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The Impact of Minimum Quality Standard Regulations on Nursing Home Staffing, Quality, and Exit Decisions

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Abstract The regulation of nursing homes in the U.S. often includes mandates that require a minimum nurse staffing level. In this paper, we exploit new minimum nurse staffing regulations by the states of New Mexico and Vermont that were implemented in the early 2000s to determine how nursing homes responded in terms of staffing, quality, and the decision to exit the market. Our identification strategy exploits the fact that some nursing homes had pre-regulatory staffing levels near the new requirement and did not need to change staffing levels. We compare these nursing homes to a group that faced binding constraints (low-staffed) and those that were significantly over the constraint (high-staffed). Low-staffed nursing homes increase staffing levels but also use less expensive nurse types to satisfy the new standard. High-staffed nursing homes decrease staffing and use fewer contracted staff. Overall, dispersion in staffing is reduced, but we find little effect by pre-regulatory staffing level on non-staffing measures of quality and the decision to exit the market.

Keywords Minimum quality standards · Regulation · Nursing homes · Nurse staff levels · Nurse staff composition · Exit

JEL Classification H75 · I18 · L51

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1 Introduction

When quality is not easily verified, firms may have an incentive to reduce quality in order to increase profits. This is particularly true in the healthcare sector, where patients are less informed than providers and quality is difficult to measure (Chou 2002). Minimum quality standards are an important tool that regulators can use to assure a minimum level of quality. Over the last 20 years, minimum quality standards have become increasingly common in hospitals and nursing homes in the U.S., often in the form of minimum staffing regulations for nurses. Since nurses play a vital role in providing care and staffing levels are easy to measure, staffing regulations set standards for the composition and level of nurse staffing with the goal of improving patient outcomes.

Advocates for minimum staffing regulations argue that low nurse staffing levels are associated with poor quality and that more stringent staffing regulations will increase staffing levels and improve quality. While it is clear that more stringent minimum staffing regulations increase staffing levels (Park and Stearns 2009), the empirical results on other quality measures are often mixed, with results that depend on the healthcare industry, type of nurse, and quality measure that is examined (Cook et al. 2012; Lin 2014). Further, more stringent staffing regulations are often not fully funded, which result in lower profitability and, in some cases, with providers losing money (Bowblis 2015). This could lead to some providers exiting the market.

The theoretical literature offers some suggestions on what will occur in the face of minimum staffing regulations. There is a general consensus that providers that are below a regulatory standard will increase staffing, but there is ambiguity in other dimensions.

In this paper, we empirically test how providers respond to minimum staffing regulations. Utilizing panel data over six-and-a-half years, we examine how nursing homes in New Mexico and Vermont responded to newly implemented minimum staffing regulations for nurses. These new regulations, which became effective in the early 2000s, impact nursing home staffing patterns, and as a result, may impact multiple dimensions of nursing home behavior. We examine these behaviors in terms of nurse staffing levels, nurse composition, use of contracted nurses, quality, and market exits.

Although there are number of papers that have examined nursing home staffing regulations (Park and Stearns 2009; Bowblis 2011a; Matsudaira 2014a, b; Bowblis 2015; Chen and Grabowski 2015), this paper differs from existing studies in a number of ways: Prior research focuses on changes in existing regulations, whereas New Mexico and Vermont did not have minimum staffing regulations prior to the early 2000s. Because these states did not have pre-existing regulations, nursing homes in these states were free to choose staffing levels to maximize objectives without significant government restraints. We are therefore able to examine how nursing homes respond to newly implemented regulations, whereas existing studies focus on the strengthening of existing regulations.

The rest of the paper begins by providing a general background on minimum quality standards and then the role of minimum nurse staffing regulations in the nursing home industry. Section 3 describes the staffing regulations in New Mexico and Vermont. Section 4 describes the data and the empirical strategies while Sect. 5 presents the main results. Section 6 concludes.

