (3) pass an English proficiency examination (if graduating from an international education program not taught in English or if English is not the individual's native language); (4) have passed the National Council Licensure Examination; (5) be eligible for or hold an active, unencumbered license (i.e., without active disciplinary action pending); (6) have submitted state and federal fingerprint-based criminal background checks; (7) have not been convicted or found guilty, or have entered into an agreed disposition of a felony offense under applicable state or federal criminal law; (8) have no misdemeanor convictions related to the practice of nursing (determined on a case-by-case basis); (9) be not currently participating in an alternative program; (10) self-disclose current participation in an alternative program; and (11) have a valid United States Social Security number (NCSBN 2024) [33].[2] To date, Rhode Island is the only state that has left the NLC and then rejoined. The NLC is first passed as a bill through the state legislature and then implemented by the State Board of Nursing. States must also pay an annual membership fee of $6,000 [34].

Current opposition to the NLC points to correlational relationships with labor market

[2]Alternative-to-discipline programs are used by boards of nursing to help nurse licensees receive needed treatment and maintain an unencumbered professional nursing license.

features and NLC membership. For example, the New York State Nurses Association, a union of 42,000 nurses, published an article finding lower wages in the compact, as well as a higher percent of hospital days with staffing shortages in NLC states throughout the pandemic [35, 36]. Table 2 shows the similarity between the demographic composition of NLC and non-NLC states, however, the higher levels of union membership in non-compact states are notable given the frequency of union opposition to the NLC. Such opponents argue that NLC membership reduces union strength by opening local markets to out-of-state nurses, suppressing bargaining power during strikes [10, 30, 37].

Additionally, jeopardizing patient safety by exposure to out-of-state nurses is often cited as a con of NLC membership. For example, in 2023 Alaska's Board of Nursing conducted a survey to gather views on the potential implementation of the NLC, and found 92% of respondents supported the NLC, however many were concerned with unsafe practices from out-of-state nurses [30]. In Illinois, where legislators have tried to pass the NLC since 2002, the state's largest nurses union (the Illinois Nurses Association) claims responsibility for "successfully block[ing] the passage of the Nurse Licensure Compact" as they believe it "would make it easier for out-of-state, non-unionized nurses from states with less stringent licensing standards and lax education requirements to enter the Illinois' workforce" [38, 39]. Conversely, the few studies exploring the impact of occupational licensing on the quality and safety of care largely agree that the two are unrelated. Timmons and Mills' 2018 paper proxy patient safety using the volume of malpractice insurance claims and finds no evidence that quality of care is improved by participation in certification programs [5]. In 2016, the White House published a summary of papers analyzing the impacts of licensing on the safety of services, showing that 8 out of 13 studies found no effect [40].

It is important to consider that whilst the NLC does not require its resident nurses to obtain brand new single-state licenses to work in other member states if a nurse permanently changes their primary state of residence (PSOR) to another compact state, they must apply for a new multi-state licensure via "licensure by endorsement" in their new home state

[41]. Nurses are granted licenses by endorsement by showing proof of residence, passing a criminal background check, verifying that they passed the National Council Licensure Examination, and graduated from a certified program. This process mirrors that of licensure by endorsement to obtain single-state licensure for non-NLC nurses, however, the processing times may be longer outside of the compact. Therefore, the NLC may not significantly reduce the cost of interstate practice for nurses permanently relocating across states. Rather, nurses who retain the same PSOR in a compact state whilst working in other compact states may be those who primarily benefit from the NLC's lowered licensing barriers [41]. This group may comprise nurses working in telemedicine, travel nurses working on short-term assignments, and military spouses temporarily stationed in one NLC state with PSOR in another NLC state [42].

2.2 COVID-19 Nurse Licensure Policies

On March 11th 2020, the US government declared a federal state of emergency as a result of the rapid spread of the COVID-19 virus [43]. There was variation in the responses to the COVID-19 pandemic through licensing policies. During the pandemic, 50 states introduced emergency licensing reforms for health care professionals to allow the freer movement of practitioners across the country [44, 45]. Although there was no federally mandated nurse licensing reform during the pandemic, there were similarities in each state's approach. Of these responses, two main types emerge: (1) the temporary license waiver, allowing nurses licensed in any state to work across the country without obtaining additional single-state licensure; and (2), the temporary license, requiring nurses to undergo an expedited and less rigorous application process to obtain temporary licensure to work in their state. Figure 3 shows the distribution of pandemic-era policies. The former more liberal policy–implemented by 32 states and applied to both RNs and LP/VNs in 23 of these states–waived the criminal background check, licensing fees, and registration requirements with state occupational licensing agencies. Although, in all cases, the temporary license waiver only applied to nurses

working under a full unrestricted license with no pending disciplinary action against them, health facilities hiring out-of-state nurses through this program were directed to verify nurse licensure status independently. Scheidt 2022 reports a case in which an NLC nurse moved to work in New York, a non-NLC state, under a pandemic temporary license waiver program [46]. This nurse then unlawfully diverted controlled substances for their own use, but was not investigated in New York because their multi-state license was not under New York's jurisdiction [46]. This provides an example of how the interplay of authority provisions within the NLC and pandemic-era policies can jeopardize the safety of care.

The temporary license partially circumvented the issues arising from the lack of state-mandated verification or registration of nurse licenses and authority provisions created by the temporary license waiver. The temporary license was implemented by 20 states and applied to both RNs and LP/VNs in 18 of these states. The temporary license requires the verification of nurse licensure status, and the disclosure of criminal and disciplinary background thereby better assuring the competency of its out-of-state pandemic employees, and granting issuing states the authority to revoke or decline the temporary license through their investigation. The temporary license system is expedited, most issued within a week of the application, with all fees waived. Four states implemented both the temporary license and the temporary license waiver. Note that many states had preexisting temporary licenses, but, as a result of the pandemic, modifications were made to expedite the process and reduce licensing costs. Outside of these main types, Arkansas implemented an expedited permanent license utilizing their existing licensing infrastructure [47]. By mid-2022, New Jersey's Temporary Emergency Reciprocity Licensure Program, their version of the temporary license, had issued roughly 50,000 temporary licenses [48]. New Jersey also implemented the NLC during the pandemic in November 2021 [49]. In a qualitative 2022 study assessing how healthcare stakeholders viewed New Jersey's temporary license reform, researchers found that interstate compacts and licensure reciprocity were viewed more favorably than pre-COVID-19 [50]. This finding is attributed to stakeholders' belief that pandemic-era licensing policies,

similar in content to the NLC, helped nurses to be more efficiently allocated across the country to regions of acute need [50]. Oppositely, in April 2023, when asked about pending NLC legislation, Nevada's National Nurses United claimed that compact membership did not make states better off during the pandemic, because all states relied on "expensive (hiring) agencies that took more than 10 days [...] to bring nurses" [10]. Given mixed perspectives on the effect of emergency licensing reforms and compact membership on interstate mobility during the pandemic, this study looks for empirical evidence by estimating its relationship with pandemic-era licensing policies, the NLC, and their interaction.

3 Data

The National Plan and Provider Enumeration System (NPPES), developed by the Centers for Medicare and Medicaid Services (CMS), assigns a unique 10-digit identification number to health care providers known as the National Provider Identifier (NPI) [51]. NPIs are used in a range of healthcare transactions, for example; to enroll in Medicare, providers must have an NPI [51]. Every month, the NPPES releases a dataset of all active NPIs, known as the full monthly replacement file, including a taxonomy code indicating the type of provider, and for individuals, their gender and primary practice location (PPL) given by a street address including a ZIP code [52]. Using the National Bureau of Economic Research's (NBER) archive of the full monthly replacement files between 2015 and 2023, I construct a panel of nurses to track their mobility through changing PPLs. Between May 2019 and December 2019, no NPPES tracking data was available through NBER's archive. The full sample of analysis consists of 92 months over 8 years. NPI-holders are responsible for manually updating their PPL through the NPPES online portal, however, all HIPAA-covered healthcare providers must do so within 30 days of the change [53]. This means that if individuals do not instantaneously update their PPL as they move, there could be up to a month-long time lag between the NPPES-reported PPL and the provider's true PPL.

Using taxonomy codes to identify nurse types, this sample only consists of LP/VNs and RNs as they are subject to the NLC. The final sample of analysis is 13.5 million observations of 205,104 nurses observed over 92 months, consisting of 146,287 RNs and 60,299 LP/VNs (Table 1).

A nurse is categorized as mobile each month if they are in a different PPL than the most recent prior period that they were observed in. This construction of labor mobility does not tie mobility to consecutive calendar months. 41% of the sample is observed for all 92 available periods, whilst on average, nurses are observed for 66 months. The mean time elapsed between the most recently observed PPL and the new PPL is 2.4 months. This definition results in 4,159 observations migrating across states and 13,903 migrating within states. The postal codes of nurse PPLs are geocoded using coordinates from Simple Maps [54]. This spatial data set is then used to compute the distance between PPLs.

