

Alleviating Worker Shortages Through Targeted Subsidies: Evidence from Incentive Payments in Healthcare*

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Abstract

Worker shortages are common in many industries. This paper examines the effect of government subsidies to address these shortages in the context of a reform that tied Medicaid payments to nursing home staffing levels. We find that the reform substantially increased staffing, especially for facilities serving many Medicaid patients. Facilities responded primarily by hiring workers in lower-wage roles rather than increasing hours of incumbent or high-wage staff. This contrasts with null effects we estimate for a non-incentivized rate increase, suggesting that the incentive structure of government payments—rather than just the level—is key to boosting employment in sectors facing worker shortages.

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1 Introduction

Worker shortages are common in many industries. In sectors that serve important public needs, such as education, healthcare, transportation, social services, and law enforcement, low staffing can have devastating consequences including poor student educational outcomes (Angrist and Lavy, 1999; Das et al., 2007; Chetty et al., 2011), high patient mortality (Aiken et al., 2002; Gruber and Kleiner, 2012; Stevens et al., 2015; Friedrich and Hackmann, 2021), and more major accidents (Huerta et al., 2023; Steel and Ember, 2023). Because the government often regulates, finances, or operates these industries, policymakers have proposed numerous ways to increase staffing. These include raising wages or benefits where the government is an employer (Britton and Propper, 2016; Dal Bó et al., 2013), increasing payments where the government is a payer (Harrington et al., 2007; Hackmann, 2019), or setting standards such as minimum staffing requirements where the government is a regulator (Angrist and Lavy, 1999; Krueger, 1999; Harrington et al., 2000; Matsudaira, 2014; Lin, 2014).

This paper examines the efficacy of employment subsidies as a way for governments to increase staffing in particular industries. We leverage a 2022 reform in Illinois that tied a large component of nursing home Medicaid payments to facilities' staffing levels. This reform is unique, both in its size and that it directly connected Medicaid reimbursement to staffing levels. Other proposed or implemented Medicaid reforms typically either raise rates universally (Cohen and Spector, 1996; Hackmann, 2019; Gandhi, 2023) or base reimbursement on reported historical costs (Nyman, 1985; Gertler, 1989, 1992; Cohen and Spector, 1996; Foster and Lee, 2015). In contrast, the Illinois reform provides large reimbursements to facilities as a function of actual staffing.

The nursing home industry is an ideal setting to study the effects of incentive payments on worker shortages for at least three reasons. First, nursing homes are a labor-intensive industry: nurse staffing costs exceed one-third of revenue for the typical firm (Bowblis et al., 2023), and worker shortages are common. Most facilities do not meet staffing standards four out of five days (Geng et al., 2019). The COVID-19 pandemic exacerbated these shortages (McGarry et al., 2020; Shen et al., 2022), even as nursing home occupancy dropped dramatically (Werner and Coe, 2021). The state we study, Illinois, faces the worst shortages in the country (Illinois HFS, 2023), and this shortage was a motivation for the reform. These shortages likely arise because since facilities receive payment on a per-diem basis—regardless of the quality of care—they may be reluctant to raise wages or increase staffing. Competition does little to alleviate these issues, since patients primarily choose facilities based on location, and nursing home quality can be difficult to measure or interpret, especially for the large fraction of residents with cognitive decline.

Second, nursing home employment has social welfare implications. Nursing homes serve approximately 1.3 million Americans per day, the vast majority of whose stays are financed by taxpayers through Medicare and Medicaid. These residents are a vulnerable population whose physical and cognitive impairments make it difficult for them to advocate for better care without government intervention. The Centers for Medicare & Medicaid Services (CMS) considers staffing to have “the greatest impact on the quality of care nursing homes deliver” (Centers for Medicare & Medicaid Services, 2019), and research likewise finds that poor staffing worsens resident health (Lin, 2014) and increases mortality (Friedrich and Hackmann, 2021). Indeed, the relationship between staffing levels and patient outcomes is so strong that staffing *itself* has become the *de facto* nursing home quality measure used most commonly by researchers, consumers, and regulators. Accordingly, there is substantial policy interest in increasing nursing home staffing. For example, many states have implemented minimum staffing requirements (Lin, 2014; Matsudaira, 2014), and CMS has proposed federal minimums (Grabowski and Bowblis, 2023).

Third, the healthcare industry is a prime example of an industry where even though services are primarily provided by private firms, the government finances many of these operations (Poterba, 1996). Other such industries include those that are heavily-reliant on government contracts, such as defense, construction, and manufacturing. While governments often aim to affect employment in these settings—e.g., by requiring or subsidizing use of union labor or imposing a higher minimum wage—there is little evidence on how government payments affect employment in these settings.

In order to examine the effect of incentive payments on staffing levels, we use a difference-in-differences event study approach that compares staffing changes at Illinois nursing homes occurring around the reform to within-facility changes in other states. We leverage administrative data on nearly every daily shift for every worker in the industry, which allows us to measure the effect of the policy on total employment, the type of workers that are employed, and the types of shifts that they work.

We find a sharp, substantial, and sustained increase in staffing after the incentive payments were implemented. The reform increased the staffing levels for the average facility by 5.35% of the clinical target, equivalent to 106.15 hours of staffing per week for the typical facility. The staffing increases were almost entirely concentrated in facilities with a large fraction of Medicaid patients and therefore a high degree of exposure to the incentive payments. We also find that firms were cost-conscious, increasing staffing primarily among low-wage certified nursing assistants (CNAs) rather than more highly-certified but higher-wage nursing staff. Facilities increased staffing primarily on the extensive margin, hiring new workers rather than increasing the hours worked by each employee or increasing retention of existing

employees. The incentive payments also slightly shifted facilities' employment composition towards part-time workers and contract staff. While greater use of contract staff has been associated with lower quality in previous work (Castle and Engberg, 2007; McMaster, 1995; Rebitzer, 1995), we still find suggestive evidence that clinical quality improved following the reform, consistent with higher staffing leading to better resident outcomes.

We contrast our findings with a 2019 reform that substantially raised Medicaid reimbursement rates but did not tie them to staffing or quality measures. Industry groups, academics, and policymakers often argue that such unconditional rate increases could improve staffing either by alleviating financial constraints (Harrington et al., 2007) or inspiring competition to attract Medicaid patients (Grabowski, 2001; Hackmann, 2019). Contrary to these assertions, we find no effect of the 2019 reform, suggesting that the incentive-based nature of the 2022 reform was a key driver of the reform's effectiveness.

While effective at increasing staffing, the 2022 incentive payments came at a significant financial cost to the government: the state paid out approximately \$60.5 million in the first quarter of 2023 alone. However, our estimates indicate that a large share of spending on high-Medicaid facilities was passed-through to workers: each additional dollar of incentive payments generated \$0.86 worth of staffing increases at market wages. This high degree of passthrough is because high-Medicaid facilities tended to have low staffing before the reform and therefore typically only received large payments when they substantially increased staffing. In contrast, payments to low-Medicaid facilities were far less effective: \$1 in incentive payments to these facilities increased staffing by just \$0.04. This lower passthrough occurs because low-Medicaid facilities also tended to have higher pre-reform staffing levels, and therefore received much larger per-patient payments even with minimal or no improvements to staffing. Finally, we note that because quality at nursing homes is a common good across all patients, some of the benefits of the staffing incentive payments accrue to non-Medicaid patients. Therefore, if Medicaid programs focus only on the benefits to Medicaid patients, this will miss some of the social benefits of the payment incentives.

2 Institutional background and policy reform

2.1 Staffing and care needs in nursing homes

Nursing homes provide residential and around-the-clock medical care to individuals who require assistance with activities of daily living (ADLs), such as eating, bathing, mobility, and toileting. Most residents are elderly, but their care needs can vary widely, from post-acute rehabilitative therapy to long-term skilled nursing care for various physical and cognitive

ailments. The typical nursing home resident receives 3.6 hours of daily care from a mix of three types of nursing staff: Registered Nurses (RNs), Licensed Practical Nurses (LPNs), and Certified Nursing Assistants (CNAs). The job tasks and educational requirements vary across these occupations. RNs, who typically have a 4-year nursing degree, develop treatment plans, administer medical treatment, and interpret medical results. LPNs typically have a 2-year degree, and they administer IVs and other basic medical treatment, prepare treatment rooms, and supervise CNAs. CNA work requires a credential, but typically no degree, and involves helping residents with activities of daily living, cleaning resident rooms, and communicating basic information with family members. Reflecting these different tasks and educational requirements, pay substantially differs across nursing occupations. For example, in May 2022, median CNA pay in nursing homes was \$17.06/hour, LPN pay was \$28.10/hour, and RN pay was \$36.53/hour (Bureau of Labor Statistics, 2023).

Higher staffing levels, especially among licensed nurses (i.e., LPNs and RNs) are associated with a higher quality of care (Lin, 2014; Mukamel et al., 2022, 2023) for health outcomes (Figueroa et al., 2020; Friedrich and Hackmann, 2021) and for quality of life more generally (Shippee et al., 2015). Indeed, given the labor-intensive nature of nursing home care, staffing levels are often relied on as a standalone proxy for quality. All states have implemented some form of minimum staffing requirements (Consumer Voice, 2021), and staffing levels are one of three key quality indicators on CMS’s consumer-facing Nursing Home Compare website.

Because the care needs of residents varies across facilities, a facility’s staffing level must be compared relative to the needs of its residents. To measure resident care needs, the federal government uses mandatory health assessments to categorize each resident into one of 66 Resource Utilization Groups (“RUG”) based on the severity of their clinical and functional needs. CMS then maps these RUGs to a “clinical target” amount of care based on the CMS Staff Time Resource Intensity Verification (STRIVE) study. Summing the STRIVE targets of patients in a facility gives a case-mix-adjusted clinical target level of staffing for the facility as a whole. The ratio of a facility’s actual staffing level to its target staffing level is known as the “STRIVE ratio.” For ease of exposition, we use the terms “STRIVE ratio” and “percent of clinical target” interchangeably.

Two caveats are important in interpreting the STRIVE ratio. First, many researchers and advocates believe that the STRIVE targets are substantially lower than the number of hours needed to provide high-quality care (Harrington et al., 2020), and therefore the ideal staffing level exceeds a 100% ratio. Indeed, the policy we study incentivizes increasing staffing up to 125% of STRIVE. Second, STRIVE ratios and the incentive payments we study do not distinguish between the hours of care provided by staff with differing levels of certification. Correspondingly, it is common to examine staffing levels separately for each staff type. For

example, CMS uses both the total STRIVE ratio and RN staffing levels specifically when evaluating nursing home staffing.

In addition to low staffing *levels*, there is also concern about high staffing *flows*. Staff turnover, especially among CNAs, is high, with most facilities having an annual CNA turnover rate exceeding 100 percent. High turnover of staff disrupts the care that residents receive and is associated with lower quality care (Gandhi et al., 2021; Loomer et al., 2022; Shen et al., 2023; Zheng et al., 2022)

2.2 Illinois Medicaid incentive payment reform

More than 60% of nursing home bed-days are paid for by Medicaid. Medicaid reimbursement formulas vary across states, but typically provide a per-diem amount for each Medicaid resident, with possible adjustments for factors such as geography or care needs.

On April 7, 2022, the Illinois legislature passed House Bill 0246 (HB0246), which aimed to increase staffing by changing how the state’s Medicaid program reimbursed nursing facilities.¹ The largest component of HB0246 was a staffing level incentive payment for nursing homes. These incentive payments provided an additional \$9 per Medicaid-resident-day for facilities achieving 70% of the clinical target and gradually increased to a maximum of \$38.68 per Medicaid-resident-day for facilities achieving at least 125% of the target.² Crucially, the incentive payments were quite large compared to the base per-diem, which averaged \$181.78 prior to the reform. Additionally, only 11.0% of Illinois facilities staffed above 125% prior to the reform, indicating that the upper threshold was rarely binding. Appendix B provides additional details on the timing and other components of HB0246.

Three additional points about the incentive payments are worth emphasizing. First, because the policy only increases Medicaid reimbursements, facilities with more Medicaid residents are more “exposed” to the payment reform and should therefore be more responsive. Second, because payments are based on staffing *levels* rather than *changes*, facilities with high levels of staffing receive large payments even if they would have had high staffing without the incentive payments. Finally, because the incentive payments do not distinguish between levels of nursing staff certification, a cost-conscious facility can achieve high staffing levels through CNAs rather than more expensive LPNs and RNs, and could even reduce expenditures on LPNs and RNs.

¹Though the bill was formally signed into law on May 2022, we treat April 1 (i.e. the start of 2022Q2) as the “event date” because executive approval was virtually certain given that the governor supported the bill.

²The shape of the incentive schedule is shown in Figure 1a. Facilities staffing below 70% of the clinical target did not receive any incentive payment.

3 Data and empirical approach

3.1 Data

Our primary data are the Payroll-Based Journal (PBJ). These administrative microdata provide shift-level information on all direct care staff for the universe of nursing homes, including a facility-specific unique identifier for each worker, the number of hours worked that day, occupation (i.e., RN, LPN, or CNA), and whether the worker was paid as an employee or as a contractor. Over our sample period (2021Q2-2023Q2), these data contain 16.8 million nursing shifts for 702 Illinois facilities, and 359.2 million nursing shifts for 14,623 non-Illinois facilities.

The PBJ data derive from payroll records submitted quarterly by nursing homes to CMS that are used to assess facilities' staffing levels. Facilities typically export their submissions directly from their payroll software, and submissions are subject to audit risk. As such, PBJ data provide a particularly reliable and precise measure of hours worked. Reporting rates are very high: the average facility reported staffing data for 106.2 of 111.00 weeks in our analysis period. While our panel is not fully balanced, we show robustness to using a fully balanced sample in Appendix Section F.1. Additional details on the data and sample are in Appendix A.

Our main outcome measures are constructed at the facility-week level from the PBJ. In addition to constructing staffing measures for the facility as a whole, we also construct measures separately by staff role, full-time and part-time staff, and employees and contractors. The unique employee identifiers also allow us to track changes to individual employees' hours, as well as track facilities' hires and departures. This allows us to construct measures to decompose effects by the extensive margin (e.g., additional workers) and intensive margin (e.g., additional hours worked by existing employees). To ease interpretation of comparing effects across different-sized facilities, we scale these employee counts by the average daily resident census in the facility-week, which is also provided in the PBJ.

We supplement the PBJ microdata with quarterly data from Nursing Home Compare (NHC), a consumer-facing report card for each facility. Crucially, NHC provides a quarterly measurement of each facility's patient case mix, which we use to adjust staffing levels for the clinical needs of a facility's patients. We interpolate between quarter midpoints to arrive at our weekly clinical target staffing percentage outcome. NHC also contains additional facility characteristics—e.g. number of beds and location—that are used in our analysis. Finally, the NHC data also provide information on patient-centered health outcomes derived from federally-mandated quarterly patient health assessments that we use to study impacts on

clinical outcomes in Appendix D.

Lastly, in order to examine heterogeneity in our results by facilities that are more and less reliant on Medicaid reimbursements, we use LTCFocus data to obtain the share of residents whose primary support was Medicaid at the time of the facility’s 2019 annual survey.

3.2 Empirical approach

To identify the effects of the incentive payments, we use a difference-in-differences (DD) event study approach that compares staffing in Illinois facilities (the “treatment” group) to facilities in all other states (“control group”). Specifically, we estimate:

$$y_{it} = \sum_{\tau \neq -1} \beta^\tau (IL_i \times d_t^\tau) + \alpha_i + \alpha_t + \varepsilon_{it} \quad (1)$$

where i indexes facility and t indexes time (in weeks). α_i and α_t are facility and time fixed effects, respectively. The d_t^τ terms denote calendar-week dummies, and IL_i is an indicator for Illinois facilities. The coefficients of interest are the β^τ terms, which capture the differences in y_{it} between Illinois facilities and the rest of the United States. All estimates are normalized relative to one week before the reform (i.e., relative to $\tau = -1$). For ease of interpretation, we add the average outcome of the treatment group in the omitted period to all estimates in order to provide a sense of scale relative to typical outcome levels.

This approach captures the effect of the Illinois reform if the parallel trends assumption holds: that is, any average *differential* changes in y_{it} in Illinois relative to the rest of the United States are due to the policy reform. While this assumption is not testable, we can assess its plausibility by examining the trends in β^τ over the period preceding the passage of the reform. Little divergence in trends between Illinois facilities and facilities in the rest of the United States over this pre-treatment period bolsters confidence in the parallel trends assumption.