2 Background

When there is significant asymmetry in information with regard to the quality of a product, minimum quality standards are often set to increase the quality produced. Theoretical work on minimum quality standards has focused on how firms would respond if a new minimum quality standard is implemented. Under perfect enforcement when standards are binding, low quality firms either increase quality or exit the market (Leland 1979; Shapiro 1983; Ronnen 1991). Ronnen (1991) also found that high-quality firms and firms that are just above the standard would increase their quality to differentiate themselves from low-quality firms. Under imperfect enforcement, Chen and Serfes (2012) also found that low-quality firms exit first, but high quality firms increase quality in order to not be labeled as noncompliant. The net result is that overall quality is improved by all firms, quality dispersion may increase, and low-quality firms exit the market.

While all of the papers find that low-quality firms improve quality, relaxing some of the assumptions of the theoretical model can lead to different results, especially for high-quality firms. For example, Crampes and Hollander (1995) found that mildly restrictive standards cause high quality firms to have lower profits and exit the market first. Additional work by Scarpa (1998) and Valletti (2000), confirms these results among high-quality firms. These papers generally suggest that quality will become less disperse and that high quality-firms will exit the market. Clearly, the theoretical literature is ambiguous as to how minimum quality standards affect the overall dispersion of quality and high-quality firms.

In this application we examine minimum quality standards in the nursing home industry in the form of minimum staffing regulations for nurses. Nursing homes provide residential care to individuals who need help in performing everyday tasks. Many of these residents have impairments in cognitive functioning due to dementia, which makes it difficult for residents to verify and monitor quality. Furthermore, federal regulations require nursing homes to provide services in a manner that maintains dignity, wellbeing, and quality of life for the residents (Centers for Medicare and Medicaid Services 2015). All of these dimensions of quality are difficult to measure, which makes the regulator's problem even more difficult. Because nurses are a primary input into the provision of nursing home care, are easy to measure, and are a primary determinant of quality (Cohen and Spector 1996), the federal and state governments have attempted to regulate nursing home quality by ensuring that nursing homes have adequate nursing staffing levels.

These regulations often dictate the level and composition of nurse staffing. Nursing homes are staffed by three types of nurses: registered nurses (RNs), licensed practical nurses (LPNs), and certified nurse aides (CNAs). RNs and LPNs

are licensed nurses because they require educational training and licenses. RNs have greater training and higher educational attainment than do LPNs, but all licensed nurses directly assess, supervise, and evaluate the care that is provided to residents. In contrast, most of the direct care needs of residents are provided by CNAs, who receive 75 h of training but do not have any additional educational requirements. Therefore, CNAs are the least expensive but lowest quality of the three types of nurses.

At the federal level, nursing staffing regulation was set under the Omnibus Budget Reconciliation Act (OBRA) of 1987. This regulation requires that a licensed nurse be on duty at all times of the day and that at least 8 h of licensed nurse supervision per day be performed by a RN.[1] OBRA effectively set a minimum staffing regulation for licensed nurse staffing, but OBRA was more ambiguous about overall nurse staffing levels. OBRA requires that nursing homes have "sufficient" nursing staff to attain and maintain resident well-being, but does not dictate how much staffing is needed (OBRA 1987). This left the states with the burden of defining "sufficient" staffing. To assure quality, some states have enacted minimum staffing regulations for total nurse staffing levels.[2] These regulations are more stringent than federal standards, and by 2004, 40 states had some form of regulation for total nurse staffing (Mueller et al. 2006). These regulations for total nurse staffing are the focus of this paper.

Empirical studies that evaluate the effect of staffing regulations in the nursing home industry tend to follow one of two strategies: The first strategy is to use a national sample of nursing homes and estimate how changes in regulations affect staffing levels and quality. In one paper, Park and Stearns (2009) examined any change in regulation that affected staffing levels and found small increases in staffing for nursing homes that were initially below or close to new standard. Bowblis (2011a) examined how the magnitude of the increase in the standard affected staffing. He found that more stringent standards caused overall staffing levels to increase mostly through the hiring of CNAs. While both of these papers confirm the theoretical literature that low-quality firms will increase quality, these papers did not examine what happens to high-quality firms.