It is important to note that only nurses who bill for their services under their own name are required to obtain an NPI [55]. This comprises roughly 5% of all active RNs and LP/VNs, as typically nurse services are not charged separately to patients but rather bundled into the final healthcare bill [1, 56]. Nurses that are likely to need an NPI include those who participate in federally funded programs, work in public health clinics that bill the government for nurse-only services such as immunizations, or work in occupational/home health [55]. I compare this study sample with a nationally representative sample of nurses in the American Community Survey (ASC) 2016-2022 and find both data have a mobility rate of roughly 2%, a percentage of female nurses around 88%, but this study's sample has a higher proportion of LP/VNs (30% vs 19% in the ACS 2016-2022). The parity in mobility rates and gender ratio suggests the mobility effects identified by analyzing this sample are likely generalizable to the broader universe of nurses. For the pandemic-era analysis, controls for monthly COVID-19 cases and deaths are aggregated from the Centers for Disease Control and Prevention's Weekly COVID-19 Case Count [57]. NLC implementation dates were retrieved by request from the NCSBN.

4 Empirical Approach

4.1 Identification Strategy

Figure 4 shows that as a percentage of nurses in the analytical sample, NLC state to NLC state labor flows have increased over time, whilst non-NLC to non-NLC flows have decreased. Local labor market shocks that coincide with NLC adoption may drive these correlations. State-level randomization of the NLC's adoption would make ideal conditions for causal inference on the effects of the NLC on labor mobility. However, this is unrealistic in practice. The NLC's staggered implementation grants the use of the difference-in-difference estimator where nurses and states outside of the NLC serve as the comparison group. Viewing COVID-19 as an exogenous shock experienced across the control and treatment groups also allows for the analysis of the effect of COVID-19 policies, which appear to not be directly correlated with COVID-19 cases or deaths.[3]

Since both NLC implementation and COVID-19 licensure policies were not assigned at random, the estimates of their effect on labor mobility may be confounded with other nurse-specific policies implemented simultaneously thus posing a threat to identification. Before the pandemic, I could not find evidence to suggest the NLC was implemented alongside other nurse-specific policies. During COVID-19, however, many states introduced policies that allowed student nurses nearing the end of their programs to obtain temporary licensure [58–60]. At least one state specified that graduates could substitute simulations, lab hours, and similar non-direct patient contact to fulfill previously required direct patient care clinical/instruction hours [59]. Some states also allowed nurses with expired licenses to reenter the workforce without going through pre-pandemic re-licensure processes [61, 62]. Additionally, I assume that the NLC does not impact the demographic composition of nurses in each state. Strategies to test the robustness of these results are focused on the redefinition of outcome variables rather than the addition of individual-level characteristics due to the

[3]Kruskal-Wallis chi-squared coefficient 0.40968 between COVID-19 cases per 100,000 and COVID-19 policies (p-value 0.9817) and 6.9713 between COVID-19 deaths per 100,000 (p-value 0.1374).

limitations of the NPI database. This is a disadvantage of this study, in comparison to DePasquale and Stange 2016 [16].

4.2 Individual-level Analysis

To estimate the relationship between the implementation of nurse licensure policies and mobility at the individual level, I employ the following difference-in-difference model:

$$Y_{ist} = \beta_0 + \beta_1 X_{ist} + \lambda_s + \lambda_i + \lambda_t + \tau_i + \epsilon_{ist} \tag{1}$$

where Y_{ist} is the outcome for individual i residing in state s during the month t; X_{ist} is a dummy variable indicating that nurse i has lived in an NLC state in a previous period; λ_s, λ_i and λ_t are fixed effects for state, individuals (NPI), and month-year; and, ϵ_{ist} is the standard error clustered at the state level. Primary outcomes at the monthly include a binary indicator for whether a nurse migrates to any state for work, and the distance migrated across states in kilometers. When interpreting results, the former is equivalent to the probability of interstate migration in a given month or the monthly migration rate. The yearly rates are obtained by multiplying the monthly rates by 12. The sample is partitioned by gender, and into three time periods to obtain the differential impact on mobility: the entire study period (2015-2023), pre-pandemic (2015-2019), and pandemic (2020-2023). The coefficient of interest β_1 is interpreted as the effect of working in an NLC state in the past on the probability of migrating to another state for work. Note that the treatment indicator X_{ist} does not in all cases perfectly identify those who hold a multi-state license, and thus can work freely across the compact. In some NLC states, such as Colorado, the multi-state license is the default license so here, β_1 estimates the effect of having a multi-state license in a prior period on interstate mobility. In states where nurses have a choice of license types, I assume that the likelihood of nurses working in the NLC having a multi-state license is much higher than those outside of the NLC. In these cases, β_1 is the relationship between working

in a NLC state and interstate mobility. The comparison group are nurses that have never worked in the NLC by a given month within the study period. Nurses who were working in an NLC state in the first period, January 2015, are dropped from the analysis, such that for every treated nurse we have a pre-treatment comparison. A linear probability model is used for binary mobility, due to the computational in-feasibility of a logit model with individual fixed effects, and a linear model is used for distance between PPLs. A brief economic model of mobility decisions is explored in Appendix 7.1.

4.3 State-level Analysis

There is a growing literature highlighting biases that arise from using the canonical two-way fixed effects estimator for staggered treatment on panel data [63–66]. Computational limitations restrict the individual-level analysis to the canonical estimator. At the state level, however, I address these issues by using Sun and Abraham's interaction-weighted estimator of relative time period treatment effects [63]:

$$Y_{st} = \beta_t \times \sum_{k=-j, k\neq -1}^{j} \mu_k \times X_{st} + \beta_x C_{st} + \lambda_s + \lambda_t + \epsilon_{st} \tag{2}$$

where Y_{st} is the outcome for state s during month t; the coefficients of interest are β_t; μ_k is a dummy denoting relative time period; X_{st} is a dummy variable indicating that state s is in the NLC; C_{st} is a vector of controls of state characteristics in a given month; λ_s and λ_t are fixed effects for state and month-year; ϵ_{st} is the standard error clustered at the state level. Controls for state characteristics include the percentage of female nurses, the percentage of bordering states that are NLC members, the percentage of nurses that are LP/VNs, and nurses per 100,000. Outcomes include nurse labor flows, computed by summing the number of nurses migrating to and from a state in each month, NLC and non-NLC specific nurse labor flows, and the difference between NLC and non-NLC labor flows computed by subtracting non-NLC flows from NLC flows. All outcomes are at the monthly level and are divided by

state population and multiplied by 100,000 to make comparisons across states. This analysis is split into 2 time periods: 2015-2019 and 2020-2023. The panel data is a balanced sample for each period, such that during 2015-2019, I observed states for 12 months prior to and post their treatment, and 5 months before and post-treatment during 2020-2023 (such that $j = 12$ during 2015-2019, and $j = 5$ during 2012-2023). The event study allows for the evaluation of the short-term effects of NLC membership. For COVID-19 analysis, additional covariates are added to control for COVID-19 cases and deaths per 100,000 in each state to proxy for demand for pandemic-specific healthcare services.

4.4 Sensitivity Analysis

The mechanism through which the NLC may affect mobility is via the elimination of obtaining single-state licensure in other compact states whilst maintaining PSOR in a single compact state. This mechanism ought to not affect intrastate migration, as no licensing barriers persist when changing PPL within the same state. Therefore, as a sensitivity analysis, I estimate the individual-level effect of NLC membership on the probability of moving within a state for work.

Previous studies have examined mobility at the yearly level and found mixed evidence of a positive effect [16–18]. To test whether monthly mobility is more responsive to NLC membership, I also estimate the effect on the individual probability of interstate practice defined at the yearly level. To mirror to the data construction in other studies and obtain the most comparable estimate, the yearly sample is restricted to nurses observed in all years and consists of 1,603 observations (0.2%) migrating across states between 2015-2023.

5 Results

5.1 Descriptive results

As shown in Table 2, the nurse population is larger within the compact, therefore we can expect that as a percentage of all nurses migrating across state lines, NLC to NLC flows should increase over time. Evidence for this trend is shown in Figure 4, alongside a decrease in non-NLC to non-NLC flows. The distribution of distance migrated across states is similar across nurse types, with an average of roughly 1,750 kilometers. The distribution of intrastate migration is more skewed to the left, implying most people migrating within the state do not migrate far, with an average of roughly 50 kilometers (Figure 5). Figure 6 aggregates the average distance nurses migrate across states to arrive at a given destination state. For relatively small states on the East Coast, the average distance migrated is around 1,000 km, whilst larger states on the West Coast such as California and Nevada have averages of closer to 5,000 km.

5.2 Main results

5.2.1 Individual-level Analysis

Table 3 presents the main results of the relationship between working in an NLC state in a previous period and the likelihood of interstate migration, or migration rate at the monthly level. The results for the full sample of analysis between 2015 and 2023 suggest a significant increase in the monthly migration rate once a nurse has worked in the NLC by 0.29 percentage points from 0.03% to 0.32%, equivalent to the yearly migration rate increasing from 0.36% to 3.84% (significant at 5%). Note that for all specifications, the intercept, or the base interstate migration rate, is between 0.03-0.06%, thus is very low in this sample. Interstate migration is unaffected by all COVID-19-related controls, as well as the interaction of treatment and COVID-19. Additionally, nurses were not more likely to work in states with high COVID-19 disease burden. Partitioning the sample into pre-

2020 and post-2020 reveals an insignificant estimate during the pandemic, and a positive effect of 0.05 percentage points prior (significant at 5%). This represents an increase in the monthly migration rate from 0.03% to 0.08%, or from 0.36% to 0.96% at the yearly level, therefore mobility in the treatment group is 2.6 times that of the comparison group. The estimates for male and female nurses do not paint a clear picture on differential mobility by gender. Additionally, Table 4 shows that the distance migrated between practice locations is unrelated to all covariates.