Our main approach uses data from April 1, 2021 ($\tau = -52$) through May 14, 2023 ($\tau = 59$).³ The analysis period begins after Covid-19 vaccinations became available, avoiding the peak of the pandemic in nursing homes.⁴ The post-treatment period begins on April 1, 2022 (a week before the reform’s passage in the legislature) because the revised payments retroactively applied to staffing levels beginning on April 1, 2022. Moreover, facilities may have anticipated the reform’s passage as it moved through the legislature.

³Our sample period ends mid-quarter because the staffing target variable is measured quarterly, and we define weekly STRIVE ratios by interpolating the denominator between quarter midpoints.

⁴Appendix Section F.1 shows similar results for a longer pre-period that begins in 2020Q2.

Because the Illinois reform adjusts the per-diem Medicaid payments that facilities receive from the state, facilities that have a larger share of Medicaid residents have stronger incentives to increase staffing. Accordingly, we assess heterogeneity in the treatment effects by interacting the treatment effect indicators ($IL_i \times d_i^\tau$) with indicators for whether the facility has a high- or low- share of Medicaid residents, defined by whether a facility’s share of Medicaid patients fell above or below the Illinois median in 2019 (58.3%).

In addition to presenting event study analyses, we also provide a “pooled” difference-in-difference estimate that summarizes the difference before and after the reform. Given potential anticipatory responses, as well as the time required to hire new workers or adjust schedules, the pooled DD estimates exclude one quarter on either side of the treatment date.

For our main analyses, we report heteroskedasticity-robust standard errors clustered at the facility-level, as this is the unit of analysis in our panel data. Appendix G provides results under alternative cluster schemes such as clustering at the state level, in addition to non-parametric block bootstrap and permutation procedures. These results indicate that facility-level clustering is generally more conservative than other approaches in this setting.

4 Results

4.1 Effects of the reform

Figure 1 previews our main result. Panel (a) presents the target staffing distribution for facilities in Illinois in 2022Q1, the last quarter before the reform passed, as well as the distribution four quarters later in 2023Q1. Panel (b) presents the staffing distributions for all non-Illinois facilities in the same periods. The divergence between panels (a) and (b) summarizes our key result: there was a noticeable rightward shift in the Illinois distribution after the reform but no distinguishable change in non-Illinois facilities.

Figure 2 formalizes the intuition from Figure 1 in the event study specification from equation (1). Panel (a) shows staffing levels for the full sample. The stability of the β^τ estimates prior to the reform indicates that Illinois facilities were not on different staffing trajectories relative to the rest of the country before the staffing incentives were introduced. In the post-treatment period, we find a steady increase that levels off in 2022Q4, consistent with firms learning and adapting to the new incentives over the first few quarters. Comparing the pooled estimates for the post-period and the pre-period (excluding the quarter on either side of the treatment) indicates that the reform increased the staffing ratio by 5.35 percentage points. This increase is equivalent to moving from the 50th to the 57.1st percentile of the pre-reform distribution in Illinois.

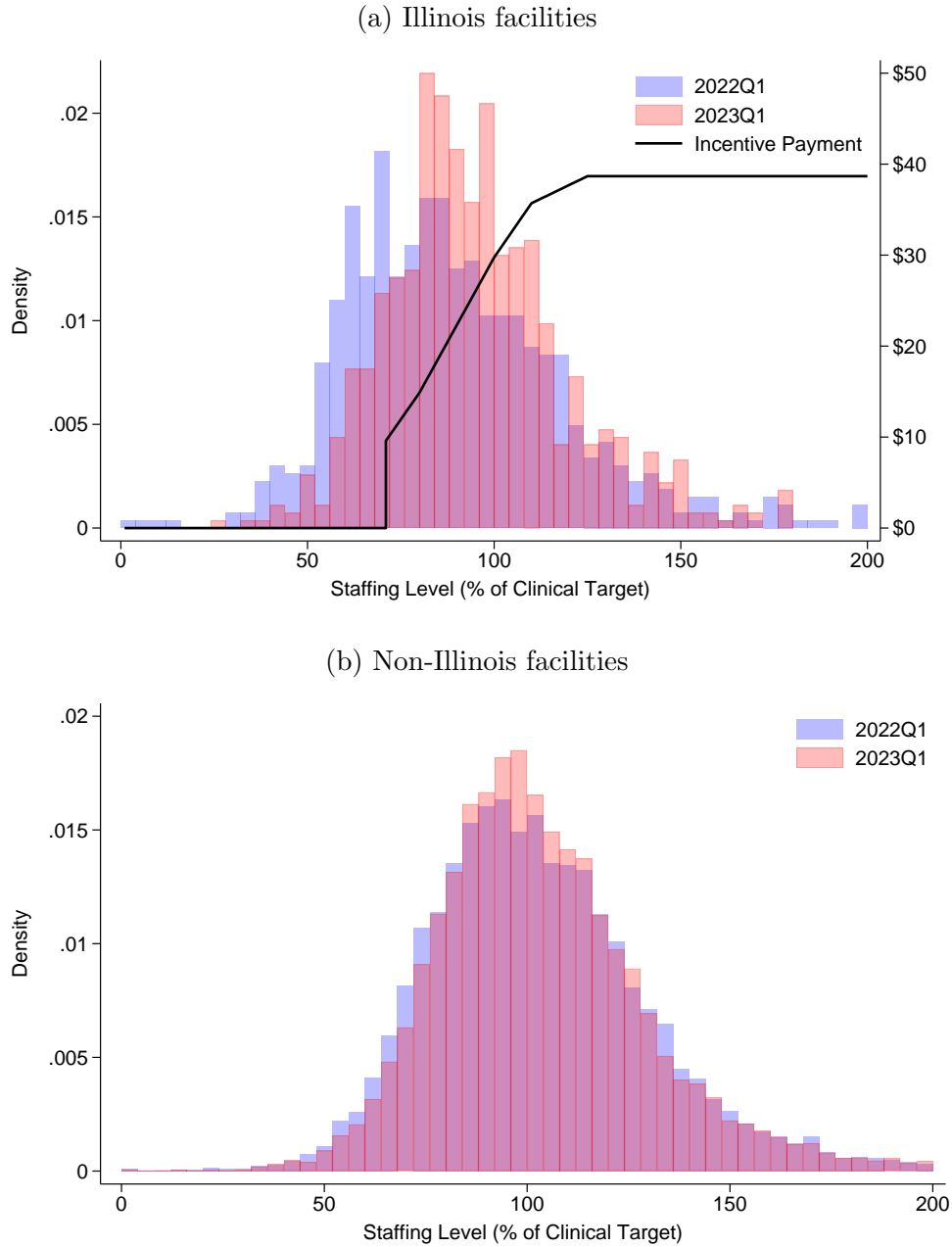


Figure 1: Comparison of staffing levels in 2022Q1 vs 2023Q1, Illinois and non-Illinois facilities

Notes: Figure plots histograms of facility-quarter staffing levels, expressed as a percent of the STRIVE target staffing level, for 2022Q1 (blue) and 2023Q1 (red). Panel (a) presents staffing levels for Illinois facilities; panel (b) presents staffing levels for non-Illinois facilities. Staffing levels exceeding 200% are excluded. Panel (a) overlays the reform incentive payment schedule (black line).

The response in Figure 2a averages across firms with varying exposure to the reform. Crucially, while facilities' per-resident staffing levels were calculated using all of the facilities'

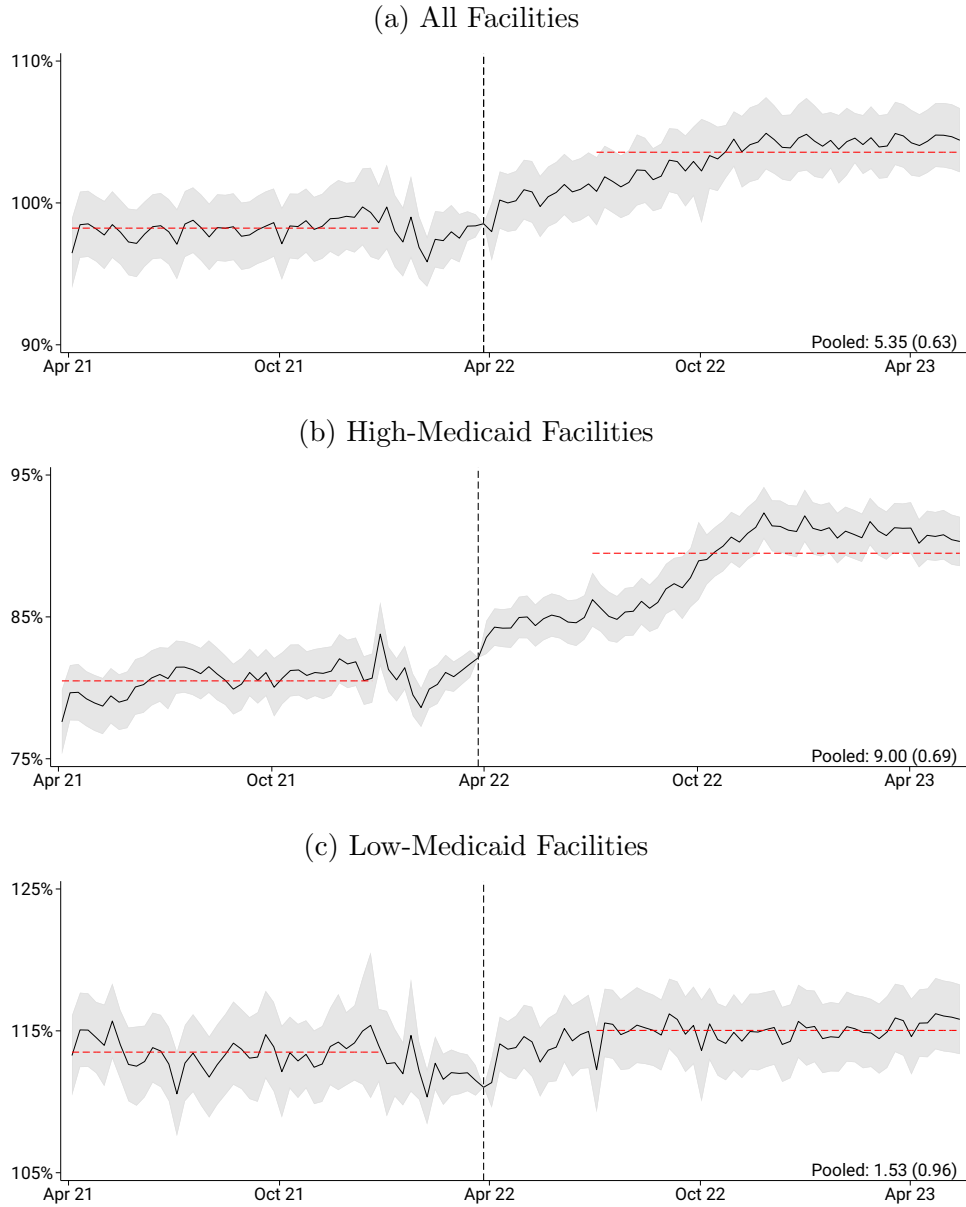


Figure 2: Staffing Levels (% of Clinical Target), by Medicaid Payer Share

Notes: Figure presents results from difference-in-difference event study regressions with each outcome centered around the mean value in Illinois during the week before the effective date. Gray area denotes 95% confidence interval with robust standard errors clustered by facility. $N=4,083,670$ facility-week observations corresponding to $N=15,828$ facilities. Dependent variable is total nurse (RN, LPN and CNA) staffing hours, expressed as a percent of the STRIVE target staffing level. The vertical line indicates the effective date of the reform: April 1, 2022. The red horizontal lines indicate pre-treatment and post-treatment averages, excluding the quarter prior and the quarter after the reform. The pooled estimate in the lower-right corner provides the difference between the post- and pre-treatment average coefficients. The standard error of this difference is reported in parentheses. High (low) Medicaid facilities defined as whether the facility had above (below) the median share of Medicaid residents in 2019 (58.3%).

residents, without regard to payer, the incentive payments increased reimbursements *only for Medicaid residents*. Therefore, the staffing incentive payments created substantially stronger financial incentives for facilities with more Medicaid residents. Accordingly, in the subsequent panels, we stratify facilities as either ‘high-’ or ‘low-Medicaid,’ corresponding to whether they had above- or below-median Medicaid shares. Two observations emerge: first, high-Medicaid facilities tend to have much lower staffing levels at baseline, which is consistent with facilities serving Medicaid populations being lower quality (Gertler, 1992; Rahman et al., 2014; Ching et al., 2015; Gandhi, 2023). Prior to the reform, the mean staffing at high-Medicaid facilities was 82.1% of the clinical target (Figure 2b), compared to 111.0% at low-Medicaid facilities (Figure 2c). Second, we find that, as expected, the effect of incentive payments was concentrated among high-Medicaid facilities: these facilities increased their staffing by 9.00 percentage points compared to just 1.53 percentage points in low-Medicaid facilities. Both the lack of pre-trends and the concentration of the effect in highly-exposed facilities strongly suggest that the effects we estimate are the result of the payment reform.

Because the incentive payments reduce the effective wage for marginal hours of labor, the staffing response provides an estimate of the own-wage elasticity of labor demand ($\epsilon = \left(\frac{\partial emp}{\partial wage}\right) \left(\frac{wage}{emp}\right)$). We calculate these elasticities for each firm in Appendix C. The average labor demand elasticity implied by these estimates is -0.142 , squarely within the existing estimates and particularly consistent with others examining short-term responses in the United States (Lichter et al., 2015). However, this average elasticity masks considerable heterogeneity. For example we find that the average implied elasticity for high-Medicaid facilities is -0.200 , compared to -0.097 for low-Medicaid facilities.

Just as high-Medicaid facilities faced stronger incentives to raise staffing at the margin, facilities faced differing incentives to adjust staffing depending on their initial staffing levels. Facilities with very low baseline staffing faced strong incentives to improve to at least the 70% benchmark given the significant discontinuous jump from \$0 to \$9 in per-resident payments for achieving that level. On the other extreme, facilities that were operating at very high staffing levels (above 125%) faced no marginal incentives because the reimbursement formula is flat above 125%. Facilities between 70% and 125% faced a relatively consistent marginal incentive to increase staffing.

Figure 3 explores this heterogeneity by presenting estimates of the treatment effect at each point of the pre-treatment staffing distribution. To do this, we allow the treatment effect to be a cubic polynomial in a facility’s pre-treatment staffing level.⁵ We follow Acemoglu and Finkelstein (2008) in accounting for heterogeneous Medicaid exposure by interacting the

⁵Appendix Figure E.5 presents comparable estimates from a piecewise quadratic regression, with different curves fit over the regions of the incentive payment schedule.

binary treatment with Medicaid share.⁶ Accordingly, the curve in Figure 3 can be interpreted as the treatment effect for a facility with only Medicaid residents.

Figure 3 indicates that the largest staffing increases occurred among facilities with low staffing prior to the reform. The effect size declines steadily with pre-treatment staffing levels and, as predicted, is statistically indistinguishable from zero for facilities above the 125% threshold.

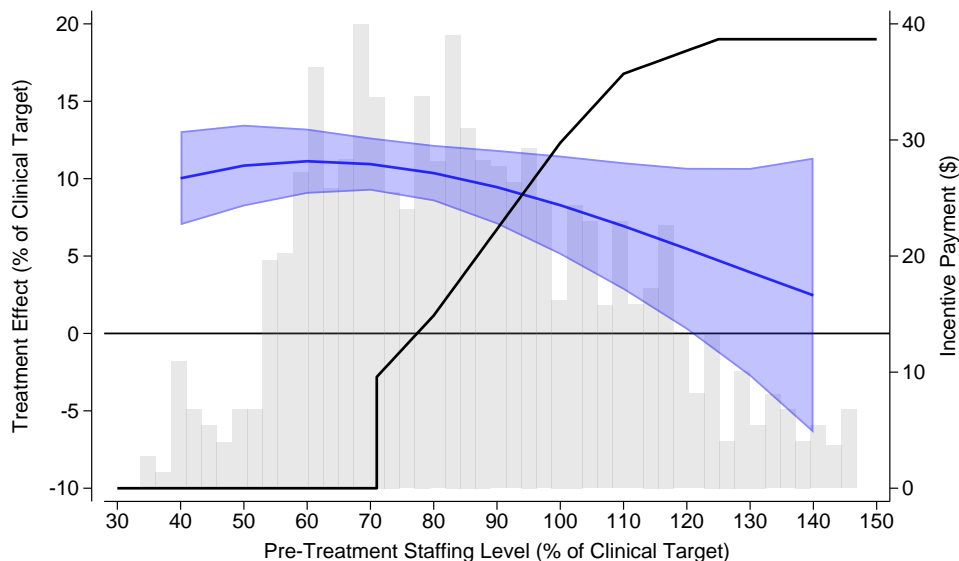


Figure 3: Heterogeneity by Pre-Treatment Staffing Level

Notes: Figure presents treatment effects across the pre-treatment staffing level distribution. Treatment effects are calculated using cubic polynomials in pre-treatment staffing. Treatment is assumed to scale linearly in Medicaid share. As with all pooled estimates, we exclude the quarters immediately before and after the reform. Shaded area denotes 95% confidence interval with robust standard errors clustered by facility. Baseline staffing distribution in gray histogram; black line denotes the incentive payment schedule.