The second strategy is to study the effect of a regulation change in one or two states. For example, Matsudaira (2014a) examined a California law passed in 1999 that increased the required number of nurses from 2.7 h of care per each resident day (HPRD)—a measure that reflects the average staffing level over a 24 h period—to 3.2 HPRD. He found that nearly three-quarters of nursing homes were out of compliance with the new standard, and that these nursing homes increased staffing

[1] Nursing homes are allowed to apply for waivers from the RN staffing requirement. A nursing home must show hardship in order to be granted a waiver; and, therefore, waivers only tend to be granted to small nursing homes.

[2] While OBRA did not specifically define "sufficient" staffing, there are at least three mechanisms that potentially deter nursing homes from understaffing their facilities: First, states may implement minimum staffing regulations which include a specific minimum nurse-to-resident ratio. These regulations are the focus of this paper. Second, states are required to inspect each nursing home on an annual basis. If state regulations determine that the nursing home does not employ "sufficient" staff, the regulators may issue a regulatory deficiency citation, fine, and/or closure of the facility. Third, understaffing a facility may lead to a greater number of accidents, and litigation risk may act as a deterrent to understaffing.

but there were no effects on other measures of quality. To identify these effects, nursing homes below the new standard were compared to those that were in compliance prior to the implementation of the new standard. Chen and Grabowski (2015) extend this work by focusing on two states that made their existing regulations more stringent: California and Ohio. Unlike Matsudaira (2014a), Chen and Grabowski (2015) also include a set of control states and identify the effect of the more stringent regulation by classifying nursing homes into quartiles based on staffing levels that were prior to the new regulation. They find that the lowest quartile increased RN and CNA staffing and the highest quartile decreased CNA staffing after the more stringent regulations became effective.

While the current literature clearly shows that more stringent regulations result in increased staffing for nursing homes out of compliance, the literature fails to address three important issues: First, the existing literature focuses on strengthening existing regulations that may have already affected the firm's choice over staffing decisions. In this paper, by studying only states that implement new staffing regulations we can fully explore the effect of implementing a minimum quality standard. Second, only Chen and Grabowski (2015) have addressed the issue of how high-staffed nursing homes respond to more stringent regulations. However, their definition for high-staffed is based on quartiles and not staffing relative to the new standard. This paper defines types based on the new staffing standard, which allows us more easily to identify the effects for nursing homes that are significantly above, below, and at the new standard. And finally, none of these papers examine the use of contracted staff or market exits.

3 New Mexico and Vermont Staffing Regulations

To examine the causal impact of minimum nurse staffing regulations, this paper examines the experiences of two states that implemented new staffing regulations for the total number of nurses in the early 2000s. Prior to these new regulations, each state had staffing regulations that were equivalent to those required by OBRA.[3] Effectively, each state had licensed nurse staffing regulations that were equivalent to federal standards, but nursing homes were free to choose the total amount of staffing that they deemed necessary to provide care to their residents. This led to significant variation in staffing levels across facilities. For example, the average facility in New Mexico for the 2 years prior to the new regulations had 2.8 HPRD of nurse staffing, but the 25th and 75th percentile facilities were 2.3 and 3.1 HPRD, respectively. Similarly for Vermont the average was 3.3 HPRD, with the 25 and 75th percentiles ranging from 2.9 to 3.7 HPRD.

New Mexico and Vermont implemented similar minimum staffing regulations for the total number of nurses on August 15, 2000, and December 1, 2001, respectively. The new standards required a minimum number of HPRD of nurses to be devoted to

[3] New Mexico required that a licensed nurse be on duty at all times and there must be a full-time director of nursing (NMAC 7.9.2.51). According to Section 7.13 of Vermont's *Licensing and Operating Rules for Nursing Homes*, nursing homes are required to have a licensed nurse on duty at all times, at least eight hours a day must be from staffed by an RN, and included in those RN hours is a RN director of nursing.

providing direct care to residents. Additionally, the new standards did not change the minimum number of licensed nurses each nursing home was required to employ. For New Mexico, the new standard became 2.5 HPRD, whereas Vermont used 3.0 HPRD. The new standards were enforced by each state's nursing home licensure authority, which is required by federal law to survey each nursing home at least once every 9–15 months. Failure to comply with the regulations after the date of implementation could result in the issuance of regulatory deficiency citations and monetary fines.