5.2.2 State-level Analysis

The analysis of joining the NLC on state-level nurse labor flows is shown in Table 6. The coefficients are averages of the time-period-specific effects from the Sun and Abraham interaction-weighted estimates. Figure 7 shows the dis-aggregated pre-COVID-19 event study coefficients from columns (1), (3), (5), and (7) of Table 6. All outcomes show insignificant pre and post-treatment estimates, suggesting no causal effect of NLC membership on nurse flows, in line with the results of DePasquale and Stange 2016 [16]. Similarly to DePasquale and Stange 2016, the NPI database has very low rates of nurse labor flows [16]. The mean value of most nurse flows is around 0.05 per 100,000. The low rates of interstate migration, accompanied by a small sample size, make these results tenuous.

Although columns (2), (4), (6), (8) of Table 6 imply that joining the NLC during the pandemic increased nurse flows, NLC nurse flows, and non-NLC flows, only the latter is unbiased, as all other outcomes show significant pre-treatment estimates and thus violate parallel trends (Figure 8). The treatment effect on non-NLC labor flows is highly dynamic, with 2 significant post-period estimates in period 3 and 5 around a significant estimate in period 4.

5.3 Sensitivity Analysis

Table 5 shows the estimates of the NLC's effect on intrastate mobility. The insignificant relationship between working in a NLC state and the probability of migrating to a different practice location within the same state (i.e. the intrastate migration rate) confirms that the NLC does not affect the cost of migration within the state. This table also reveals a mixed relationship between intrastate mobility and COVID-19 conditions. Firstly, states with higher COVID-19 cases per 100,000 and, hence, greater demand for pandemic-specific healthcare services are more likely to migrate to other healthcare facilities within their state. Secondly, the intrastate migration rate for nurses working in NLC states that implemented the temporary license and waiver decreased by 0.03 percentage points from 0.14% to 0.11% (significant at 1%). Recall that the temporary license and waiver is the most liberal COVID-19 emergency licensing reform and was implemented by 4 NLC states: Idaho, Louisiana, Wisconsin, and Ohio (which joined the NLC in January 2023).

To test whether monthly mobility is more responsive to NLC membership, I perform an analysis of its effect on mobility defined at the yearly level, shown in Table 7. The insignificance of both the pre-pandemic and pandemic estimates of previously working in the NLC on yearly mobility affirms the hypothesis that those moving temporarily to different practice locations within the year are those who benefit from the NLC's reduced licensing barriers.

6 Discussion

The treatment variable is defined differently for individual and state-level mobility. The individual-level analysis explores the relationship between a nurse previously working in an NLC state and mobility decisions. Previous work in the NLC is a proxy for a nurse holding a multi-state license. I conclude that the probability of interstate mobility increases 2.6 times once a nurse has worked in an NLC state. A caveat of this chosen definition and dataset for

the individual-level analysis is the inability to identify which nurses with primary practice locations in an NLC state have a multi-state license. In some NLC states, the multi-state license is the default, whilst in others, nurses can choose to obtain either a multi-state or single-state license. This likely biases these estimates downwards, as those who chose the single-state license are actively selecting out of the lowered licensing barriers enabled by the compact's multi-state license. The state-level analysis explores the effect of joining the NLC on the number of nurses entering and leaving the state, and where they are going. All pre-pandemic estimates are insignificant, however, low rates of labor mobility complicate the detection of treatment effects. The pandemic-era estimates imply that joining the NLC between 2015 and 2023 significantly increased labor flows, however, these estimates are unreliable due to the violation of parallel trends shown in the event study plots.

This study provides the first analysis of the Nurse Licensure Compact's effect on interstate mobility defined at the monthly level. Previous studies have focused on permanent moves, defined as migrating across states across years. The "licensure by endorsement" process for nurses permanently relocating across state lines is very similar irrespective of compact membership status. Therefore, those who may benefit the most from the NLC's lowering of licensing barriers are nurses looking to work temporarily in other compact states. These nurses are the most likely to change their primary practice location multiple times throughout the year and are more likely to be detected by a monthly-level analysis. This study finds that when deciding to migrate permanently across states, defined by yearly-level mobility, licensing costs are likely a small component of a large, incurred cost of migration. When moving multiple times in one year, defined by monthly-level mobility, the NLC allows nurses to take advantage of the reduced cost of temporary moves. These nurses are able to respond to increased demand or surges in wages within the NLC, before returning to a "base" NLC primary state of residence.

The insignificance of the interaction between COVID-19 policies and NLC adoption implies that having reduced barriers to engaging in temporary work in other NLC states did

not induce an increased likelihood of interstate migration during the pandemic. Further, we can conclude that inefficiencies in the allocation of nurses to sites of acute need were unrelated to licensing barriers. Sensitivity analysis revealed an increased likelihood of intrastate migration within states with high COVID-19 cases. This may suggest that due to various lockdown rules, nurses were less likely to migrate further from their primary residences and families to work in other states with high labor demand, but instead moved to local health facilities to meet demand within their communities for their services. These results provide insight into how non-market factors such as personal desires to help one's community, public health restrictions, and nearness to family members became more important to mobility decisions during the pandemic, outweighing the reduction in the cost of interstate work caused by emergency licensing policies.

References

1. Bureau of Labor Statistics. *Occupational Employment and Wage Statistics* May 2023. https://www.bls.gov/oes/current/oes_nat.htm.

2. McDougal, B. *et al.* The 2011 Uniform Licensure Requirements for Adoption. *Journal of Nursing Regulation* **2.** Publisher: Elsevier, 19–22. https://doi.org/10.1016/S2155-8256(15)30272-6 (Oct. 2011).

3. Martin, B., Buck, M. & Zhong, E. Evaluating the Impact of Executive Orders Lifting Restrictions on Advanced Practice Registered Nurses During the COVID-19 Pandemic. *Journal of nursing regulation* **14.** Place: United States, 50–58 (Apr. 2023).

4. Smiley, R. A. *et al.* The 2022 National Nursing Workforce Survey. *Journal of Nursing Regulation* **14,** S1–S90. https://www.sciencedirect.com/science/article/pii/S2155825623000479 (2023).

5. Timmons, E. J. & Mills, A. Bringing the Effects of Occupational Licensing into Focus. *Eastern Economic Journal* **44.** Publisher: Springer, 69–83. https://www.jstor.org/stable/48717552 (2018).

6. National Council of State Boards of Nursing. *NLC States* June 2023. https://www.ncsbn.org/public-files/NLC_Map.pdf.

7. Omobola Awosika Oyeleye. The Nursing Licensure Compact and Its Disciplinary Provisions: What Nurses Should Know. *The Online Journal of Issues in Nursing* **24.** https://ojin.nursingworld.org/table-of-contents/volume-24-2019/number-2-may-2019/articles-on-previously-published-topics/what-nurses-should-know/ (May 2019).

8. Brinegar, P. in *The Book of the States 2005* 495–498 (The Council of State Governments, 2005).

9. Ohio Nurses Association. *Multi-State Nurse Licensure Compact Position Statement* June 2017. https://ohnurses.org/wp-content/uploads/2017/02/Multi-State-Compact-Licensure-Compact-Statement.pdf.

10. April Corbin Girnus. Labor unions push back on proposal to allow licensure reciprocity for nurses. *Nevada Current.* https://nevadacurrent.com/2023/04/09/labor-unions-push-back-on-proposal-to-allow-licensure-reciprocity-for-nurses/ (Apr. 2023).

11. Lawrence F. Katz & Olivier Blanchard. in *Regional Evolutions* (1992). https://www.brookings.edu/articles/regional-evolutions/.

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

13. Morris M. Kleiner & Karen Greene. Barriers to Labor Migration: The Case of Occupational Licensing. *Industrial Relations: A Journal of Economy and Society* **21,** 383–391. https://onlinelibrary.wiley.com/doi/10.1111/j.1468-232X.1982.tb00245.x (Sept. 1982).

14. Sean E. Mulholland & Andrew T. Young. Occupational Licensing and Interstate Migration. *Cato Journal* **36.** https://www.cato.org/sites/cato.org/files/serials/files/cato-journal/2016/2/cato-journal-v36n1-2.pdf (2016).

15. Johnson, J. E. & Kleiner, M. M. Is Occupational Licensing a Barrier to Interstate Migration? *American Economic Journal: Economic Policy* **12,** 347–73. https://www.aeaweb.org/articles?id=10.1257/pol.20170704 (Aug. 2020).

16. DePasquale, C. & Stange, K. *Labor Supply Effects of Occupational Regulation: Evidence from the Nurse Licensure Compact* Working Paper 22344. Series: Working Paper Series (National Bureau of Economic Research, June 2016). http://www.nber.org/papers/w22344.

17. Aimi Abdul Ghani. in *OECD Economic Survey of the United States: Key Research Findings* 103–119 (Mar. 2019). https://doi.org/10.1787/a9993f12-en.

18. Shakya, S., Ghosh, S. & Norris, C. Nurse Licensure Compact and Mobility. *Journal of Labor Research* **43,** 260–274. https://doi.org/10.1007/s12122-022-09333-2 (June 2022).

19. Norris, C. & Nandy, P. The Nurse Licensure Compact's Effect on Telemedicine Usage. *Journal of patient experience* **10.** Place: United States, 23743735231179060 (2023).

20. Peri, G. & Zaiour, R. Changes in international immigration and internal native mobility after COVID-19 in the USA. *Journal of Population Economics* **36,** 2389–2428. https://doi.org/10.1007/s00148-023-00972-y (Oct. 2023).