Figure 4 focuses on high-Medicaid facilities and examines various margins of staffing adjustment that may have generated the overall increase in staffing. Panels (a), (b), and (c) examine the contributions of CNA, LPN, and RN nursing staff to the overall staffing ratio. By far the largest contributor to the overall staffing growth comes from higher CNA staffing: the CNA component of the STRIVE ratio rises by 6.64 percentage points, compared to 1.26 for LPNs and 1.10 for RNs. As firms are rewarded for their total staffing and not their “skill-mix,” increasing hours primarily of the lowest-cost staff suggests that facilities were cost-conscious in their approach to obtaining greater staffing incentive payments. These changes alter the average skill-mix: the reform increased the share of hours that come from CNAs by 1.74 percentage points (Panel (d)). Importantly, however, the estimates imply

⁶This implicitly assumes a linearity of treatment effect in Medicaid share, as well as a stronger form of parallel trends (Callaway et al., 2024).

that this shift occurs primarily through *additional* CNA employment and not from cutting or replacing highly certified staff.

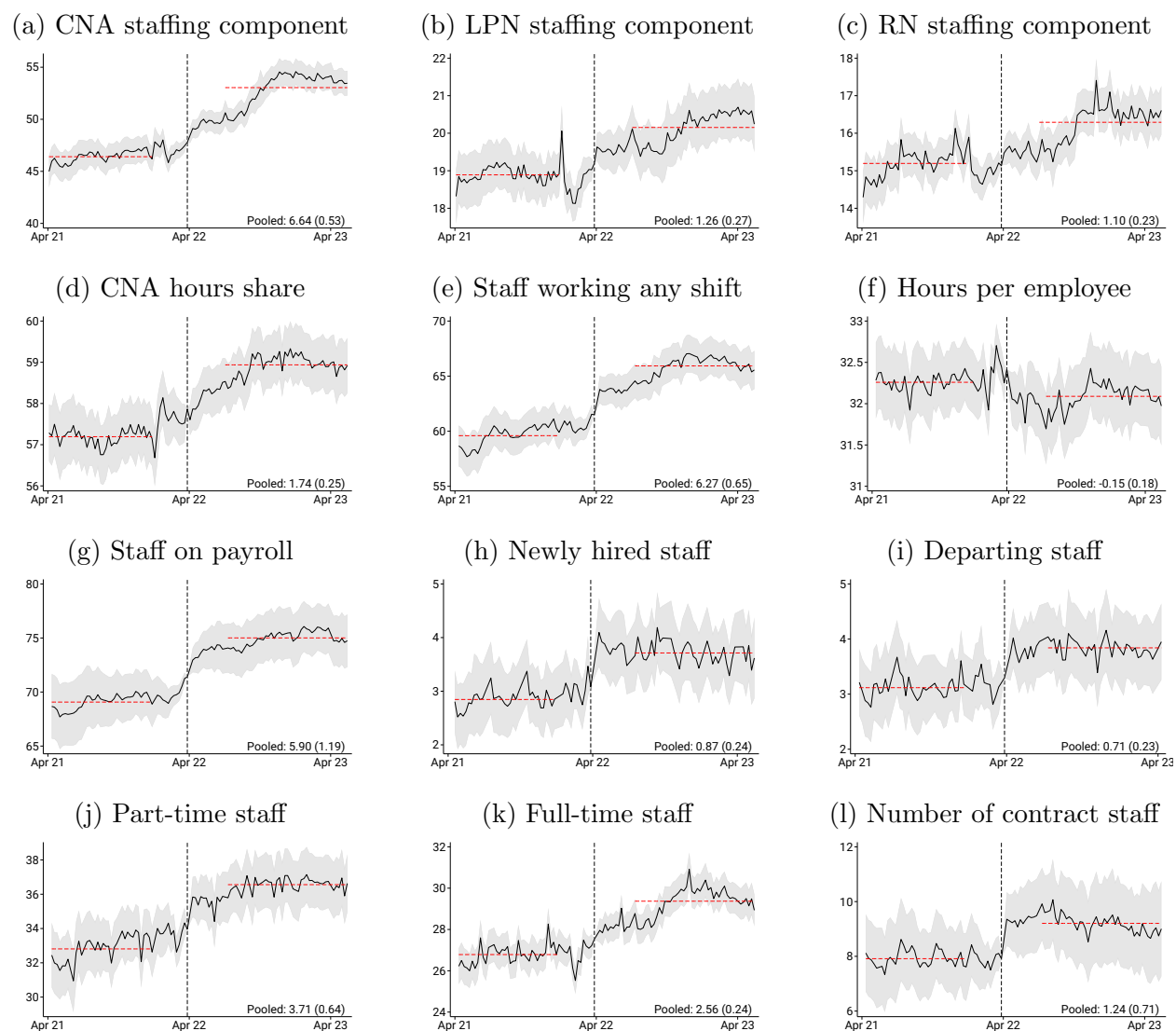


Figure 4: Margins of staffing adjustment, high-Medicaid facilities

Notes: Figure presents results from difference-in-difference event study regressions with each outcome centered around the mean value in Illinois during the week before the effective date. Sample limited to facilities with above the median share of Medicaid residents in 2019 (58.3%). Employee counts are scaled by the facility’s average daily resident census (per 100 residents). Gray area denotes 95% confidence interval with robust standard errors clustered by facility. The vertical line indicates the effective date of the reform: April 1, 2022. The red horizontal lines indicate pre-treatment and post-treatment averages, excluding the quarter prior and the quarter after the reform. The pooled estimate in the lower-right corner provides the difference between the post- and pre-treatment average coefficients. The standard error of this difference is reported in parentheses.

We also examine whether the observed staffing increases result from the extensive margin—i.e., increases in the number of staff—or the intensive margin—i.e., greater hours worked by

existing staff. Panel (e) shows that the number of staff who worked at least one shift in a given week rose sharply following the reform: 6.27 additional employees per 100 residents working in a given week. Panel (f) finds a small and statistically insignificant decrease in hours per employee, indicating that extensive margin responses are driving the overall staffing increase.

These extensive margin changes could be driven by increasing either hiring of new staff or retention of existing staff. Panels (g) and (h) suggest a strong role for additional hiring, as both the number of staff on payroll and the number of new hires (employees working their first week at the facility) rise immediately after the incentive payments take effect.⁷ In contrast, Panel (i) suggests that the extensive margin changes are *not* due to an increase in retention, as the weekly number of departing staff increased following the reform.

Panels (j) and (k) examine how the change in employment was distributed across part-time (< 35 hours in a given week) and full-time workers (≥ 35 hours in a given week). We find increases in both part-time and full-time work, with an additional 3.71 part-time employees per 100 residents (Panel (j)) and an additional 2.56 full-time workers per 100 residents (Panel (k)). Finally, we examine the number of staff who are employed by contract agencies, rather than directly employed by the facility. Contract work is common in the nursing home industry: prior to the reform, the average high-Medicaid facility in Illinois staffed 7.56% of their hours with contract staff. Panel l shows that contract staff explain just part of the staffing increase: the number of contract staff increased by 1.24 employees per 100 residents. In Appendix Figure E.4, we show that these changes resulted in slight compositional shifts towards more part-time and contract workers.

In Appendix D, we investigate whether these changes in staffing were associated with improvements in clinical outcomes. Given the well-established link between staffing and quality of care established by the prior literature, we would expect improvements in clinical outcomes that are associated with staff. In line with this prediction, we find modest improvements in resident health.

4.2 Contrast with an unincentivized rate increase

The incentive payments we study are relatively unique in explicitly connecting reimbursement to staffing levels. In doing so, the reimbursement schedule directly incentivizes higher staffing levels. In contrast, most other reforms increase reimbursement rates without incentives. Industry advocates typically argue that even unincentivized rate increases will alleviate financial constraints and allow greater spending on staffing. The academic literature further

⁷That facilities were able to hire additional workers contrasts with industry rhetoric that staffing levels cannot be increased because no workers are available (AHCA, 2023).

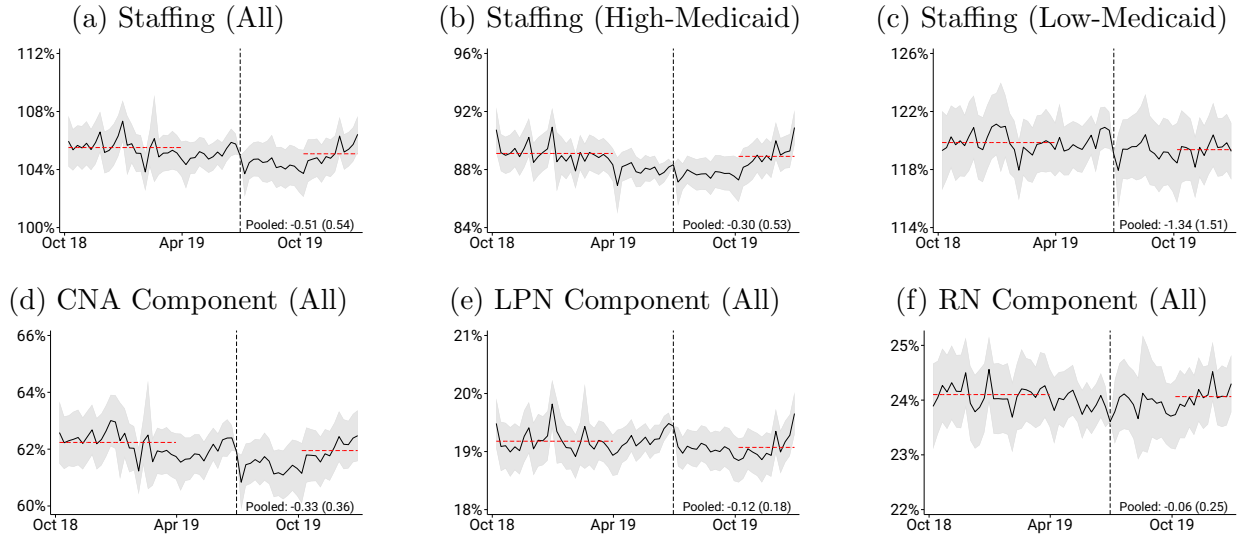


Figure 5: Event study of staffing levels before and after 2019 reform

Notes: Figure presents results from difference-in-difference event study regressions with each outcome centered around the mean value in Illinois during the week before the effective date. Gray area denotes 95% confidence interval with robust standard errors clustered by facility. For the top row, the dependent variable is total nurse (RN, LPN and CNA) staffing hours, expressed as a percent of the STRIVE target staffing level, for all facilities (Panel (a)), high-Medicaid facilities (Panel (b)), and low-Medicaid facilities (Panel (c)). For the bottom row, the dependent variable is CNA, LPN, and RN staffing separately, expressed as a percent of the STRIVE target staffing level, for all facilities. The vertical line indicates the effective date of the rate reform: July 1, 2019. The red horizontal lines indicate pre-treatment and post-treatment averages, excluding the quarter prior and the quarter after the reform. The pooled estimate in the lower-right corner provides the difference between the post- and pre-treatment average coefficients. The standard error of this difference is reported in parentheses.

argues that unincentivized rate increases can improve quality by increasing competition over Medicaid patients. Most notably, Hackmann (2019) estimates a structural model of the industry that implies that an across-the-board 10% increase in Medicaid reimbursement would yield a 8.7% increase in staffing.

In order to distinguish whether the large effects we estimate in Section 4.1 are attributable to the sloped nature of the staffing incentive or simply to increasing the average rate, we examine an unincentivized Illinois rate reform from 2019. This 2019 reform increased the average Medicaid per-diem by \$16.51 (10.91%) through an across-the-board rate increase and a facility-specific increase based on each facility's *historical* costs. Crucially, neither component was tied to facilities' staffing levels or even to other contemporaneous measures of quality or expenditures.

We analyze this reform analogously to equation (1) using data from October 1, 2018 ($\tau = -52$) to January 1, 2020 ($\tau = 26$). The treatment date for this policy ($\tau = 0$) is July 1, 2019, the effective date of the 2019 reform. The shorter post-period in this analysis avoids

the start of the Covid-19 pandemic.

The results in Figure 5 dramatically differ from the patterns shown in Figure 2. In contrast to the 2022 reform that directly tied reimbursement to staffing levels, the 2019 reform led to no discernible change in any dimension of staffing. The inefficacy of the 2019 reform suggests that simply raising reimbursement rates is not effective at increasing staffing. The comparison between the two reforms highlights the importance of directly connecting reimbursement policies to current staffing levels if policymakers' goal is to increase employment.

4.3 Assessing the cost of the 2022 staffing incentive payments

Section 4.1 demonstrated that the 2022 incentive payments successfully raised nursing home staffing levels. To evaluate cost-effectiveness, we benchmark the cost of the incentive payments against the market price of the additional staffing induced by the rate reform. Doing so allows us to evaluate the extent to which the incentive payments were passed through as greater spending on staffing rather than spent on other inputs or otherwise captured by the firm.

Data from the Illinois Department of Healthcare and Family Services (HFS) indicate that for the first quarter of 2023 (the last full quarter of our analysis period), the average incentive payment to a facility was \$93,338. To assess the size of this transfer compared to the amount of increased staffing, we calculate the market price of the additional staff hours induced by the policy. To do this, we first multiply the treatment effect estimates $\hat{\beta}$ (expressed as the ratio of actual staffing to the clinical target) by the clinical targets for each facility to obtain the marginal CNA, LPN, and RN hours induced by the reform for each facility. Appendix Figure E.8 shows the distributions of marginal hours both overall and by Medicaid share.

We then estimate the average hourly market cost of an additional labor hour for CNAs, LPNs, and RNs using total compensation (wage plus fringe benefits) data from the 2022 federal Healthcare Cost Report Information System (HCRIS). In Illinois, an additional CNA hour costs \$23.40, compared to \$38.52 per LPN-hour and \$45.19 per RN-hour. These market prices can then be used to determine the extent to which the incentive payments were passed through to generate higher staffing. We perform these calculations separately for high- and low-Medicaid facilities, summarized in Appendix Table E.2.

On average, the payment incentives induced an increase in staffing worth \$36,448 at market wages each quarter. Given that the quarterly cost to the government of incentive payments for the average facility was \$93,338, this implies a passthrough of 39.0%—i.e., on average, a dollar of spending on staffing incentive payments resulted in an additional 39.0¢ of

staffing. For high-Medicaid facilities, the balance is more favorable to the government: facilities received a mean incentive payment of \$93,594 which generated staffing increases valued at \$80,497, implying a passthrough rate of 86.0%. For low-Medicaid facilities, however, the passthrough was just 3.56%. These facilities received large payments—\$93,146 on average—but negligible staffing increases valued at only \$3320 on average.

This divergence in cost-effectiveness stems from two forces. First, as indicated by the results in Section 4.1, the incentive payments increased staffing much less in low-Medicaid facilities. Second, the per diem incentive payments for low-Medicaid facilities tended to be *larger* due to high baseline staffing levels, enough so that the overall payments (i.e., the daily incentive payments multiplied by the number of Medicaid days) were nearly identical to those for low-Medicaid facilities (\$93,594 vs. \$93,146 in 2023Q1).

Such patterns reflect a well-understood but often overlooked dynamic: paying for quality may involve substantial transfers to inframarginal facilities that already had high staffing. In many settings, this implies that a significant share of each public dollar spent does not change behaviors, and therefore yields no concrete benefits. In the nursing home setting it highlights a regressive pattern of these incentive payments: due to their greater baseline staffing, facilities that serve few Medicaid patients receive total incentive payments similar to the facilities that serve a large number of Medicaid patients. This inefficiency could be counteracted by targeting changes rather than levels—i.e., by rewarding *improvements* in staffing—but this may not always be practically or politically feasible.