The implementation of minimum nurse regulations in both states was not anticipated. New Mexico Governor Gary Johnson vetoed a nursing home staffing bill in 1997 that proposed an increase in staffing requirements, and there were no votes on other staffing bills introduced by the legislature during the period.[4] Similarly, there were no bills in the Vermont legislature that were related to nursing home staffing regulations. Regulatory agencies in both states implemented new requirements unilaterally and in a short time frame. Only 4–5 months before the effective date of new regulation, the Vermont Department of Aging and Disabilities initially announced a proposal to implement staffing regulations in July of 2001 and held public hearings on August 22, 2001.[5]

4 Data and Empirical Strategy

The data for this analysis comes from Online Survey Certification and Reporting (OSCAR) system. Data in OSCAR are collected as part of a yearly re-certification process that all government reimbursed nursing homes undergo every 9–15 months. The information that is collected in OSCAR includes staffing levels, physical structure of the facility, ownership, and aggregated resident characteristics. Using the provider identification number and the physical address of each nursing home, we constructed a panel dataset of nursing homes for the states of New Mexico and Vermont using all OSCAR surveys that occur two and half years before and 4 years after the effective date of the MDCS regulation for each state. Each year is assumed to have 365 days, which makes the study period for New Mexico approximately March 1998 to February 2004, and June 1999 to June 2005 for the state of Vermont.

In this paper, we exploit the fact that nursing homes were free to choose staffing levels in the pre-regulation period to determine how nursing homes responded to new staffing regulations. In nursing homes, staffing levels are measured in terms of hours per resident day (HPRD), which in theory reflects the average amount of time that each nurse could devote to each resident over a 24-hour period.[6] Using all OSCAR surveys in the pre-regulation period, we calculate the average total staffing

[4] Senate Bill 194 was vetoed in April of 1997. Governor Gary Johnson held office from 1995 and 2003. Source: "Governor Vetoes Nursing Home Bill." April 11, 1997. *Albuquerque Journal.*

[5] Source: "Vermont Weighs Nursing Home Rules." July 30, 2001. *The Burlington Free Press.*

[6] Occasionally, OSCAR reports staffing levels that are unreliable. These observations are not utilized in this analysis. Unreliable observations for total staffing levels are identified as those with more than twenty-four hours of staffing, zero staffing, and (among those surveys that do not fall within the first two criteria) nursing homes that have staffing levels that are three standard deviations outside the mean.

levels for each nursing home and compare it to the new staffing standard within each state (i.e., 2.5 or 3.0 HPRD). The difference in the average staffing level and the regulated requirement is used to classify nursing homes into three types.

The first type is low-staffed facilities: These nursing homes had staffing levels that were below the new standard and would be required to increase staffing in order to not pay penalties and fines. The second type is high-staffed facilities: These facilities have staffing levels that are 10 % above the new requirement. The third and final type is 'control' facilities: The control facilities have pre-regulation staffing levels that range from *at to* 10 % above the new standard. These are facilities that do not need to change staffing levels because they satisfy the new standard, but also do not have staffing levels that are significantly above the standard.

In our data, we identify a total of 114 nursing homes—69 of which are in New Mexico, and 45 are in Vermont—that can be classified into low, control, and high-staffed facilities. A total of 10 nursing homes exit the market after the effective date of the staffing regulation. An exit is defined as failing to appear in the OSCAR data for at least 3 years, as per the method described in Bowblis (2011b). Of the 104 facilities that remain open for the entire study period, 42 are low-staffed, 21 are controls, and 41 are high-staffed.

4.1 Empirical Model for Staffing and Quality

Our empirical objective is twofold: The first objective is to determine how nursing homes responded to the staffing regulation in terms of staffing levels, composition, use of contracted nurses, and quality. To determine the impact of the regulations on these measures, we utilize a panel of nursing homes that remain open for the entire study period, which resulted in a sample of 582 OSCAR surveys.[7] Let y_{it} be a measure of staffing or quality for nursing home i in OSCAR survey t. By regressing y_{it} on a set of variables that compare low and high-staffed nursing homes to control facilities, a standard difference-in-difference model is estimated. The fact that the control facilities do not significantly change staffing levels over the study period allows us to treat nursing homes in this group as a control group, whereas low and high-staffed nursing homes each act as separate treatment groups.