21. Chaudhry, H. J. The Important Role of Medical Licensure in the United States. *Academic Medicine* **85.** https://journals.lww.com/academicmedicine/fulltext/2010/11000/the_important_role_of_medical_licensure_in_the.5.aspx (2010).

22. Diane Benefiel. The Story of Nurse Licensure. *Nurse Educator* **36,** 16–20. https://downloads.lww.com/wolterskluwer_vitalstream_com/journal_library/nne_03633624_2011_36_1_16.pdf (2011).

23. Bullough, B. The law and the expanding nursing role. *American journal of public health* **66.** Place: United States, 249–254 (Mar. 1976).

24. Pew Health Professions Commission. *Reforming Heatlh Care Workforce Regulation - Policy Considerations for the 21st Century* tech. rep. (Dec. 1995). https://www.leg.state.nv.us/App/InterimCommittee/REL/Document/21360?rewrote=1.

25. Pew Commission Outlines Reforms for Health Care Regulation. *Journal of the American Dietetic Association* **97,** 580. https://www.sciencedirect.com/science/article/pii/S0002822397001478 (1997).

26. Carolyn Hutcherson & Susan H. Williamson. Nursing Regulation for the New Millennium: The Mutual Recognition Model. *The Online Journal of Issues in Nursing* **4.** https://ojin.nursingworld.org/MainMenuCategories/ANAMarketplace/ANAPeriodicals/OJIN/TableofContents/Volume41999/No1May1999/MutualRecognitionModel.html (May 1999).

27. Sen. Pressler, Larry [R-SD]. *S.652 - Telecommunications Act of 1996* Feb. 1996. https://www.congress.gov/bill/104th-congress/senate-bill/652/text.

28. Bauer, L., Creeron, A., Dada, J. & Macedo, L. *Nurse licensure compacts before, during, and after COVID* Feb. 2023. https://www.brookings.edu/articles/nurse-licensure-compacts-before-during-and-after-covid/.

29. Philipsen, N. C. & Haynes, D. The Multi-State Nursing Licensure Compact: Making Nurses Mobile. *The Journal for Nurse Practitioners* **3,** 36–40. https://www.sciencedirect.com/science/article/pii/S155541550600835X (Jan. 2007).

30. National Council of State Boards of Nursing. *2023 Alaska Nurse Licensure Compact Survey* tech. rep. (Alaska Department of Commerce, Community, and Economic Development, Jan. 2024). https://www.commerce.alaska.gov/web/Portals/5/pub/2023%20NLC%20Survey%20Report_Final.pdf.

31. Lauren Rivera. *The Benefits of Working in Nurse Licensure Compact States* Aug. 2023. https://www.healthecareers.com/career-resources/nurse-credentialing-and-education/benefits-working-nurse-licensure-compact-states.

32. Sandra Evans. The Nurse Licensure Compact: A Historical Perspective. *Journal of Nursing Regulation* **6,** 11–16 (Oct. 2015).

33. National Council of State Boards of Nursing. *Uniform Licensure Requirements for a Multistate License* https://www.ncsbn.org/public-files/NLC_ULRs.pdf.

34. National Council of State Boards of Nursing. *Legislator Fact Sheet* https://nursecompact.com/files/Updated-Legislator-FAQ.pdf.

35. New York State Nurses Association. *About NYSNA* 2024. https://www.nysna.org/strength-at-work/about-nysna#:~:text=The%20New%20York%20State%20Nurses,staffing%2C%20and%20healthcare%20for%20all..

36. Pat Kane. *Lowering Nurse Licensing Standards Won't Solve The Nurse Staffing Crisis - But Could Harm Patient Care* tech. rep. (New York State Nurses Association, 2023). https://www.nysna.org/lowering-nurse-licensing-standards-won%E2%80%99t-solve-nurse-staffing-crisis%E2%80%89%E2%80%94%E2%80%89-could-harm-patient-care.

37. Jackson LLP. *Healthcare License Compacts in Illinois: Where We Are, Where We're Going* 2024. https://jacksonllp.com/healthcare-license-compacts-illinois/.

38. Ruda, V. *Interstate Nurse Licensure Compact Fiscal Impact Statement* Jan. 2002. https://archive.iga.in.gov/2002/bills/PDF/FISCAL/HB1297.002.pdf.

39. Illinois Nurses Association. *PAC Accomplishments* 2024. https://illinoisnurses.com/legislation-politics/political-action-committee/.

40. Department of the Treasury Office of Economic Policy, the Council of Economic Advisers & Department of Labor. *Occupational Licensing: A Framework for Policymakers* tech. rep. (The White House, 2016), 58. https://obamawhitehouse.archives.gov/sites/default/files/docs/licensing_report_final_nonembargo.pdf.

41. National Council of State Boards of Nursing. *Moving Scenarios Fact Sheet* 2018. https://www.ncsbn.org/public-files/2018_Moving_Scenarios_Factsheet.pdf.

42. The National Council of State Boards of Nursing. *What You Need to Know: Federal/Military Nurses and Spouses* 2018. https://www.ncsbn.org/public-files/2018MilitaryFactsheetFINAL.pdf.

43. Federal Emergency Management Agency. *COVID-19 Disaster Incident Period* Jan. 2024. https://www.fema.gov/disaster/historic/coronavirus#:~:text=

FEMA%20established%20May%2011%2C%202023,%2D19%2Drelated%20funeral%20expenses..

44. National Council of State Boards of Nursing. *State Response to COVID-19* Mar. 2020.

45. David C. Benton, Rebecca Fotsch, Maryann Alexander & Nicole Livanos. Lessons Learned and Insights Gained: A Regulatory Analysis of the Impacts, Challenges, and Responses to COVID-19. *The Online Journal of Issues in Nursing* **25.** https://ojin.nursingworld.org/table-of-contents/volume-25-2020/number-3-september-2020/articles-on-previously-published-topics/regulatory-analysis-of-the-impacts-challenges-and-responses-to-covid-19/ (Aug. 2020).

46. Scheidt, L. Challenges to Nursing Regulation During the Pandemic: A Case Study. *Journal of nursing regulation* **12.** Place: United States, 47–49 (Jan. 2022).

47. Unwin, H. J. T. *et al.* State-level tracking of COVID-19 in the United States. *Nature communications* **11.** Place: England, 6189 (Dec. 2020).

48. Nguyen, A. M. *et al.* Impact Of The New Jersey COVID-19 Temporary Emergency Reciprocity Licensure Program On Health Care Workforce Supply. *Health affairs (Project Hope)* **41.** Place: United States, 1125–1132 (Aug. 2022).

49. National Council of State Boards of Nursing. New Jersey Implements Nurse License Compact. https://www.ncsbn.org/news/new-jersey-implements-nurse-license-compact (Nov. 2021).

50. Nguyen, A. M., Farnham, J. J. & Ferrante, J. M. How COVID-19 Emergency Practitioner Licensure Impacted Access to Care. *Journal of Medical Regulation* **108.** Publisher: Journal of Medical Regulation, 7–19. https://www.jstor.org/stable/48712076 (2022).

51. Centers for Medicare and Medicaid Services. *NPI: What You Need to Know* Mar. 2022. https://www.cms.gov/outreach-and-education/medicare-learning-network-mln/mlnproducts/downloads/npi-what-you-need-to-know.pdf.

52. National Plan and Provider Enumeration System. *NPI Files* May 2024. https://download.cms.gov/nppes/NPI_Files.html.

53. National Plan and Provider Enumeration System. *Address Page* 2016. https://nppes.cms.hhs.gov/webhelp/nppeshelp/ADDRESS%20PAGE.html.

54. Simple Maps. *US Zip Codes Database* CSV. Apr. 2024. https://simplemaps.com/data/us-zips.

55. Tracy A. Klein. *Do Registered Nurses Need a National Provider Identifier (NPI)?* Sept. 2008. https://www.medscape.com/viewarticle/579984?form=fpf.

56. Lasater, K. B. Invisible economics of nursing: analysis of a hospital bill through a Foucauldian perspective. *Nursing philosophy : an international journal for healthcare professionals* **15.** Place: England, 221–224 (July 2014).

57. Centers for Disease Control and Prevention COVID-19 Response. *Weekly United States COVID-19 Cases and Deaths by State* Feb. 2024. https://data.cdc.gov/Case-Surveillance/Weekly-United-States-COVID-19-Cases-and-Deaths-by-/pwn4-m3yp/about_data.

58. Colorado Department of Regulatory Agencies. *Updated FAQs Regarding Board of Nursing Emergency Rules* Dec. 2020. https://content.govdelivery.com/accounts/CODORA/bulletins/2b15ccc.

59. Arizona State Board of Nursing. *Emergency Declaration March 2020 FAQs* Mar. 2020. https://www.azbn.gov/news-and-events/emergency-declaration-march-2020.

60. Idaho Board of Nursing. *Idaho Board of Nursing Response to Surge in COVID-19* Aug. 2021. https://web.archive.org/web/20220207054519/https://ibn.idaho.gov/pressrelease/idaho-board-of-nursing-response-to-surge-in-covid-19/.

61. WJTV. MS Board of Nursing enacts temporary disaster permit. https://www.wjtv.com/news/ms-board-of-nursing-enacts-temporary-disaster-permit/ (Mar. 2020).