It is also important to note that the additional staffing induced by the Medicaid reform is likely enjoyed by *all* residents, not only those whose stays were covered by Medicaid. Nursing homes are legally prohibited from varying quality of care by payer, and previous research has shown that staffing is empirically a common good enjoyed by all patients at a facility (Grabowski et al., 2008). Accordingly, the passthrough calculation in this section compares the benefits to all payers (including Medicare and private-pay patients) against the cost paid by Medicaid. A narrower cost-effectiveness analysis might consider only the benefits to Medicaid residents (i.e. multiplying each facility’s additional staffing hours by its Medicaid resident share to obtain the number of new staffing hours serving Medicaid patients assuming the new staffing hours are distributed equally across all residents). This narrower calculation yields lower passthrough rates of 69.3% (high-Medicaid) and 1.9% (low-Medicaid). That Medicare and private payers also benefited from the incentive payments relates to a large literature on cross-payer spillovers in health care (e.g. Clemens and Gottlieb, 2017; Einav et al., 2020; Barnett et al., 2023). In such circumstances, a payer that considers only the benefits to their patients would understate a policy’s social benefits and may therefore be reluctant to undertake similar policies in the future.

5 Conclusion

In settings where the government pays for services, connecting reimbursement schedules to staffing levels can be an effective lever to reduce staffing shortages. In the nursing home sector, we find that tying Medicaid reimbursement to staffing levels increased staffing by 5.35 percent of the clinical target overall, and 9.00 percent among facilities serving a relatively large share of Medicaid residents. These large effects contrast with the negligible changes following a previous unincentivized rate reform. The difference between these two reforms highlights that funding formula should be explicitly connected to the policy goal.

Our results also show that most of the increase in staffing was due to increased work in occupations that typically receive low wages, namely new staff working part-time as CNAs. These patterns are consistent with firms responding cost-consciously. Correspondingly, our findings suggest that if policymakers wish to increase staffing among more costly workers—such as more highly-certified or highly-tenured workers—the incentive payments may need to target these workers directly. Finally, we find that while facilities with the largest responses to the policy were those serving the largest share of lower-income, Medicaid residents, most dollars went to firms that had high staffing levels before implementation and that did not increase staffing.

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A Additional detail on data and methods

The PBJ are daily employee-level staffing data for each facility, and are required reporting for all direct care staff. For each employee working at a given facility on a given day, the PBJ reports the staff type, contract type, and number of hours worked. We use the data from 2018Q1-2023Q2.

We limit our analysis to CNAs, LPNs, and RNs, including those with administrative duties. We construct weekly measures (Monday-Sunday) for each facility of the hours worked, number of unique employees who worked at a facility, number of unique employees on payroll, and new hires and departures. To construct a consistent measure of new hires and departures over time, we implement a 12-week look-back (look-forward) for new hires (departures)—that is, any employee who worked their first week after 12 weeks of not working is considered a new hire, and any employee who worked their last week before at least 12 weeks of not working is considered a departure. An employee is “on payroll” for all weeks starting with their hire date, and ending with their departure date, i.e. the number of employees on payroll will include both employees who worked a shift that week and employees who were “absent” that week.

In order to identify each employee’s hire date and separation date, it is necessary to have continuous reporting by facilities. Thus, for our outcome measures regarding new hires, separations, and payroll, we limit our sample to the last period of continuous reporting for each facility. In addition, although the PBJ data are generally of high quality due the potential for government audit, there are some instances in the data where nearly all of a facility’s employee IDs changed in a given week and were replaced by an entire new staff of employee IDs. These changes likely reflect errors in the data (caused by, for example, a new payroll software) rather than real turnover. We identify these “software changes” as instances where the total nursing staff count changed by no more than 25% relative to the previous week but more than 50% of the IDs were new and again keep for each facility only the period following the last software change, if any changes were identified. Together, these changes exclude 10.3% of facility-weeks from our sample.

Finally, even after removing obvious software changes, there are some instances of implausibly high turnover at the start of new quarters. To avoid these outlier values creating potential bias in our results, we exclude the week of the first day of each quarter from our analysis for all dependent variables that count unique employees. We exclude that “first-week-of-the-quarter” week and the week prior for our measure of new hires, and we excluded the “first-week-of-the-quarter” week and the week following for our measure of departures.

B Additional detail on Illinois’s Medicaid reform

B.1 Timing of the reform

HB0246 was introduced in the House on January 25, 2021. The bill passed both houses on April 7, 2022 and Governor Pritzker signed the bill into law on May 31, 2022.

To allow for staffing data to become available, the staffing incentive payment uses a three-quarter lag, meaning payments made in 2022Q3 (the first quarter after the reform) were based on staffing data from 2021Q4. Because this means that for the first two quarters of payments made following the reform (2022Q3 and 2022Q4 payments), the relevant staffing quarters had already passed prior to the reform’s passage, the bill phased in the staffing incentive by paying facilities the greater of their actual staffing payment and the incentive payment for a facility that staffed at 85% of STRIVE for those two quarters (i.e. facilities that staffed below 85% STRIVE in those two quarters were paid as though they had staffed at 85% STRIVE). The full staffing incentive schedule took effect for 2022Q2 staffing; for this reason, we call April 1, 2022 the “effective” date of the reform.

B.2 Entire reform package

The bill allocated \$717 million in additional funding to nursing homes.⁸

The \$717 million budgeted amount includes the following, by far the largest of which is the STRIVE incentive payment:

1. **STRIVE incentive program, \$360 million:** See Section 2.2 for details.
2. **Voluntary CNA subsidy program, \$85 million:** Facilities that choose to participate in this component must establish a CNA pay scale that pays CNAs with more years of industry experience higher wages: the scale must increase wages for CNAs with one year of experience by at least \$1.50 per hour (relative to CNAs with less than one year of experience), and offer an additional \$1 per hour for each additional year of experience beyond the first year, up to a maximum of \$6.50 for CNAs with at least 6 years of experience. Medicaid will fully subsidize wage increases of these amounts; facilities can increase wages more steeply with experience, but those wage increases would not be subsidized. Facilities can also choose to participate in a promotion pay scale that increases hourly wages by \$1.50 per hour for CNA who are promoted, capped at 15% of the facility’s CNA workforce.

⁸Because these reforms are partially funded through an increase in a tax on nursing homes, the estimated net increase is about \$465 million per year.

3. **Quality Incentive Payments, \$70 million:** This component divides \$17.5M each quarter among nursing homes based on their long-stay quality star rating. The incentive payments are calculated such that facilities receiving 1 star receive no payment, and facilities receiving 2-5 stars are paid proportionally to the number of extra stars above 1.
4. **Across-the board per-diem increase, \$202 million:** This component increases the base per-day reimbursement rate by \$7 per resident for all facilities, and by an additional \$4 per day for facilities in which Medicaid covers at least 70% of their residents.

The main challenge to attributing our findings to the STRIVE incentive program is that the reform also included a voluntary CNA experience program. However, it is unlikely that the experience program is the primary driver of our results for several reasons. First, while we cannot measure the year-of-experience variable that is used to determine the CNA payscale, the fact that we see substantial hiring rather than greater retention or greater hours suggests that firms were not only increasing staffing among the more experienced workers. Second, not all facilities chose to participate in the CNA subsidy program. As of April 2023, 402 Illinois facilities (54%) had elected to participate in this program. In Figure B.1 we compare the change in target staffing for these 402 facilities to the change in target staffing for the remaining facilities that did not participate, splitting the sample by whether the facility was a high- or low-Medicaid facility pre-reform.⁹ Focusing on high-Medicaid facilities, we find that the increases in staffing are very similar for facilities participating in the program and facilities that did not participate in the program.

We include all components of the reform in additional cost estimates in Table B.1, where we replicate the cost effectiveness analysis of Section 4.3 using the *total* change in Medicaid reimbursement as the cost to the government (rather than only the STRIVE incentive payments). Given the size of the “level” shifts included in the package, the full reform was much less cost effective than only the incentive program, even for high-Medicaid facilities.

⁹High-Medicaid facilities were disproportionately likely to opt in to the policy: 72% of high-Medicaid facilities opted in, compared to only 48% of low-Medicaid facilities.

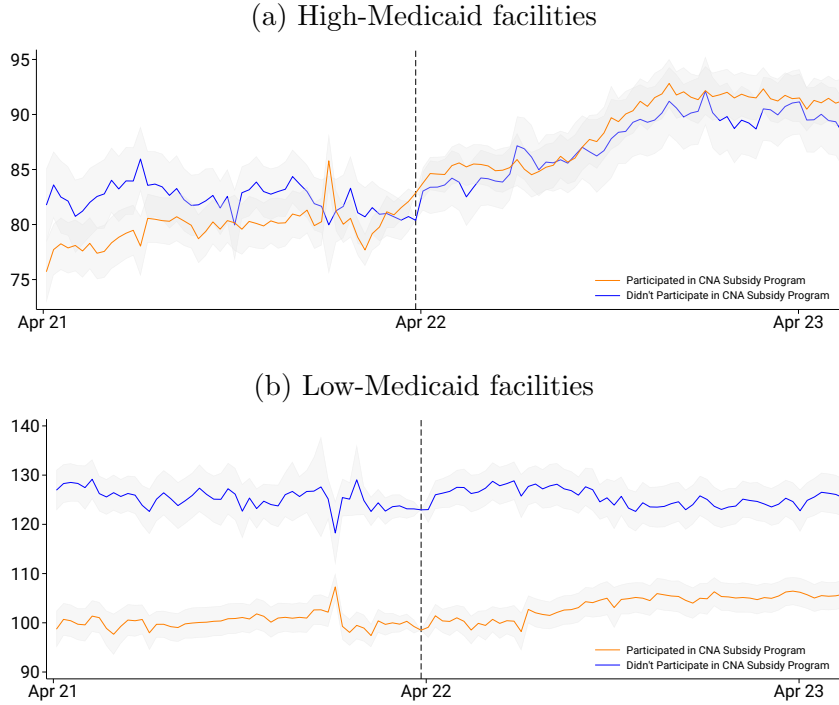


Figure B.1: Event study of staffing, by CNA incentive participation

Notes: Regression coefficients and 95% confidence intervals from event study regression. Each point estimate is added to the baseline average value for IL facilities in the pre-treatment period. Gray area denotes 95% confidence interval with robust standard errors clustered by facility. The vertical line indicates the effective date of the rate reform: April 1, 2022.

	All Facilities (1)	High-Medicaid (2)	Low-Medicaid (3)
Additional Staffing Expenditure (\$)			
CNA	28,083.14	49,189.38	13,238.61
LPN	7,722.45	15,412.13	2,314.10
RN	-777.53	15,696.08	-12,363.84
Total Value of Additional Staffing (\$)	36,447.68	80,497.07	3,319.62
Additional Total Payment from Reform (\$)	196,310.78	244,430.66	160,121.44
Implied Passthrough (%)	18.57	32.93	2.07
Medicaid Utilization (%)	62.07	78.47	49.75
Implied Medicaid-Only Passthrough (%)	14.69	26.52	1.11

Table B.1: Assessment of Cost of Total 2022 Reform

Notes: Table provides a cost effectiveness calculation from the entirety of the 2022 reform. The top panel contains the additional staffing expenditure in 2023Q1 implied by the point estimates. The market price of the marginal hours is calculated using wages and benefits from Medicare cost reports. Hourly costs for CNAs, LPNs, and RNs are \$23.40, \$38.52 and \$45.19, respectively. To calculate the additional total payment of the reform, we compute the facility-level changes in Medicaid reimbursement between 2022Q2 and 2023Q1. The implied passthrough is the ratio of the value of the marginal staffing expenditure over the additional quarterly payment under the reform. The Medicaid-only passthrough considers only the benefit of additional staffing accrued to Medicaid patients. Separate estimates are given for all facilities (column (1)), high-Medicaid facilities (column (2)), and low-Medicaid facilities (column (3)).

C Labor demand elasticity calculation

In this section, we describe the procedure to calculate the labor demand elasticity at each facility implied by the treatment effect estimates.

The facility-specific elasticity, ϵ_i , is the percentage change in labor divided by the percentage change in the effective wage. The numerator is straightforward to compute. For each facility i , the post-treatment staffing level y_i is observed. To determine the percentage change in y_i , we calculate the counterfactual staffing level $\tilde{y}_i = y_i - \hat{\beta}$ that facility i would have had in the absence of treatment, where $\hat{\beta}$ is the pooled treatment effect estimated in Section 4.1. We allow high- and low-Medicaid facilities to vary in their treatment effects, as described in the main text. The relative change in labor is then given by $(y_i - \tilde{y}_i)/\tilde{y}_i$.

The percentage change in effective wages is determined by two components: the observed wage cost of moving from \tilde{y}_i to y_i and the marginal incentive payment the facility receives for doing so. Recall that y_i is a ratio (the level of staffing relative to the target level per resident day based on the facility’s patient case mix). To convert this ratio to marginal hours, we multiply y_i by the staffing the facility reports in the post-treatment period by the number of observed patient days, to compute the number of marginal staff hours induced by the policy. To determine the marginal cost of these hours, we use facility-level CNA/LPN/RN wages reported in the federal HCRIS cost report data for the years 2021 and 2022. Given the noise inherent to the HCRIS data, we winsorize wages at the 1st and 99th percentiles. We compute the facility-level average hourly wages using each facility’s skill mix (CNA/LPN/RN shares of total direct care hours). Denote the observed wage cost of the marginal hours as w_i .

Finally, we can compute the additional incentive payments each facility receives as a result of changing their staffing from \tilde{y}_i to y_i using the known reimbursement schedule shown in Figure 1. We take the product of the incentive payments and the number of Medicaid days (using the baseline Medicaid shares used throughout). This provides the marginal incentive payments from the additional hours, denoted p_i . The effective wage cost for facility i moving from \tilde{y}_i to y_i is then given by $w_i - p_i$, i.e. the wage cost net of the marginal incentive payment. Accordingly, the percentage change in wages is given by: $((w_i - p_i) - w_i)/w_i = -p_i/w_i$.

The labor demand elasticity for facility i is then:

$$\epsilon_i = \frac{(\tilde{y}_i - y_i)/\tilde{y}_i}{-p_i/w_i}$$

The distribution of ϵ_i is shown in Figure C.1. The figure is truncated at -0.55, approximately the 2nd percentile. The mean elasticity is -0.142 , well within the range of conventional estimates, particularly for short-term responses and for the US labor market (Lichter

et al., 2015). This mean elasticity includes considerable heterogeneity: high-Medicaid facilities are more elastic, with a mean elasticity of -0.200 , compared to only -0.097 for low-Medicaid facilities.

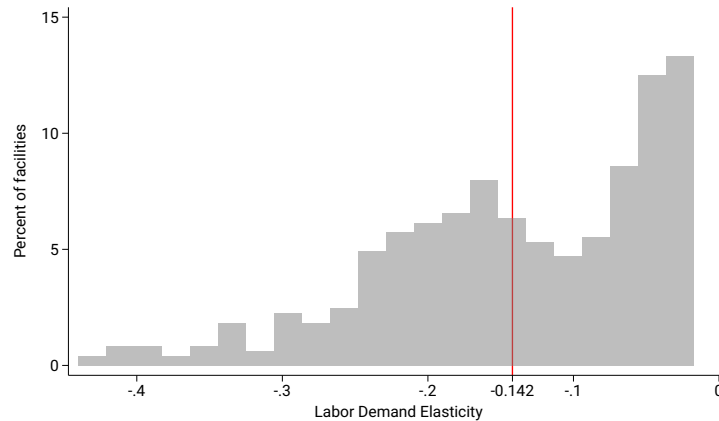


Figure C.1: Distribution of Implied Labor Demand Elasticities

Notes: Figure presents estimates of the labor demand elasticities implied by the change in labor and change in effective wages at each firm. Vertical red line denotes the overall mean elasticity.

D Effects of the reform on clinical quality

In light of the large staffing increases documented in the paper, this section examines the impact of the rate reform on patient health.

The quarterly NHC data provide several measures of resident health, however, many of these measures are unlikely to be sensitive to changes in direct staffing measures, especially in the short-term. Shen et al. (2023) show that measures related to functioning of long-stay residents (in contrast to short-term patients whose stays are primarily focused on rehabilitation, and more process-based measures such as the use of antipsychotic medications) are particularly sensitive to changes in staffing, and so we focus our attention on these measures. Specifically, we examine the share of long-stay residents whose need for assistance with the activities of daily living (ADL) increased, as well as the share of long-stay residents whose mobility worsened. Since both outcomes are measured quarterly, we modify equation (1) to include quarter, rather than week, fixed effects. Since the quarterly data provide fewer observations over a given time period, we also expand the sample to include data beginning in 2020Q2 to allow us to better assess the plausibility of the parallel trends assumption.

Figure D.1 shows modest improvements in both measures of resident health. The share of long-stay residents whose need for ADL help increased over the prior period fell by 1.61

percentage points at the end of the sample period. Similarly, the share of long-stay residents whose mobility worsened fell by 1.47 percentage points by the end of the sample period. These estimates suggest potentially larger effects for high-Medicaid facilities, for whom the improvements in these quality measures were 2.05 and 1.50 percentage points, respectively, compared to 1.14 and 1.62 percentage points for low-Medicaid facilities.

Prior literature finds a wide range of effects of the relationship between staffing and resident health: a 1% increase in staffing has been shown to improve outcomes by anywhere from 0.002-0.012 standard deviations.¹⁰ Our estimates indicate that the reform led to a 5.4% increase in the staffing level, a 1.6 percentage point decline in the share of patients who need help with ADLs and a 1.5 percentage point decline in the share whose mobility worsened. These results correspond to a 1% increase in target staffing leading to 0.033 and 0.030 standard deviation reduction in these two clinical outcomes, respectively. Given that the reform we study was explicitly intended to increase staffing and improve clinical outcomes, it is unsurprising that we find larger results than past studies.

¹⁰For instance, two recent studies, Furtado and Ortega (2023) and Grabowski et al. (2023), both examine the impact of immigration on nursing home staffing and clinical outcomes. They find that a 1% increase in staffing corresponds to increases in quality outcomes of 0.002 and 0.012 standard deviations, respectively.

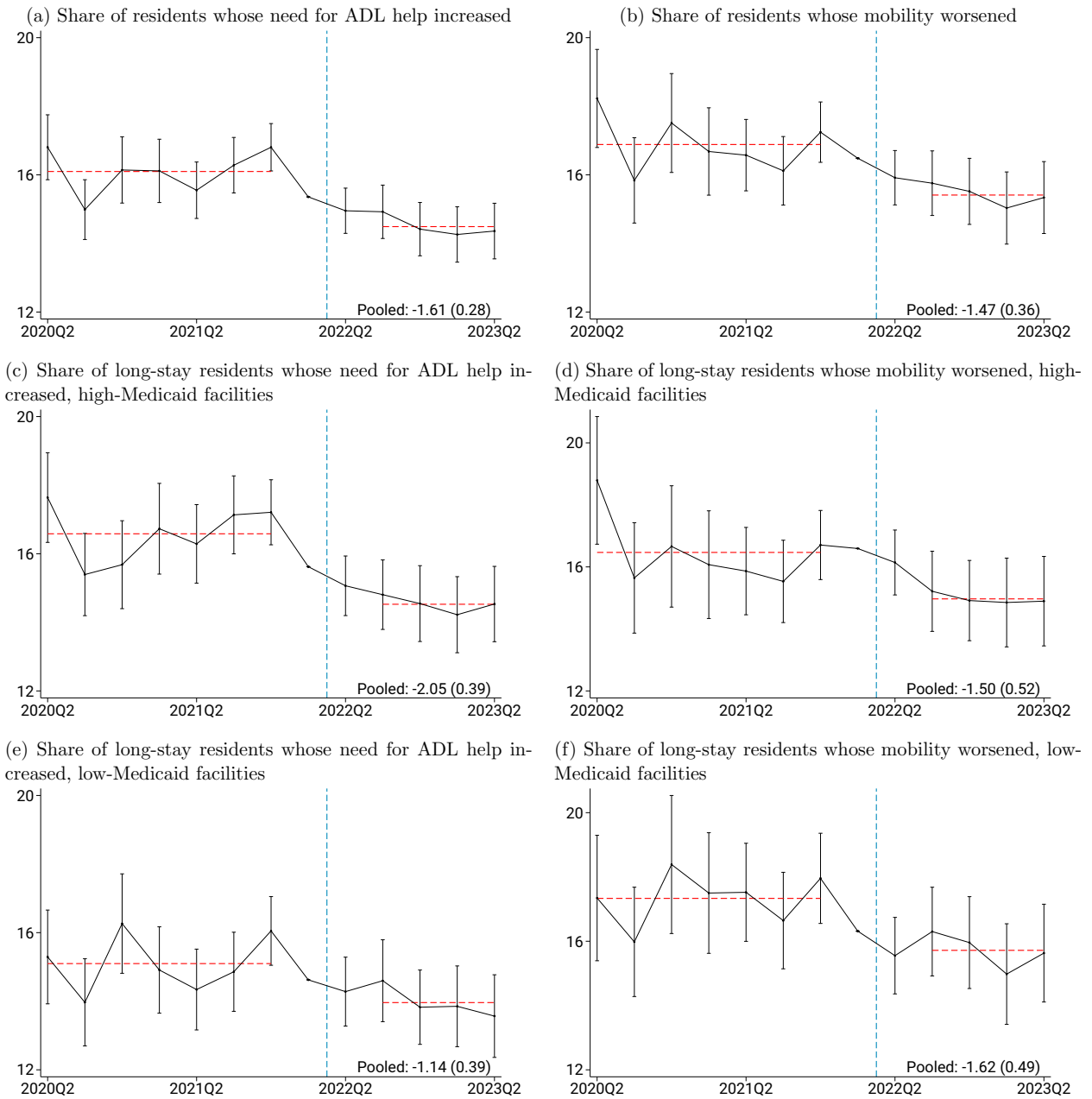


Figure D.1: Event study of staffing-sensitive clinical quality measures

Notes: Figure presents results from difference-in-difference event study regressions with each outcome centered around the mean value in Illinois during the week before the effective date. Vertical bars denote 95% confidence interval with robust standard errors clustered by facility. Dependent variables are quarterly facility quality measures from NHC. The left column is the share of long-stay residents whose need for ADL help increased relative to the previous quarter. The right column is the share of long-stay residents whose mobility worsened relative to the previous quarter. The vertical line indicates the effective date of the reform: April 1, 2022. The red horizontal lines indicate pre-treatment and post-treatment averages, excluding the quarter prior and the quarter after the reform. The pooled estimate in the lower-right corner provides the difference between the post- and pre-treatment average coefficients. The standard error of this difference is reported in parentheses.

E Additional results

This section includes additional analyses that supplement the analyses in the main text.

1. Table E.1 shows summary statistics of the Illinois and non-Illinois facilities included in our analysis.
2. Figures E.1 and E.2 replicate the analysis in Figure 4 (extensive and intensive margins of staffing adjustment) but for all facilities and low-Medicaid facilities, respectively. In general, the staffing results are larger in high-Medicaid facilities than low-Medicaid facilities.
3. Figure E.3 replicates the staffing adjustment margins analysis in Figure 4, focusing on CNAs, the occupation most affected by the reform.
4. Figure E.4 includes additional outcomes.
 - (a) Figure E.4a and E.4b confirm that the increase in staffing levels is not the result of facilities limiting or changing their admissions practices to reduce their census or case-mix and thus inflate their staffing ratios. We observe a slight increase in average resident count in Illinois after the policy, and no change in case mix.
 - (b) Figure E.4c shows that the policy did not change the share of staff hours that are worked on weekends, and Figure E.4d shows that it did not change the share of overtime hours (hours after the 40th hour in a week for a given employee).
 - (c) Figures E.4e, E.4f complement the findings in Figure 4 of an increase in both part-time and full-time staff by decomposing the increase in staffing hours by part-time (< 35 hours per week) and full-time (≥ 35 hours per week) workers, finding that full-time workers are contributing slightly more to the overall increase. Figure E.4g shows that the share of hours coming from part-time workers is unchanged, and Figure E.4h shows that the share of workers on staff who were part-time workers increased slightly as a result of the reform.
 - (d) Figures E.4i and E.4j complement the findings in Figure 4 by decomposing the overall staffing increase into hours worked by contract workers and hours worked by non-contract workers. We find that hours worked by non-contract workers explain almost all of the increase. Nonetheless, the increase in contract staff is related to a slight increase in the share of hours worked by contract workers and a slightly larger increase in the share of workers who are contract workers.

5. Figure E.5 presents a piecewise analogue to Figure 3, with separate quadratic polynomials estimated over different regions of the payment schedule.
6. Figure E.6 illustrates the time series variation in daily Medicaid rates over our sample period.
7. Figure E.7 presents an event study of the 2019 reform using a continuous treatment design. This design leverages the fact that the 2019 reform contained two components: one component of the 2019 reform increased the per-diem for Medicaid residents by \$4.55 a day, and a second component increased the “support rate” – that is, allocated funds to facilities based on *historical* costs. Since this second component varied across facilities, we construct an “exposure” variable equal to the additional payment per resident that a facility would be expected to receive as a result of the rate increase, equal to the facility’s share of residents who are on Medicaid multiplied by the change in the Medicaid per-diem for that facility between 2019Q2 and 2019Q3. We then estimate an identical event study specification of the form:

$$y_{it} = \sum_{\tau \neq -1} \beta^\tau (IL_i \times \text{Exposure}_i \times d_t^\tau) + \alpha_i + \alpha_t + \varepsilon_{it} \quad (2)$$

8. Figure E.8 presents the histograms of marginal hours induced by the reform used for the cost calculation conducted in Section 4.3.
9. Table E.2 presents the cost calculations underlying the assessment in Section 4.3.

	Illinois		Non-Illinois	
	Pre-Policy	Post-Policy	Pre-Policy	Post-Policy
	(1)	(2)	(3)	(4)
STRIVE Ratio	99.20	102.94	114.25	113.48
CNA STRIVE	56.89	61.59	64.77	65.49
LPN STRIVE	19.54	20.01	28.55	28.34
RN STRIVE	22.78	21.33	20.93	19.65
Total Payroll	66.31	77.77	69.05	73.97
Total Staff Working Any Shift	54.76	63.46	57.84	61.73
Hours per Employee	31.34	30.46	32.13	31.64
Staff Working < 20 hours	14.70	19.31	13.78	15.66
Staff Working 20-34 hours	16.72	18.83	17.78	18.47
Staff Working \geq 35 hours	23.34	25.32	26.28	27.60
Weekly New Hires	3.13	4.78	2.66	3.23
Weekly Separations	3.03	4.74	2.66	3.24
Share Hours by Contract Staff	7.31	9.79	8.07	9.81
% ADL Need Increased	13.87	12.43	14.66	14.62
% Mobility Worsened	17.40	13.77	17.62	14.92
N	697	694	14,397	14,286

Table E.1: Summary Statistics

Notes: Table provides summary statistics for all facilities studied, from the pre- and post-policy periods for each outcome. The pre-period ranges from 2021Q2 through 2022Q1. The post-period ranges from 2022Q2-2023Q2.

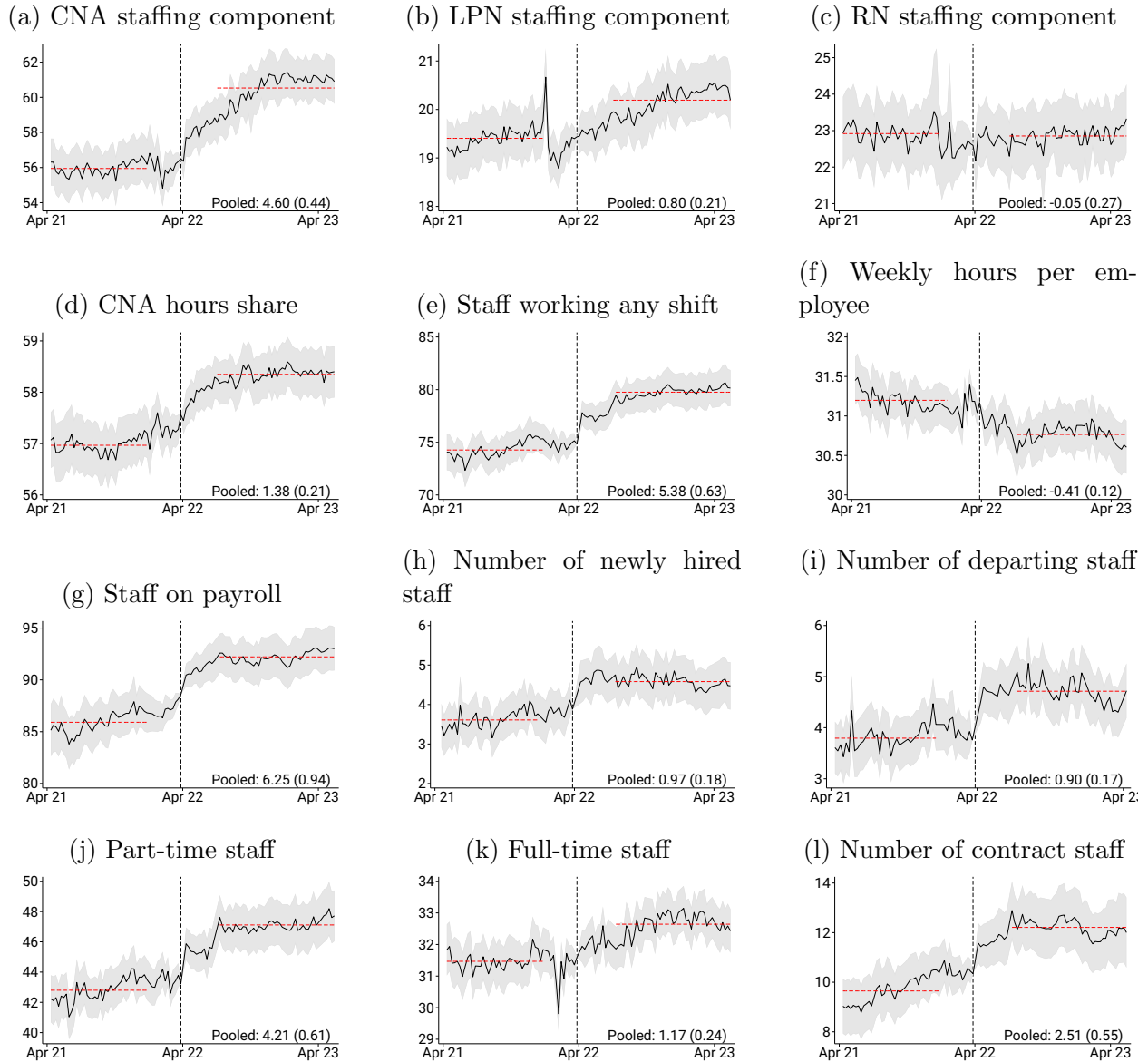


Figure E.1: Event study of different margins of staffing adjustment, all facilities

Notes: Figure presents results from difference-in-difference event study regressions with each outcome centered around the mean value in Illinois during the week before the effective date. Employee counts are scaled by the facility's average daily resident census (per 100 residents). Gray area denotes 95% confidence interval with robust standard errors clustered by facility. The vertical line indicates the effective date of the reform: April 1, 2022. The red horizontal lines indicate pre-treatment and post-treatment averages, excluding the quarter prior and the quarter after the reform. The pooled estimate in the lower-right corner provides the difference between the post- and pre-treatment average coefficients. The standard error of this difference is reported in parentheses.