62. Board of Registration in Nursing. *Temporary License Extended: COVID-19 Public Health Emergency Order No. 2021-6. Issued August 26, 2021* Aug. 2021. https://www.mass.gov/news/temporary-license-extended-covid-19-public-health-emergency-order-no-2021-6-issued-august-26-2021.

63. Sun, L. & Abraham, S. Estimating dynamic treatment effects in event studies with heterogeneous treatment effects. *Journal of Econometrics* **225,** 175–199. https://www.sciencedirect.com/science/article/pii/S030440762030378X (2021).

64. Callaway, B. & Sant'Anna, P. H. C. Difference-in-Differences with multiple time periods. *Journal of Econometrics* **225,** 200–230. https://www.sciencedirect.com/science/article/pii/S0304407620303948 (2021).

65. De Chaisemartin, C. & D'Haultfœuille, X. Two-Way Fixed Effects Estimators with Heterogeneous Treatment Effects. *American Economic Review* **110,** 2964–96. https://www.aeaweb.org/articles?id=10.1257/aer.20181169 (Sept. 2020).

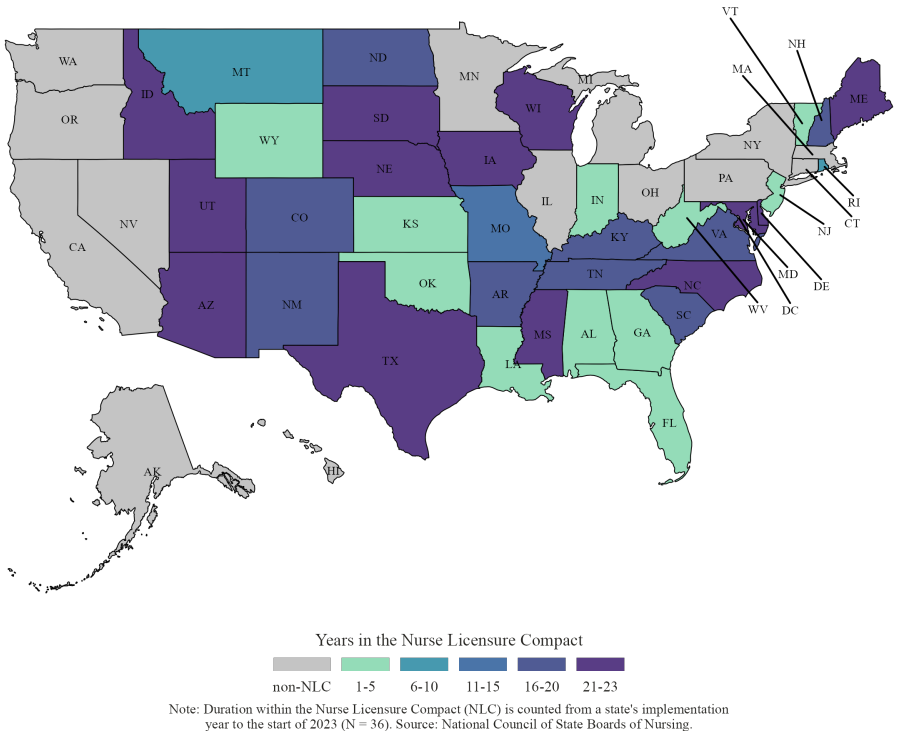
66. Goodman-Bacon, A. Difference-in-differences with variation in treatment timing. *Journal of Econometrics* **225,** 254–277. https://www.sciencedirect.com/science/article/pii/S0304407621001445 (2021).

67. Seema Jayachandran *et al.* Moving to Opportunity, Together. *National Bureau of Economic Research.* https://seemajayachandran.com/moving_together.pdf (Feb. 2024).

68. Foged, M. Family migration and relative earnings potentials. *Labour Economics* **42,** 87–100. https://www.sciencedirect.com/science/article/pii/S0927537116300860 (2016).

69. Hannah Illing, Johannes Schmieder & Simon Trenkle. The Gender Gap in Earnings Losses after Job Displacement. *Institute of Labor Economics.* https://repec.iza.org/dp14724.pdf (Sept. 2021).

Figure 1: Years in the Nurse Licensure Compact, 2000-2023



Note: Duration within the Nurse Licensure Compact (NLC) is counted from a state's implementation year to the start of 2023 (N = 36). Source: National Council of State Boards of Nursing.

Figure 2: Nurse Licensure Compact membership, 2000-2023

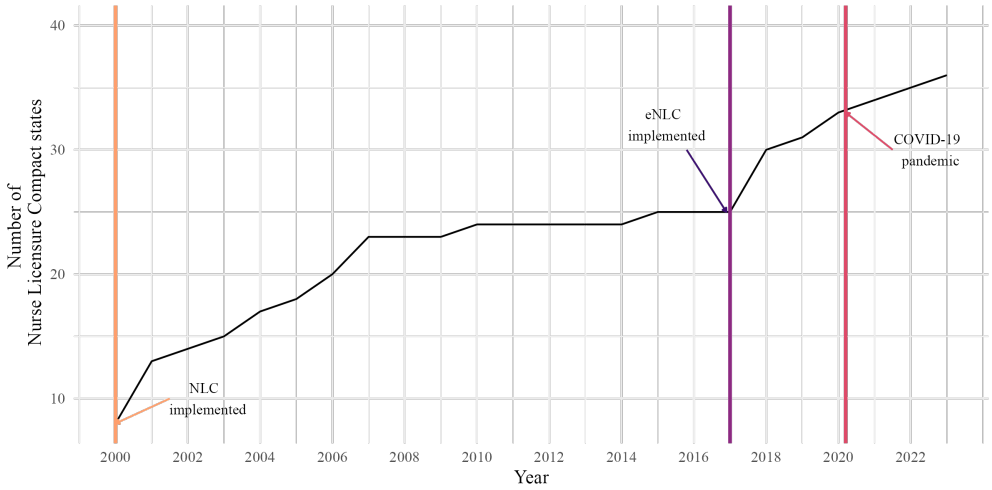


Figure 3: COVID-19 Nurse Licensure Policies, 2020-2023

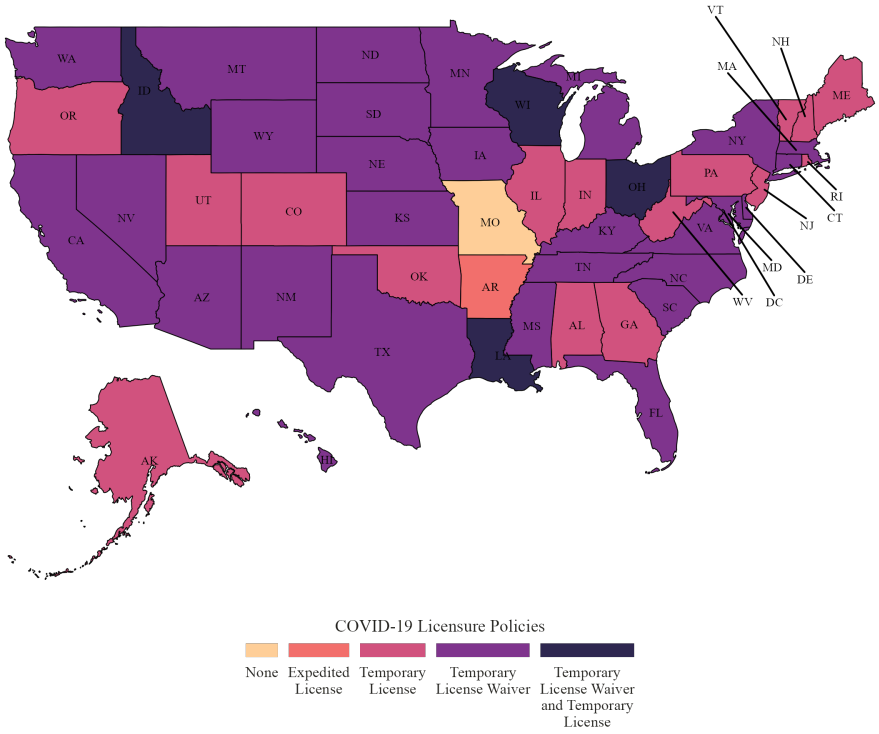
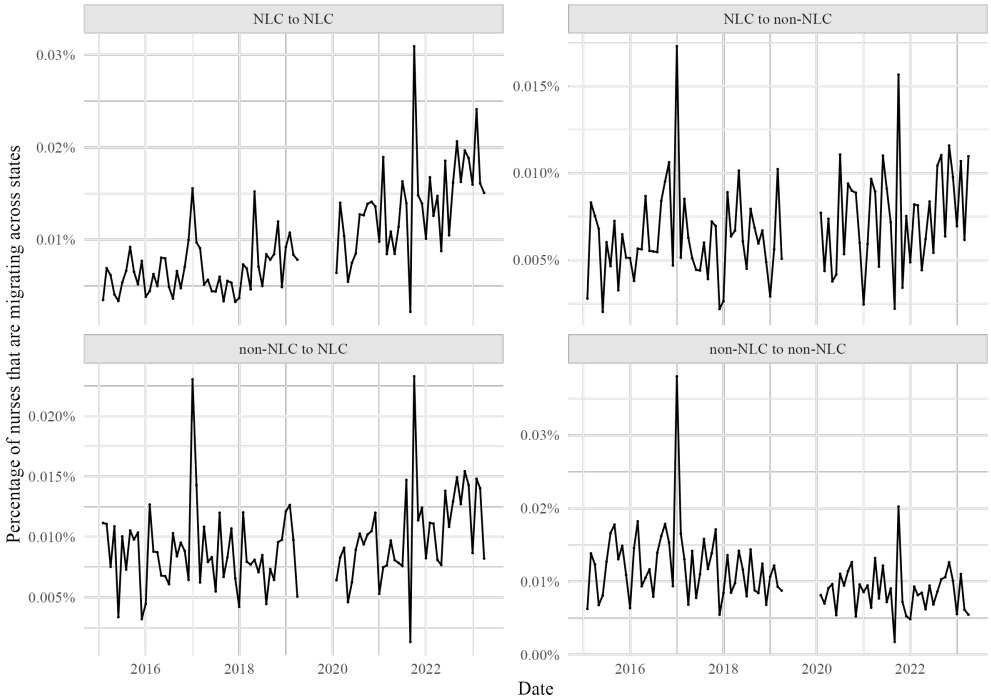
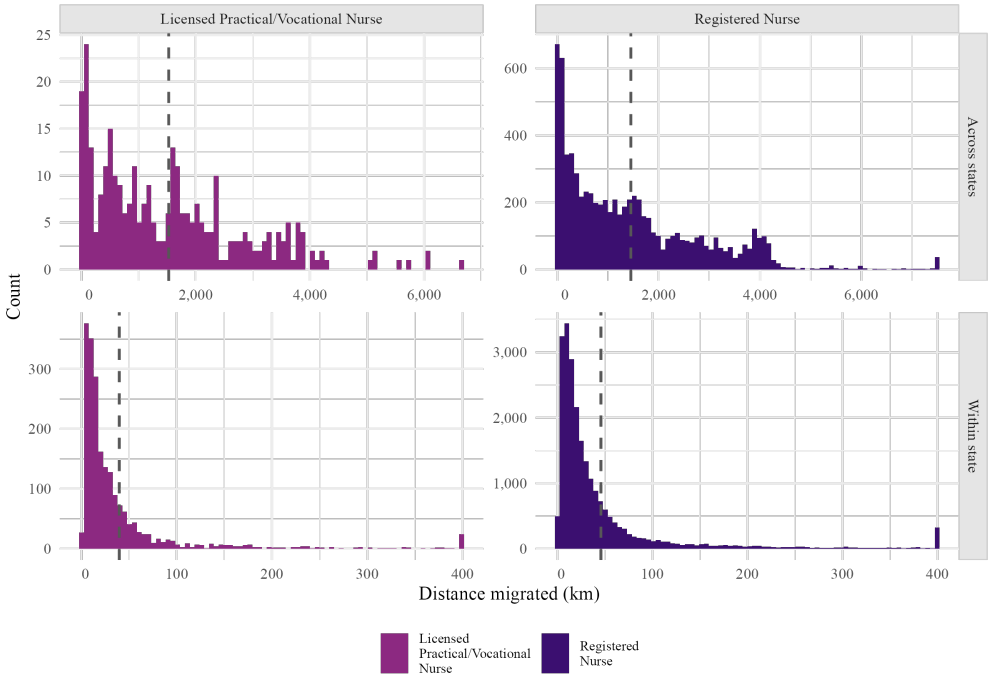