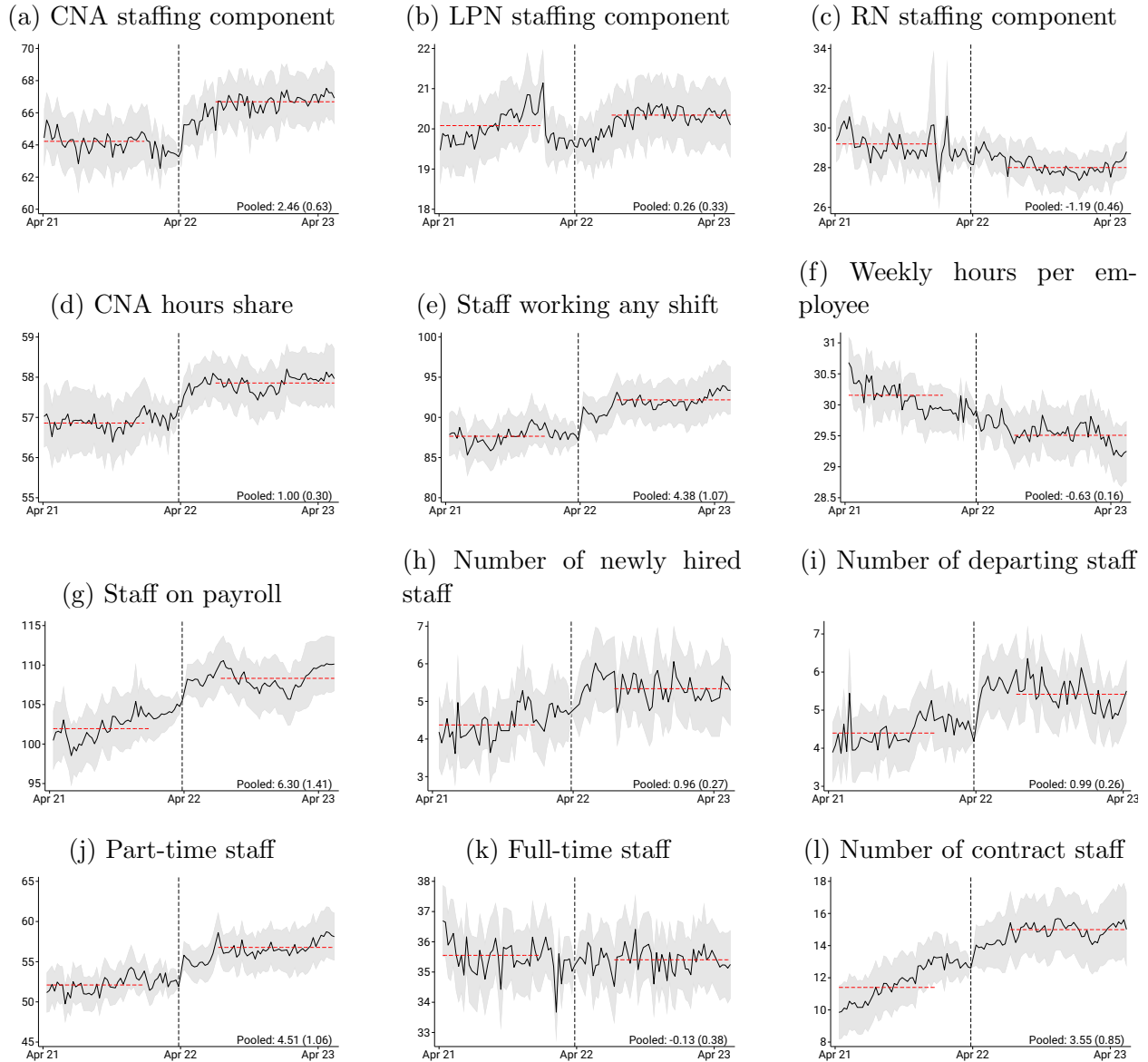


Figure E.2: Event study of different margins of staffing adjustment, low-Medicaid facilities

Notes: Figure presents results from difference-in-difference event study regressions with each outcome centered around the mean value in Illinois during the week before the effective date. Low Medicaid facilities defined as whether the facility had below the median share of Medicaid residents in 2019 (58.3%). Employee counts are scaled by the facility's average daily resident census (per 100 residents). Gray area denotes 95% confidence interval with robust standard errors clustered by facility. The vertical line indicates the effective date of the reform: April 1, 2022. The red horizontal lines indicate pre-treatment and post-treatment averages, excluding the quarter prior and the quarter after the reform. The pooled estimate in the lower-right corner provides the difference between the post- and pre-treatment average coefficients. The standard error of this difference is reported in parentheses.

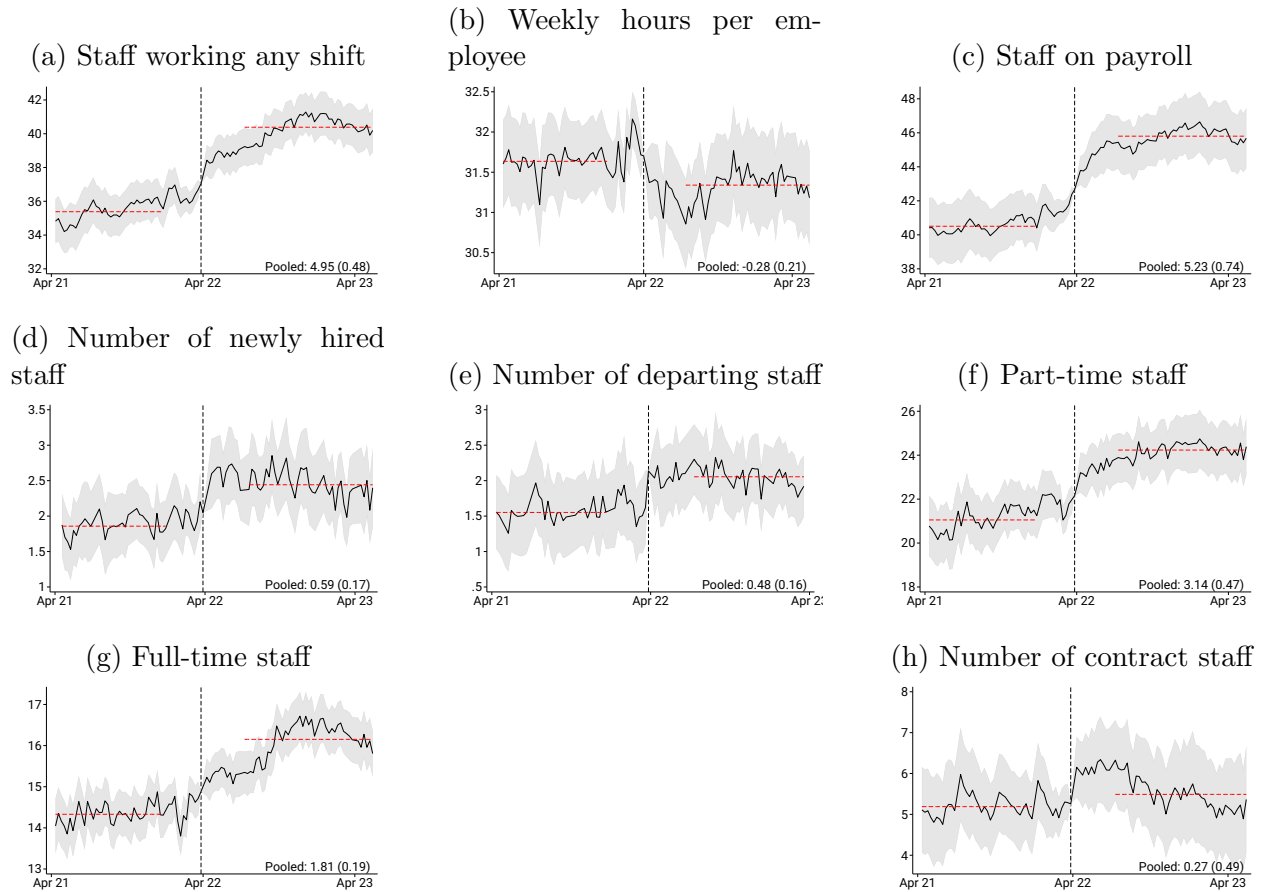


Figure E.3: Event study of different margins of staffing adjustment, CNA staff only, high-Medicaid facilities

Notes: Figure presents results from difference-in-difference event study regressions with each outcome centered around the mean value in Illinois during the week before the effective date. Sample limited to facilities with above the median share of Medicaid residents in 2019 (58.3%). Employee counts are scaled by the facility's average daily resident census (per 100 residents). Gray area denotes 95% confidence interval with robust standard errors clustered by facility. The vertical line indicates the effective date of the reform: April 1, 2022. The red horizontal lines indicate pre-treatment and post-treatment averages, excluding the quarter prior and the quarter after the reform. The pooled estimate in the lower-right corner provides the difference between the post- and pre-treatment average coefficients. The standard error of this difference is reported in parentheses.

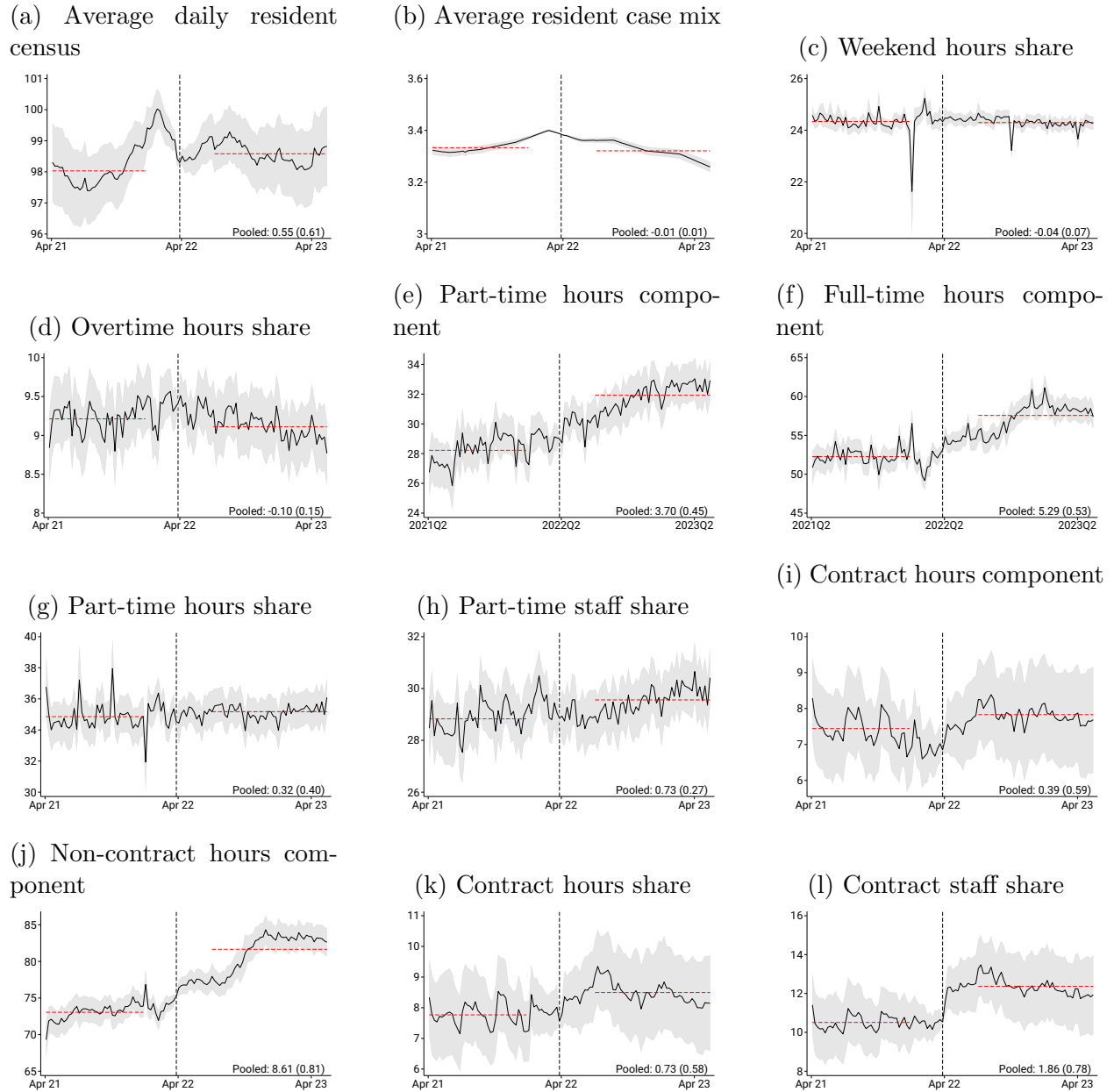


Figure E.4: Event study of additional dependent variables, high-Medicaid facilities

Notes: Figure presents results from difference-in-difference event study regressions with each outcome centered around the mean value in Illinois during the week before the effective date. Sample limited to facilities with above the median share of Medicaid residents in 2019 (58.3%). Employee counts are scaled by the facility's average daily resident census (per 100 residents). Gray area denotes 95% confidence interval with robust standard errors clustered by facility. The vertical line indicates the effective date of the reform: April 1, 2022. The red horizontal lines indicate pre-treatment and post-treatment averages, excluding the quarter prior and the quarter after the reform. The pooled estimate in the lower-right corner provides the difference between the post- and pre-treatment average coefficients. The standard error of this difference is reported in parentheses.

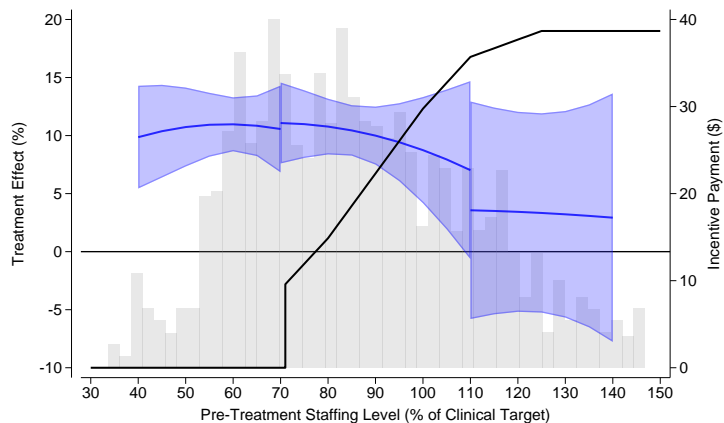


Figure E.5: Heterogeneity by pre-treatment target staffing level: Piecewise

Notes: Figure presents treatment effects across the pre-treatment staffing level distribution. Treatment effects are calculated using piecewise quadratic polynomials in pre-treatment staffing separately across different regions of the payment schedule. Treatment is assumed to scale linearly in Medicaid share. Shaded area denotes 95% confidence interval with robust standard errors clustered by facility. Baseline staffing distribution in gray histogram; black line denotes the incentive payment schedule.

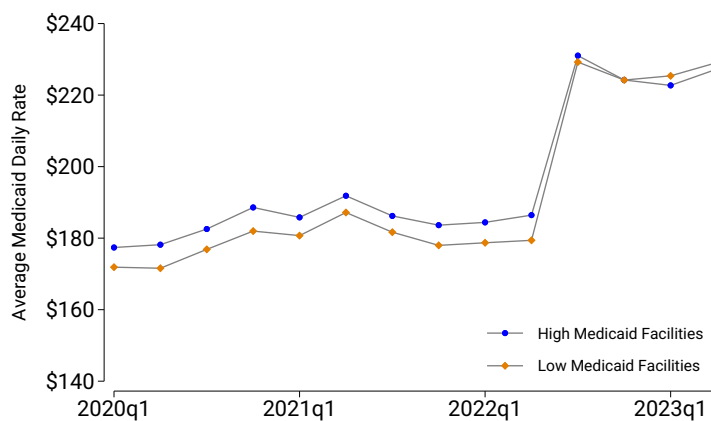


Figure E.6: Impact of reform on daily Medicaid rates

Notes: Average total Medicaid rate by quarter. Facilities are classified based on the median share of Medicaid residents in 2019 (58.3%)