Figure 4: Direction of interstate mobility



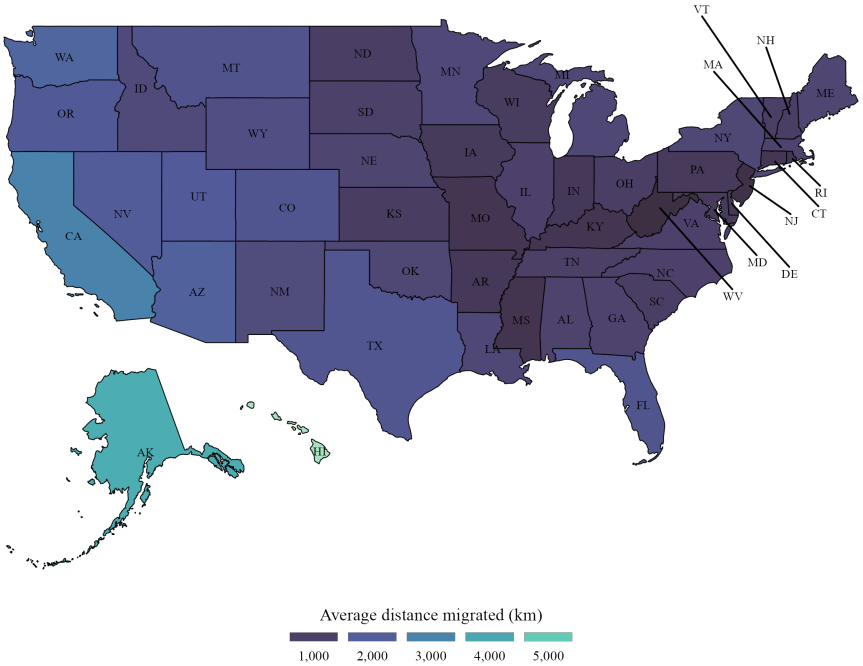
Note: Date is defined as the month that a provider appears in a different practice location than in previously. NPPES NPI data was unavailable from May to December 2019.

Figure 5: Distance migrated by nurse and mobility type



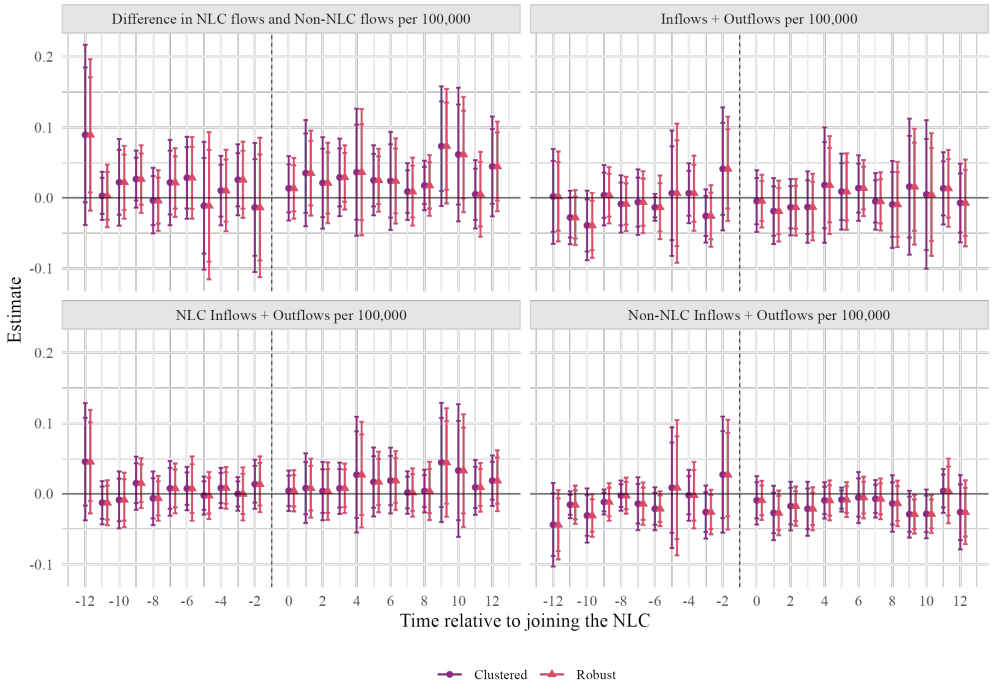
Note: For postal mobility, distances > 400km are winsorized. For state mobility, distances > 7500km are winsorized. Count denotes observations, not unique providers. For example, if a provider moves twice, each observation is included. Dashed line indicates winsorized mean.

Figure 6: Average distance migrated to arrive at a given state



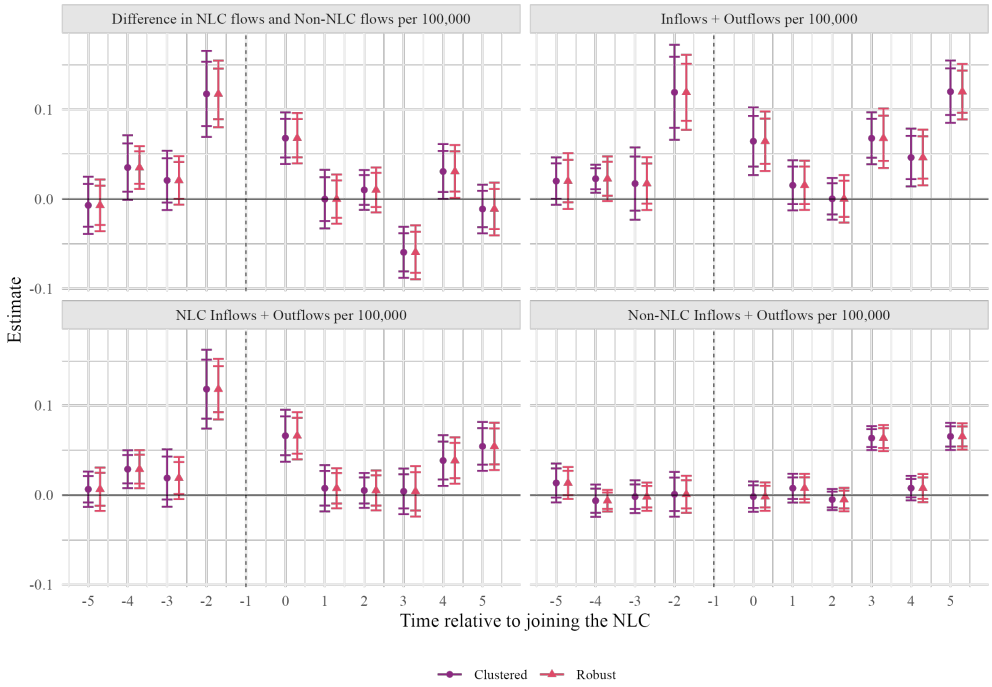
Note: Average distance migrated is defined as an average of the distance migrated across states to arrive at a given state. This average is computed using each instance of interstate migration, i.e. observations, not unique providers. For example, if a provider moves twice, each observation is included in the average.

Figure 7: State-level event study (2015-2019)



Note: Clustered standard errors are at the state-level. Error lines represent 95% and 99% confidence intervals respectively.

Figure 8: State-level event study (2020-2023)



Note: Clustered standard errors are at the state-level. Error lines represent 95% and 99% confidence intervals respectively.

Table 1: Analytical sample

Year	Months	Unique nurses	Observations	Female	LP/VNs	RNs	Intrastate mobility	Interstate mobility
2015	12	114,263	1,285,044	102,248	36,693	77,898	1,346	339
2016	12	124,028	1,413,100	110,845	40,027	84,068	1,674	410
2017	12	137,230	1,552,342	122,446	43,590	94,174	1,593	512
2018	12	147,992	1,682,317	131,862	46,764	101,835	1,606	478
2019	4	150,482	590,222	134,050	47,525	103,354	571	195
2020	12	169,422	1,942,784	150,437	52,417	117,813	3,204	909
2021	12	181,632	2,036,096	160,963	54,739	127,594	2,361	670
2022	12	189,889	2,176,634	168,143	57,148	132,903	2,607	780
2023	4	190,140	755,828	168,433	57,295	132,879	953	272
Total	12	205,104	13,434,367	181,094	60,299	146,287	13,902	4,159

Note: LP/VNs and RNs indicate number of unique Licensed Practical/Vocational Nurses, and Registered Nurses respectively.

Table 2: State characteristics by Nurse Licensure Compact membership

Statistic	NLC	Non-NLC
Number of states	36	15
Population	205,289,471	132,831,115
	Labor market	
Total number of employed nurses	2,147,960	1,658,550
Nurse jobs per 1,000	13.11	11.80
Non-nurse jobs per 1,000	4.28	4.31
Mean annual nurse wage	$70,879	$83,739
Mean annual non-nurse wage	$67,091	$75,845
Union membership	3.5%	8.2%
	Racial Demography	
	Non-nurses	
Female	50.8%	50.5%
White	76.5%	73.6%
Black	15.4%	10.4%
Hawaiian/Pacific Islander	0.2%	0.8%
Asian	4.0%	10.4%
Native	1.2%	1.2%
Other race	2.6%	3.5%
	Nurses	
Female	86.4%	85.6%
White	74.5%	68.1%
Black	19.5%	15.1%
Hawaiian/Pacific Islander	0.2%	0.6%
Asian	4.9%	12.9%
Native	0.5%	0.6%
Other race	0.4%	2.6%

Source: Bureau of Labor Statistics May 2023 National Occupational Employment and Wage Estimates [1], National Council of State Boards of Nursing.

Table 3: Impact of the Nurse Licensure Compact on individual probability of interstate mobility

Dependant variable:	Interstate mobility								
	2015-2023			2015-2019			2020-2023		
	All	Male	Female	All	Male	Female	All	Male	Female
Treated	0.0029*	0.0048	0.0026*	0.0005*	0.0008*	0.0004	0.0018	0.0030	0.0016
	(0.0013)	(0.0025)	(0.0012)	(0.0002)	(0.0004)	(0.0002)	(0.0009)	(0.0015)	(0.0008)
COVID-19 federal state of emergency	-0.1377	-1.2302	-0.5569						
	(9.6623)	(50.4189)	(48.4962)						
COVID-19 cases per 100,000	0.0000	0.0000	0.0000				0.0000	0.0000	0.0000
	(0.0000)	(0.0000)	(0.0000)				(0.0000)	(0.0000)	(0.0000)
COVID-19 deaths per 100,000	0.0000	0.0000*	0.0000				0.0000	0.0000*	0.0000
	(0.0000)	(0.0000)	(0.0000)				(0.0000)	(0.0000)	(0.0000)
Treated x COVID-19 federal state of emergency	-0.0027	-0.0045	-0.0024						
	(0.0014)	(0.0026)	(0.0012)						
COVID-19 Expedited License							-0.0115*	-0.0001	-0.0147*
							(0.0048)	(0.0001)	(0.0065)
COVID-19 Temp. License							0.0000	-0.0004	0.0000
							(0.0002)	(0.0003)	(0.0002)
COVID-19 Temp. License Waiver							-0.0002	-0.0002	-0.0002
							(0.0001)	(0.0002)	(0.0001)
COVID-19 Temp. License and Waiver							0.0002	0.0005	0.0002
							(0.0001)	(0.0003)	(0.0001)
Treated x COVID-19 Temp. License							-0.0008	-0.0011	-0.0007
							(0.0006)	(0.0009)	(0.0006)
Treated x COVID-19 Temp. License Waiver							0.0006	-0.0002	0.0007
							(0.0006)	(0.0008)	(0.0006)
Treated x COVID-19 Temp. License and Waiver							0.0001	-0.0021	0.0004
							(0.0006)	(0.0022)	(0.0006)
Dependant variable mean	0.0003	0.0005	0.0003	0.0003	0.0004	0.0003	0.0004	0.0006	0.0004
Adjusted R^2	0.01736	0.01896	0.01730	0.02143	0.02858	0.02151	0.02521	0.03078	0.02505
Observations	13,434,367	1,465,597	11,968,770	6,523,025	691,872	5,831,153	6,911,342	773,725	6,137,617
State fixed effects	✓	✓	✓	✓	✓	✓	✓	✓	✓
Nurse type fixed effects	✓	✓	✓	✓	✓	✓	✓	✓	✓
NPI fixed effects	✓	✓	✓	✓	✓	✓	✓	✓	✓
Year x Month fixed effects	✓	✓	✓	✓	✓	✓	✓	✓	✓

Note: A nurse is *treated* if their primary practice location is in a Nurse Licensure Compact state in a month prior to t. *Interstate mobility* = 1 if a nurse changes their primary practice location in a past month to another state in period t. COVID-19 cases, deaths and Licensure policy are defined at the state-month level. Standard errors are clustered at the state-level.

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 4: Impact of the Nurse Licensure Compact on distance migrated across states (km)

Dependant variable:	Distance migrated across states (km)		
	2015-2023	2015-2019	2020-2023
Treated	-0.1109	0.7581	0.2179
	(0.6756)	(1.5057)	(1.3019)
COVID-19 Temp. License	0.0631		0.9251
	(0.8111)		(1.2692)
COVID-19 Temp. License Waiver	-0.0559		-0.4960
	(0.6330)		(0.9943)
COVID-19 Temp. License and Waiver	0.7405		-0.6152
	(1.9272)		(2.7983)
COVID-19 cases per 100,000	-0.0002		0.0001
	(0.0002)		(0.0005)
COVID-19 deaths per 100,000	-0.0054		-0.0320
	(0.0173)		(0.0364)
Treated x COVID-19 Temp. License	0.0578		-0.5275
	(0.8619)		(2.3839)
Treated x COVID-19 Temp. License Waiver	0.2452		0.4205
	(0.6868)		(1.3088)
Treated x COVID-19 Temp. License and Waiver	-0.6900		0.6777
	(1.7212)		(2.8524)
Dependant variable mean	6.5604	6.5883	6.5399
Adjusted R^2	0.68766	-0.59964	0.74698
Observations	4,625	1,957	2,668
State fixed effects	✓	✓	✓
Nurse type fixed effects	✓	✓	✓
NPI fixed effects	✓	✓	✓
Year x Month fixed effects	✓	✓	✓

Note: A nurse is treated if their primary practice location is in a Nurse Licensure Compact state in a month prior to t. Distance migrated across states is computed by calculating the distance between most recently observed primary practice location and primary practice location in period t. COVID-19 cases, deaths and Licensure policy are defined at the state-month level.

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 5: Impact of the Nurse Licensure Compact on individual probability of intrastate mobility

Dependant variable:	Intrastate mobility		
	2015-2023	2015-2019	2020-2023
Treated	0.0000	0.0001	-0.0002
	(0.0001)	(0.0002)	(0.0001)
COVID-19 federal state of emergency	0.0086		
	(1.1172)		
COVID-19 cases per 100,000	0.0000**		0.0000**
	(0.0000)		(0.0000)
COVID-19 deaths per 100,000	0.0000*		0.0000
	(0.0000)		(0.0000)
Treated x COVID-19 federal state of emergency	0.0000		
	(0.0001)		
COVID-19 Expedited License			0.0011*
			(0.0005)
COVID-19 Temp. License			-0.0002
			(0.0002)
COVID-19 Temp. License Waiver			-0.0001
			(0.0001)
COVID-19 Temp. License and Waiver			-0.0001**
			(0.0000)
Treated x COVID-19 Temp. License			0.0003
			(0.0002)
Treated x COVID-19 Temp. License Waiver			-0.0002
			(0.0002)
Treated x COVID-19 Temp. License and Waiver			-0.0003**
			(0.0001)
Dependant variable mean	0.0012	0.0011	0.0014
Adjusted R^2	0.01243	0.01164	0.01482
Observations	13,434,367	6,523,025	6,911,342
State fixed effects	✓	✓	✓
Nurse type fixed effects	✓	✓	✓
NPI fixed effects	✓	✓	✓
Year x Month fixed effects	✓	✓	✓

Note: A nurse is *treated* if their primary practice location is in a Nurse Licensure Compact state in a month prior to t. *Zip mobility* = 1 if a nurse changes their primary practice location in a past month to another zip code within the same state in period t. COVID-19 cases, deaths and Licensure policy are defined at the state-month level.