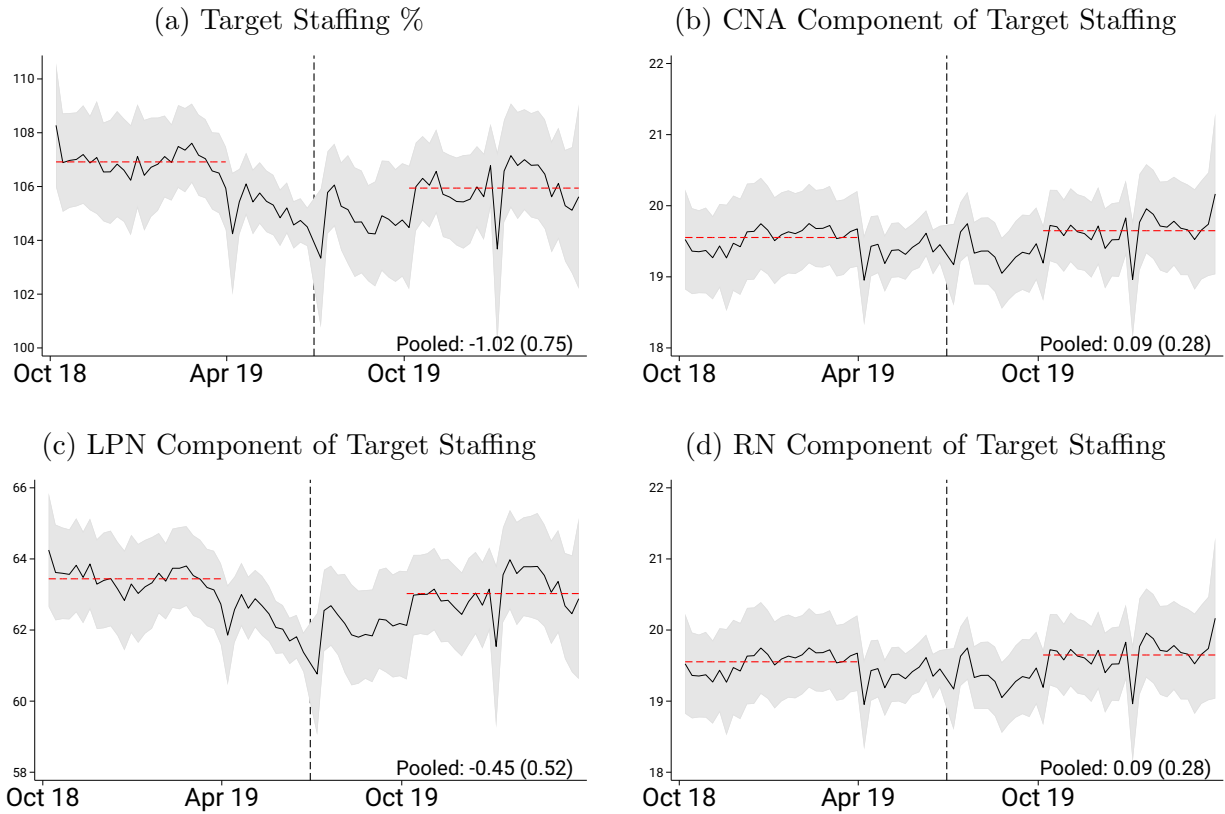
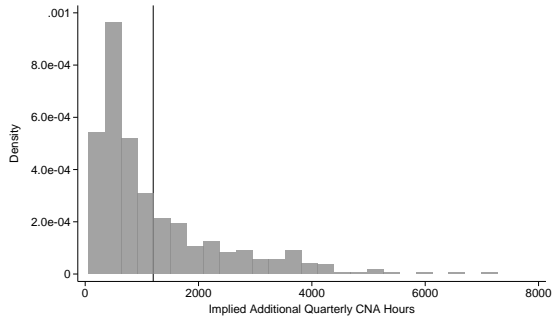


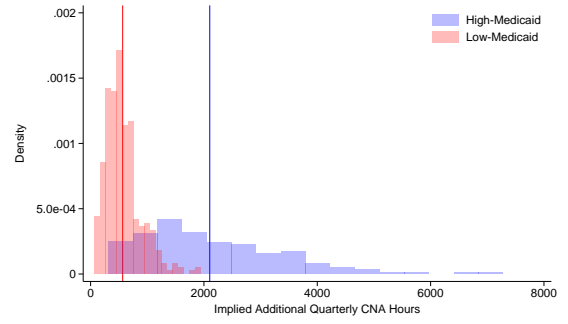
Figure E.7: Event study of staffing levels before and after 2019 reform, continuous treatment

Notes: Figure presents results from difference-in-difference event study regressions with each outcome centered around the mean value in Illinois during the week before the effective date. Dependent variable is total nurse (RN, LPN, and CNA) staffing hours, expressed as a percent of the STRIVE target staffing level. Independent variables are week indicators, interacted with each facility’s “exposure” to the reform, defined as the change in reimbursement per resident day. Gray area denotes 95% confidence interval with robust standard errors clustered by facility. The vertical line indicates the effective date of the reform: April 1, 2022. The red horizontal lines indicate pre-treatment and post-treatment averages, excluding the quarter prior and the quarter after the reform. The pooled estimate in the lower-right corner provides the difference between the post- and pre-treatment average coefficients. The standard error of this difference is reported in parentheses.

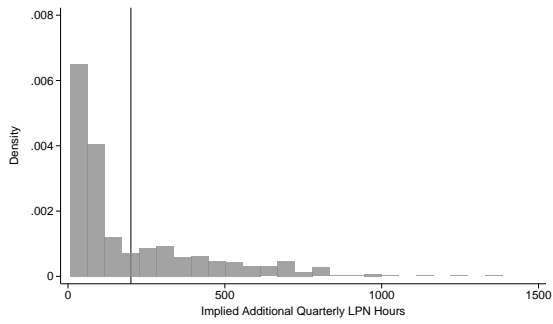
(a) Quarterly CNA hours: All Facilities



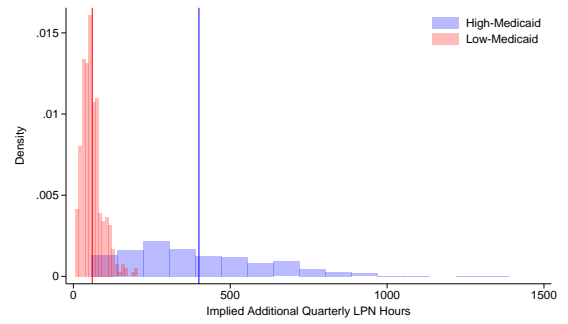
(b) Quarterly CNA hours: By Medicaid



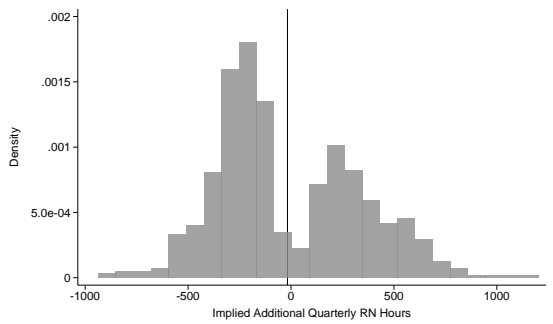
(c) Quarterly LPN hours: All Facilities



(d) Quarterly LPN hours: By Medicaid



(e) Quarterly RN hours: All Facilities



(f) Quarterly RN hours: By Medicaid

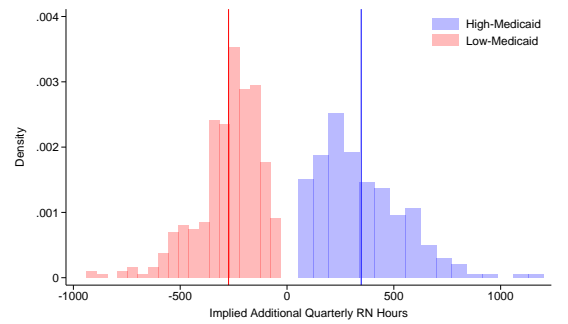


Figure E.8: Distributions of additional hours implied by estimates

Notes: Figure presents histograms of implied additional hours of nursing induced by the reform. These distributions, implied by the treatment effect estimates in Section 4.1, are used to determine the cost efficacy of the reform in Section 4.3.

	All Facilities (1)	High-Medicaid (2)	Low-Medicaid (3)
Additional Staffing Expenditure (\$)			
CNA	28,083.14	49,189.38	13,238.61
LPN	7,722.45	15,412.13	2,314.10
RN	-777.53	15,696.08	-12,363.84
Total Value of Additional Staffing (\$)	36,447.68	80,497.07	3,319.62
Average Facility Incentive Payment (\$)	93,338.37	93,593.71	93,146.34
Implied Passthrough (%)	39.05	86.01	3.56
Medicaid Utilization (%)	62.07	78.47	49.75
Implied Medicaid-Only Passthrough (%)	30.90	69.26	1.91

Table E.2: Assessment of Cost of Reform

Notes: Table provides a cost effectiveness calculation from the incentive component of the reform. The top panel contains the additional staffing expenditure in 2023Q1 implied by the point estimates. The market price of the marginal hours is calculated using wages and benefits from Medicare cost reports. Hourly costs for CNAs, LPNs, and RNs are \$23.40, \$38.52 and \$45.19, respectively. The average facility incentive payment reflects the payments received in 2023Q1. The implied passthrough is the ratio of the value of the marginal staffing expenditure over the additional quarterly payment under the reform. The Medicaid-only passthrough considers only the benefit of additional staffing accrued to Medicaid patients. Separate estimates are given for all facilities (column (1)), high-Medicaid facilities (column (2)), and low-Medicaid facilities (column (3)).

F Alternate samples and matched control analysis

F.1 Alternative Sample Definitions

Extended pre-period: Our main sample period begins in 2021Q2, which allows us to observe facilities for a full year prior to the Illinois rate reform. In Figure F.1, we replicate the analysis of Figure 2, but extend the pre-period by a year to begin at the beginning of 2020Q2. This allows for an additional year of pre-period data while also continuing to exclude the first quarter of 2020Q1, which marked the start of the COVID-19 pandemic in the US and in which PBJ reporting was not mandatory. Pre-trends remain fairly stable with this additional year of pre-period data, although with generally more movement in 2020 than the year immediately prior to the reform. This volatility may reflect waves of the pandemic, which may have affected Illinois facilities differently than non-Illinois facilities.

Balanced panel: The main results use data for all facility-weeks that appear in the PBJ data, allowing facilities to appear for different numbers of weeks. To instead construct a balanced sample of facility-weeks, we retain the last period of reporting after any software change or gap in reporting, and require that facilities are observed for the entire sample period (11,287 facilities (73.6%) of the 15,346 facilities are included). Figure F.2 shows the results of our primary analysis in this fully balanced sample of facilities. The results are

quantitatively similar.

F.2 Matched control analysis

In this section, we consider a matched control approach wherein we match each Illinois facility to a narrower group of control facilities in other states that are most observationally similar to Illinois firms.

The matched control groups are constructed from *pre-pandemic* data – the last values observed for each matching variable in 2019. The matching variables include: ownership status, county population density, NHC Overall rating, share of patients on Medicaid, average daily number of residents, share of hours worked by new employees, and overall STRIVE ratio, as well as the STRIVE contributions coming from CNA, LPN, and RN workers separately. Given the overall STRIVE ratio is our primary outcome, we apply calipers of 15 percent to ensure similar matches on this variable. For each Illinois facility, there are 4-5 matched controls; any facility with fewer than 4 matches is excluded from the analysis.

Accordingly, our matched specification is given by:

$$y_{ict} = \sum_{\tau \neq -1} \beta^\tau (IL_i \times d_t^\tau) + \alpha_{ic} + \alpha_{ct} + \varepsilon_{ict} \quad (3)$$

where i indexes facility, c indexes match cohort, and t indexes calendar week. Notice that our data vary at the facility-cohort level, as some non-Illinois facilities may be matched controls for multiple treated facilities. Accordingly we include both facility-cohort fixed effects, α_{ic} , to account for any residual facility-level differences within each cohort that persist after the matching exercise, as well as cohort-by calendar-week fixed effects, α_{ct} , which allow us to control for differential time trends across match cohorts. This specification is considerably more flexible than standard calendar year fixed effects, which impose the same time trend for all facilities.

As in Equation 1, the remaining terms identify the treatment effect, under the identifying assumptions. The d_t^τ terms denote calendar-week dummies, and IL_i is an indicator for Illinois facilities. The coefficients of interest are the β^τ terms that capture the residual differences in y_{ict} of the Illinois facilities relative to their matched counterparts. The key identification assumption is that of parallel trends: *within* a match cohort, any differential patterns in y_{ict} are attributable to the Illinois reform.

The results of the matching process are shown in Appendix Table F.1. Relative to all non-Illinois facilities, the matched sample are substantially more similar on observable characteristics. The results from estimating equation (3) for our primary analysis are reported

in Appendix Figure F.3a. The estimates are nearly identical to those recovered from the unmatched control group.

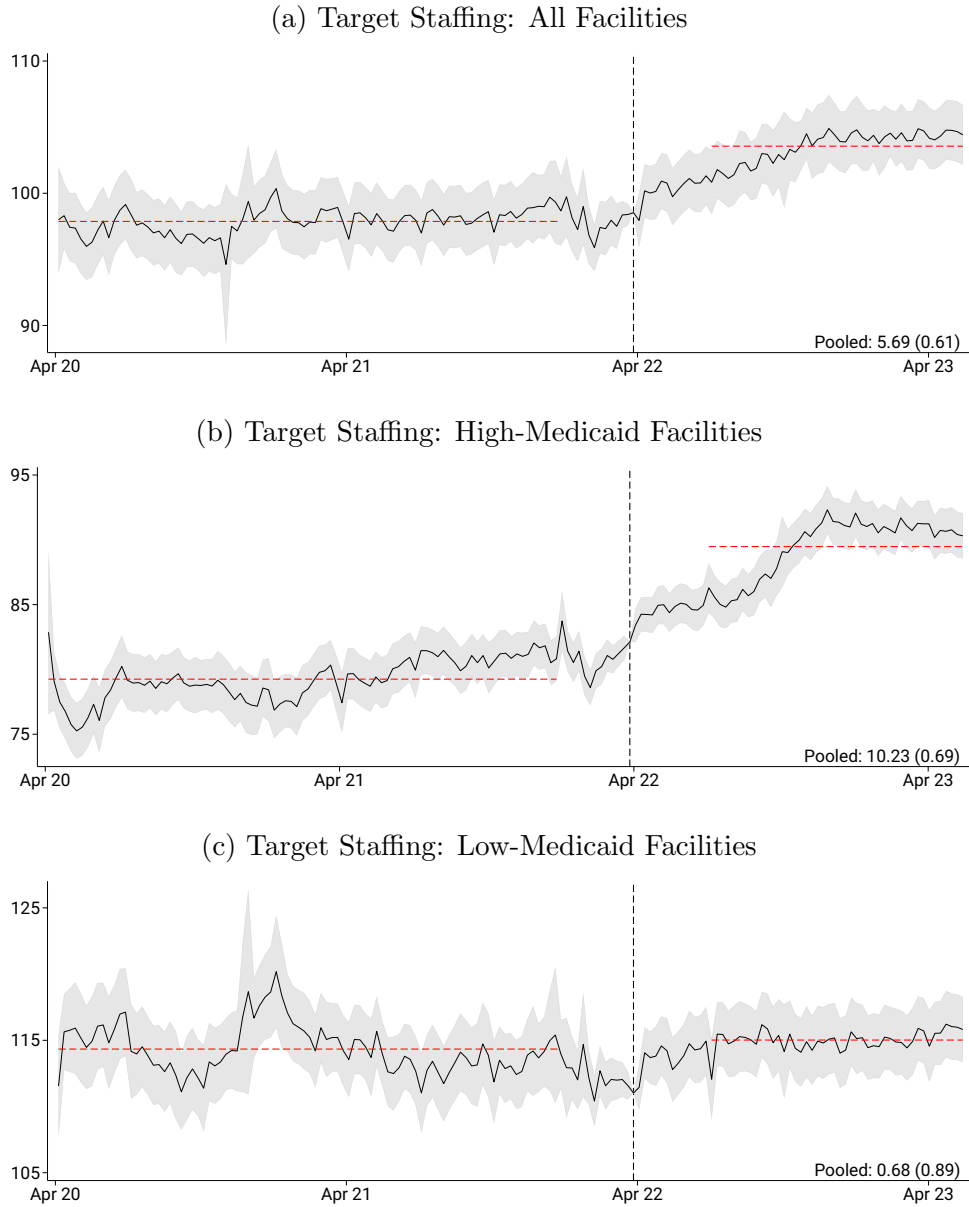


Figure F.1: Event study of staffing levels, by Medicaid payer share, extended pre-period

Notes: Figure presents results from difference-in-difference event study regressions with each outcome centered around the mean value in Illinois during the week before the effective date. Gray area denotes 95% confidence interval with robust standard errors clustered by facility. The vertical line indicates the effective date of the reform: April 1, 2022. The red horizontal lines indicate pre-treatment and post-treatment averages, excluding the quarter prior and the quarter after the reform. The pooled estimate in the lower-right corner provides the difference between the post- and pre-treatment average coefficients. The standard error of this difference is reported in parentheses.