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 6: Impact of the Nurse Licensure Compact on state-level nurse labor flows

	Nurse Flows		NLC Nurse Flows		Non-NLC Nurse Flows		NLC - Non-NLC Nurse Flows	
	2015-2019	2020-2023	2015-2019	2020-2023	2015-2019	2020-2023	2015-2019	2020-2023
Treated	0.0003	0.0524***	0.0154	0.0294***	-0.0150	0.0230***	0.0304	0.0064
	(0.0141)	(0.0095)	(0.0121)	(0.0079)	(0.0086)	(0.0042)	(0.0156)	(0.0084)
Percentage of nurses that are female	-0.0044	0.0046	-0.0004	0.0004	-0.0040	0.0042*	0.0036	-0.0037
	(0.0037)	(0.0030)	(0.0009)	(0.0023)	(0.0034)	(0.0019)	(0.0034)	(0.0030)
Percentage of nurses that are LP/VNs	0.0009	-0.0070	0.0006	-0.0061	0.0003	-0.0009	0.0002	-0.0053
	(0.0014)	(0.0043)	(0.0005)	(0.0044)	(0.0011)	(0.0014)	(0.0009)	(0.0049)
Percentage of bordering states in the NLC	-0.0207	-0.0247	-0.0125	-0.0405	-0.0081	0.0158	-0.0044	-0.0564
	(0.0246)	(0.0395)	(0.0133)	(0.0367)	(0.0197)	(0.0180)	(0.0229)	(0.0422)
Nurses per 100,000	0.0008	0.0020	-0.0001	0.0022	0.0009	-0.0002	-0.0011	0.0024
	(0.0011)	(0.0015)	(0.0004)	(0.0014)	(0.0009)	(0.0004)	(0.0008)	(0.0013)
COVID-19 cases per 100,000		0.0000		0.0000		0.0000		0.0000
		(0.0000)		(0.0000)		(0.0000)		(0.0000)
COVID-19 deaths per 100,000		-0.0003		0.0003		-0.0007*		0.0010*
		(0.0005)		(0.0003)		(0.0003)		(0.0004)
COVID-19 Expedited License		-0.0068		-0.0057		-0.0011		-0.0047
		(0.0066)		(0.0048)		(0.0032)		(0.0048)
COVID-19 Temp. License		-0.0068		-0.0167		0.0099		-0.0265
		(0.0132)		(0.0221)		(0.0111)		(0.0324)
COVID-19 Temp. License Waiver		0.0130		0.0092		0.0038		0.0053
		(0.0089)		(0.0068)		(0.0048)		(0.0077)
COVID-19 Temp. License and Waiver		0.0208		0.0163*		0.0045		0.0118
		(0.0106)		(0.0069)		(0.0069)		(0.0089)
Dependant variable mean	0.0531	0.0805	0.0257	0.0469	0.0274	0.0336	-0.0017	0.0133
Adjusted R^2	0.28635	0.44914	0.22410	0.38171	0.18472	0.28872	0.09441	0.21676
Observations	1,086	999	1,086	999	1,086	999	1,086	999
State fixed effects	✓	✓	✓	✓	✓	✓	✓	✓
Year x Month fixed effects	✓	✓	✓	✓	✓	✓	✓	✓

Note: Estimates are computed by averaging the Sun and Abraham interaction-weighted estimates of states joining the Nurse Licensure Compact (NLC). Treated = 1 if a state is a member of the NLC. All outcomes are computed by summing up the number of nurses changing their primary practice location to a given state in a given month and the number of nurses departing a given state to change their primary practice location to another state. This is then divided by the population in each state and multiplied by 100,000 to get flows per 100,000 people. COVID-19 cases, deaths and Licensure policy are defined at the state-month level. Each treated observation is observed for 12 months prior and post joining the NLC if the joined prior to 2020, and 6 months prior and post if joined after 2020. Standard errors are clustered at the state-level.

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 7: Impact of the Nurse Licensure Compact on individual probability of yearly interstate mobility

	Yearly interstate mobility	
	2015-2019	2020-2023
	(1)	(2)
Treated	0.0014	0.0053
	(0.0016)	(0.0028)
COVID-19 Expedited License		-0.1484***
		(0.0412)
COVID-19 Temp. License		-0.0008
		(0.0008)
COVID-19 Temp. License Waiver		-0.0014
		(0.0008)
COVID-19 Temp. License and Waiver		0.0002
		(0.0009)
COVID-19 cases per 100,000		0.0000
		(0.0000)
COVID-19 deaths per 100,000		0.0000
		(0.0000)
Treated x COVID-19 Temp. License		-0.0025
		(0.0028)
Treated x COVID-19 Temp. License Waiver		0.0025
		(0.0032)
Treated x COVID-19 Temp. License and Waiver		-0.0028
		(0.0027)
Dependant variable mean	0.0018	0.0020
Adjusted R^2	0.16072	0.17083
Observations	472,850	378,280
State fixed effects	✓	✓
Nurse type fixed effects	✓	✓
NPI fixed effects	✓	✓
Year x Month fixed effects	✓	✓

Note: A nurse is treated if their primary practice location is in a Nurse Licensure Compact state in a month prior to t. Yearly interstate mobility = 1 if a nurse changes their primary practice location to another state from the year prior to period t. COVID-19 cases, deaths and Licensure policy are defined at the state-month level. Standard errors are clustered at the state-level.

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

7 Appendix

7.1 Model

This analysis is framed by a static model of mobility decisions, as such from DePasquale and Stange 2016 [16]. The labor market can be characterized by three geographic areas: the current primary home state of residence (H), a location in another state that one can work in without permanently moving from state H either via daily commuting or short-term visits (T), and a location in another state that one permanently moves from state H for work (P). Nurses receive wage offers associated with each location in each period $\{W_{i,H}, W_{i,T}, W_{i,P}\}$. Nurses also receive random draws of utility associated with living in either H or P $\{e_{i,H}, e_{i,P}\}$. This utility is comprised of exogenous shocks such as family health shocks and spousal job prospects.

The transportation and/or temporary accommodation costs incurred to work in location T is $C_{i,T}$, whilst the cost permanently relocating to location P is $C_{i,P}$, such that $C_{i,T} < C_{i,P}$. For example, travel nurses that have multiple short-term assignments in one year may work in location T whilst maintaining primary residence in H. During these assignments, nurses incur transportation and accommodation costs, but do not move all of their belongings to location T, purchase or rent a new home, and pay other costs associated with permanently moving to location P. As a result of the state-level occupational licensing system, to work in either location T or P nurses pay a licensing cost L. Due to the similarity of the process of obtaining a multi-state license for NLC nurses permanently relocating to another NLC and the process for non-NLC nurses obtaining a single-state license, I modify DePasquale and Stange's framework by asserting that licensing cost L is only eliminated for nurses working in location T. The clearing conditions for interstate mobility are as follows.

Nurses will relocate permanently from state H to location P if:

$$max\{W_{i,H} - C_{i,P} - L, 0\} + e_{i,P} > max\{W_{i,H}, W_{i,T} - C_{i,T} - L, 0\} + e_{i,H}$$

For the case that both home state H and location T are in the NLC, the licensing cost L is dropped from the right hand-side of the clearing condition to become:

$$max\{W_{i,H} - C_{i,P} - L, 0\} + e_{i,P} > max\{W_{i,H}, W_{i,T} - C_{i,T}, 0\} + e_{i,H}$$

Nurses will work in location T without permanently relocating from H if:

$$W_{i,T} - C_{i,T} - L > W_{i,H}$$

Similarly, the elimination of the licensing costs associated with working in location T whilst maintaining primary residence in location H means that if both locations are in the compact, nurses will work in location T if:

$$W_{i,T} - C_{i,T} > W_{i,H}$$

The introduction of pandemic-era licensing policies can be viewed as the reduction of licensing costs L for both location T and P because all reforms either reduced the time delay between applying for licensure and obtaining licensure, eliminated licensing fees and background checks, or both. Using this framework, this paper will analyze the relationship between reduced licensing costs via NLC membership, pandemic-era policies, or both on interstate mobility. As I am more likely to detect within-year movement of nurses satisfying $W_{i,T} - C_{i,T} > W_{i,H}$, a monthly-level definition of mobility is most suited to exploring the differential effect of the multi-state license by permanent and temporary migration for work.

It is important to bear in mind a few components of the mobility decision that are excluded from this analysis. Among heterosexual married couples, some studies find evidence of mobility decisions weighing the male's job prospects more [67–69]. This component is beyond the scope of this paper, as I am unable to identify married couples due to limited individual level data. The effect of other individual characteristics such as age, number of dependants in the household, education and job experience are also excluded.