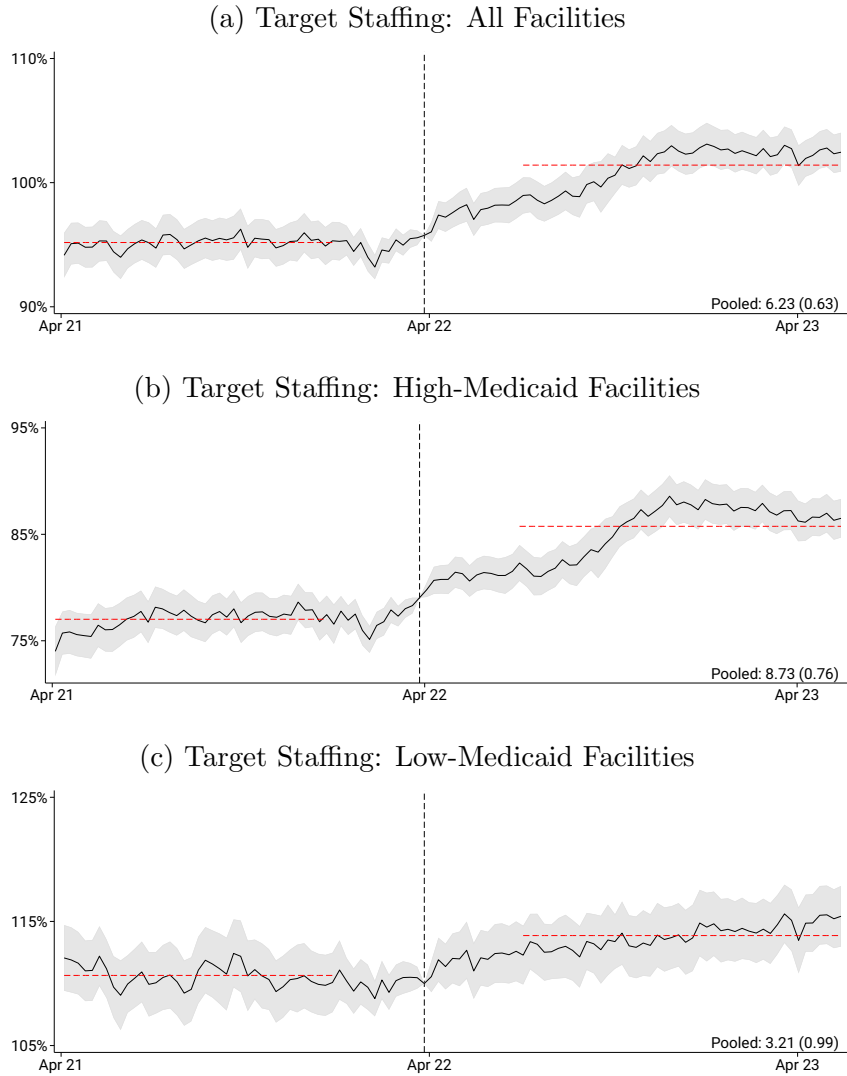


Figure F.2: Event study of staffing levels, by Medicaid payer share, balanced panel

Notes: Figure presents results from difference-in-difference event study regressions with each outcome centered around the mean value in Illinois during the week before the effective date. Gray area denotes 95% confidence interval with robust standard errors clustered by facility. The vertical line indicates the effective date of the reform: April 1, 2022. The red horizontal lines indicate pre-treatment and post-treatment averages, excluding the quarter prior and the quarter after the reform. The pooled estimate in the lower-right corner provides the difference between the post- and pre-treatment average coefficients. The standard error of this difference is reported in parentheses.

	Illinois (1)	Non-Illinois (2)	Matched Controls (3)	<i>P</i> -value (4)
<i>Matching Variables</i>				
STRIVE Ratio	1.050	1.227	1.069	0.054
RN STRIVE	0.231	0.208	0.204	< 0.001
LPN STRIVE	0.195	0.281	0.219	< 0.001
CNA STRIVE	0.624	0.739	0.646	< 0.001
Share of Hours by New Employees	0.132	0.125	0.127	0.002
NHC Overall Rating	2.89	3.04	2.80	0.141
Medicaid Share	0.535	0.620	0.566	0.002
For-profit	0.730	0.695	0.730	0.989
Government	0.039	0.066	0.039	0.977
Non-profit	0.231	0.231	0.230	0.977
Large Central Metro	0.271	0.206	0.264	0.700
Large Fringe Metro	0.252	0.187	0.253	0.947
Medium Metro	0.097	0.214	0.098	0.922
Small Metro	0.078	0.109	0.079	0.900
Micropolitan	0.165	0.130	0.166	0.925
Noncore	0.137	0.147	0.139	0.901
Alzheimer's Unit	0.168	0.136	0.146	0.159
<i>Non-matching Variables</i>				
Total Beds	123.5	107.5	106.6	< 0.001
Occupancy Rate	0.720	0.806	0.811	< 0.001
Age	79.9	78.5	79.4	0.095
Female	0.573	0.577	0.572	0.739
Black	0.171	0.159	0.151	0.061
N	619	12,006	3,024	

Table F.1: Matching Approach Summary Statistics

Notes: Table presents statistics from the Illinois sample in column (1), all non-Illinois facilities in column (2), and the matched control sample in column (3). *P*-values from comparison of means between columns (1) and (3) are presented in column (4).

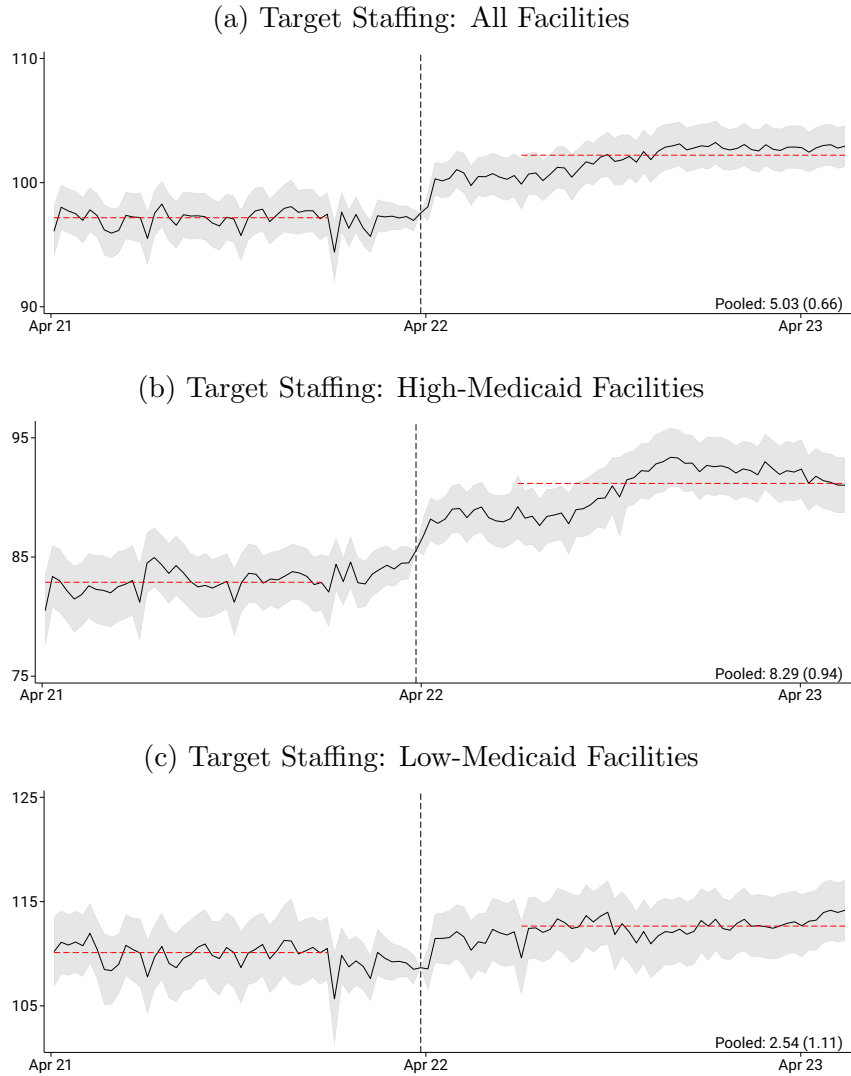


Figure F.3: Event study of staffing levels, by Medicaid payer share, matched control analysis

Notes: Figure presents results from difference-in-difference event study regressions with each outcome centered around the mean value in Illinois during the week before the effective date. Gray area denotes 95% confidence interval with robust standard errors clustered by facility. Sample limited to Illinois facilities and a matched control group for other states (Appendix F.2). The vertical line indicates the effective date of the reform: April 1, 2022. The red horizontal lines indicate pre-treatment and post-treatment averages, excluding the quarter prior and the quarter after the reform. The pooled estimate in the lower-right corner provides the difference between the post- and pre-treatment average coefficients. The standard error of this difference is reported in parentheses.

G Robustness to alternative inference approaches

In this section, we discuss our approach to statistical inference and describe the robustness of our findings to alternative approaches. While our main results are readily apparent in

aggregate time series data (Appendix Figure G.1), one may nonetheless be concerned that our policy analysis relies on the comparison of outcomes for firms in one treated state against all other states. Accordingly, we conduct a battery of tests to assess the robustness of our findings, rather than rely on only one approach.

To assess the robustness of our results, we consider a slightly modified version of our main difference-in-differences regression (1). Specifically, we estimate the model:

$$y_{it} = \sum_{\tau \neq -1} \beta^\tau (IL_i \times q_t^\tau) + \alpha_i + \alpha_t + \varepsilon_{it} \quad (4)$$

in which the original calendar-week terms d_t^τ , meant to capture differential trends for facilities in Illinois relative to other states, are replaced with calendar-quarter terms q_t^τ . This substitution is made only for brevity in comparing standard errors; there is no meaningful change to the inference from this grouping. Notice that our calendar week fixed effects capturing aggregate trends α_t remain unchanged.

In our main specification, we cluster our standard errors at the facility level. Our reasoning for this is that there may be autocorrelation in the error term at the facility-level. Indeed, heteroskedastic-robust standard errors that do not account for this clustering are likely to be underestimated (Appendix Table G.1, panel A). Moreover, as our panel data are analyzed at the facility-week level, this is the natural unit of clustering. Reassuringly, we find no meaningful change in our inference when we shift to the quarterly effects model (Appendix Table G.1, panel B).

Because our treatment is defined at the state level, one may instead prefer to cluster at the level of treatment-assignment (i.e., the state level). Indeed, when we cluster at this level, we find that our standard errors decline slightly from the facility-level clustering approach (Appendix Table G.1 panel C). Cameron et al. (2008) point out that when conducting inference with small numbers of clusters (in our case, states), cluster-robust standard errors may be biased downwards, which can potentially explain why we find smaller standard errors when we cluster at the state rather than facility level. Accordingly, we follow and assess the sensitivity of our inference to non-parametric approaches. We implement a block bootstrapping procedure, in which we resample states with replacement. We conduct 2,000 bootstrap replications. This procedure generates standard errors that closely mirror those from the state-cluster robust approach (Appendix Table G.1 panel D). Next, we implement the wild-cluster bootstrap-t procedure recommended by Cameron et al. (2008). We use Rademacher weights in our wild bootstrap procedure, using states as clusters. The resulting p-values from the bootstrapped distribution of t-statistics, in panel E, show no meaningful divergence from the prior approaches. Finally, we consider a fully non-parametric permutation test approach,

in which for each of the other 49 untreated states, we assign a dummy treatment status, and re-estimate equation (4) using this permuted treatment variable. We plot each of the corresponding β^τ estimates in Appendix Figure G.2, and report the resulting p-values (calculated from Illinois's rank in the empirical distribution) in Appendix Table G.1 panel F. We find inference results that are consistent with each of the preceding models.

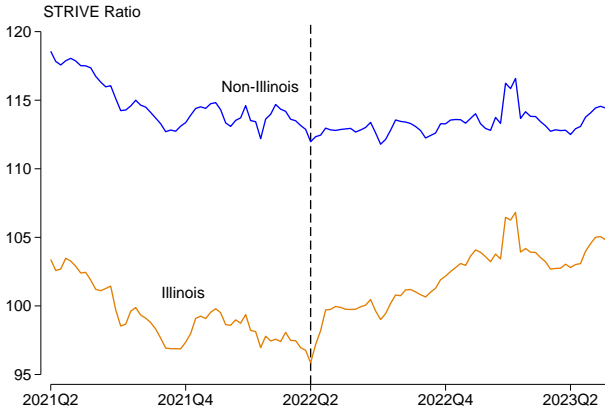


Figure G.1: Evolution of target staffing over time

Notes: Figure plots 3-week rolling average of target staffing in Illinois facilities compared to facilities in all other states.

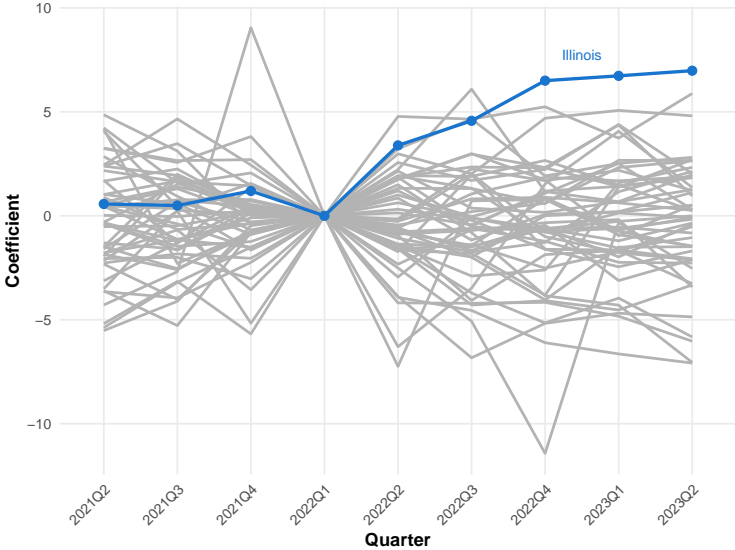


Figure G.2: Permutation test

Notes: Results from permutation test. Each state is assigned a treatment status, and we estimate the main event study regression (1) using this new treatment dummy for each state. Illinois is plotted in blue; all other states are in gray. Quarter effects replace d_t^i in the treatment interaction term for visual clarity. Week fixed effects denoted by α_t persist.

	2021Q2	2021Q3	2021Q4	2022Q2	2022Q3	2022Q4	2023Q1	2023Q2
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Panel A: Heteroskedasticity-Robust Standard Errors								
Coefficient	0.434	0.202	0.623	2.654	4.015	5.941	6.486	6.885
Standard Error	(0.267)	(0.261)	(0.286)	(0.247)	(0.258)	(0.276)	(0.253)	(0.379)
P-Value	[0.104]	[0.438]	[0.029]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
Panel B: Facility-Cluster-Robust Standard Errors								
Coefficient	0.434	0.202	0.623	2.654	4.015	5.941	6.486	6.885
Standard Error	(0.679)	(0.683)	(0.595)	(0.535)	(0.631)	(0.720)	(0.674)	(0.732)
P-Value	[0.523]	[0.767]	[0.295]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
Panel C: State-Cluster-Robust Standard Errors								
Coefficient	0.434	0.202	0.623	2.654	4.015	5.941	6.486	6.885
Standard Error	(0.291)	(0.254)	(0.226)	(0.280)	(0.339)	(0.397)	(0.458)	(0.481)
P-Value	[0.142]	[0.430]	[0.008]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
Panel D: Block-Bootstrap Standard Errors								
Coefficient	0.434	0.202	0.623	2.654	4.015	5.941	6.486	6.885
Standard Error	(0.315)	(0.287)	(0.298)	(0.341)	(0.361)	(0.403)	(0.507)	(0.500)
Panel E: Wild Cluster Bootstrap-t								
Coefficient	0.434	0.202	0.623	2.654	4.015	5.941	6.486	6.885
P-Value	[0.117]	[0.436]	[0.014]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
Panel F: Permutation Test								
Coefficient	0.434	0.202	0.623	2.654	4.015	5.941	6.486	6.885
P-Value	[0.340]	[0.400]	[0.180]	[0.020]	[0.060]	[0.000]	[0.000]	[0.000]

Table G.1: Alternative inference approaches

Notes: Table provides alternative approaches to inference. For clarity, the model described in equation (1) is modified to contain quarter, rather than week, effects in the main treatment interaction term (the d_t^r terms). Calendar week fixed effects (α_t) capturing aggregate trends remain the same. Panel A reports the results from heteroskedasticity-robust standard errors. Panel B corresponds to our primary analysis, and provides results from cluster-robust standard errors, where the clustering is at the facility level. Panel C presents results from state-level cluster-robust standard errors. Panel D presents the results from a block bootstrap procedure using states as blocks (Bertrand et al., 2004). Panel E presents results from a wild cluster bootstrap-t procedure (Cameron et al., 2008). Panel F presents the results from a permutation test in which each other state is assigned treatment status.