So long as nursing homes do not anticipate the regulatory change as argued in the previous section, we can estimate the following regression model:

$$y_{it} = \alpha_0 + \alpha_1 Post_{it} + \left(\sum_{k=Low,High} \beta_1^k Treat_{it}^k + \beta_2^k Treat_{it}^k * Post_{it} \right) + \theta X_{it} + \delta_i + \tau_i + \varepsilon_{it} \quad (1)$$

where $Post_{it}$ is an indicator that identifies the period before and after the effective date of the new staffing regulation, $Treat_{it}^k$ is an indicator variable that represents whether a nursing home is low or high-staffed, X_{it} is a vector of nursing home

[7] While nursing homes are required to be surveyed every 12 months, longer intervals do occur causing there to be fewer observations for the 104 nursing homes than expected.

characteristics, δ_i is a facility fixed effect,[8] τ_i is a set of year indicator variables that capture time trends that affect all nursing homes, and ε_{it} is an error term.

The dependent variables are various measures of staffing in each nursing home. Staffing levels are measured as the total number of nurses in HPRD. This includes all RNs, LPNs, and CNAs that provide direct care to residents. Staffing composition can be measured one of two ways: the level of staffing for each type of nurse in HPRD, or as a percent of each type of nurse relative to total nurse staffing. To account for the fact that using percentages alone make it difficult to determine if composition changes are due to the firing or hiring of only one type of nurse, we report staffing levels for RNs and licensed nurses (RNs & LPNs) as well as staffing composition as a percentage of all nurses.[9] We also examine the use of contracted nurses, which is calculated as the percentage of full-time equivalents of all nurses that are contracted.

In addition to measures of staffing we also determine if quality changes. We examine four measures of quality: the percentage of residents that *acquired* a pressure ulcer, contracture, or physical restraint at the facility, and the total percentage of residents who use a feeding tube.[10] A pressure ulcer is an injury to the skin that is caused by pressure and a lack of repositioning, whereas contractures are the shortening of the soft tissue due to a lack of stretching the limbs. Both are preventable by repositioning and stretching the limbs of the resident every few hours. In the cases of physical restraints and feeding tubes, both can lead to psychological harm, physical injury, and infections. For all of these quality measures, higher values are associated with lower quality.

In order for the difference-in-difference framework to be valid there must be a common trend among the three types of nursing homes in the pre-regulation period: the period directly before the new regulations become effective. Figure 1 reports the average staffing levels for the three staffing types for the combined data of New Mexico and Vermont (Fig. 1a), only New Mexico (Fig. 1b), and only Vermont (Fig. 1c). While each state has greater variation due to smaller sample sizes, the combined data show that low-staffed nursing homes have staffing levels about 0.2 HPRD below the requirement, control facilities are slightly above the requirement, and high-staffed nursing homes are about 0.9 HPRD above the requirement. Of key importance is that staffing levels across the three groups are flat until the first year that the new regulations became effective: from -2.5 to -1 years after the effective date in Fig. 1a. While it should be noted that there seems to be a slight upward trend in the control facilities during the pre-regulatory period, this is due to only half the nursing homes having data in the first year of the study period. More importantly,

[8] Hausman tests found that all models should include fixed effects and not random effects.

[9] For example, it is expected that nursing homes will hire cheaper CNAs if they need to increase staffing or fire more expensive RNs if they need to reduce staffing. Composition may change without changes in staffing levels of certain nurses.

[10] Pressure ulcers, contractures, and physical restraints are calculated as the percentage of residents that acquired the condition at the facility. The number of facility-acquired conditions is defined as the number of residents currently with the condition minus the number of residents that had the condition prior to admission. If a nursing home is able to restore functioning, it is possible for these measures to have negative values.

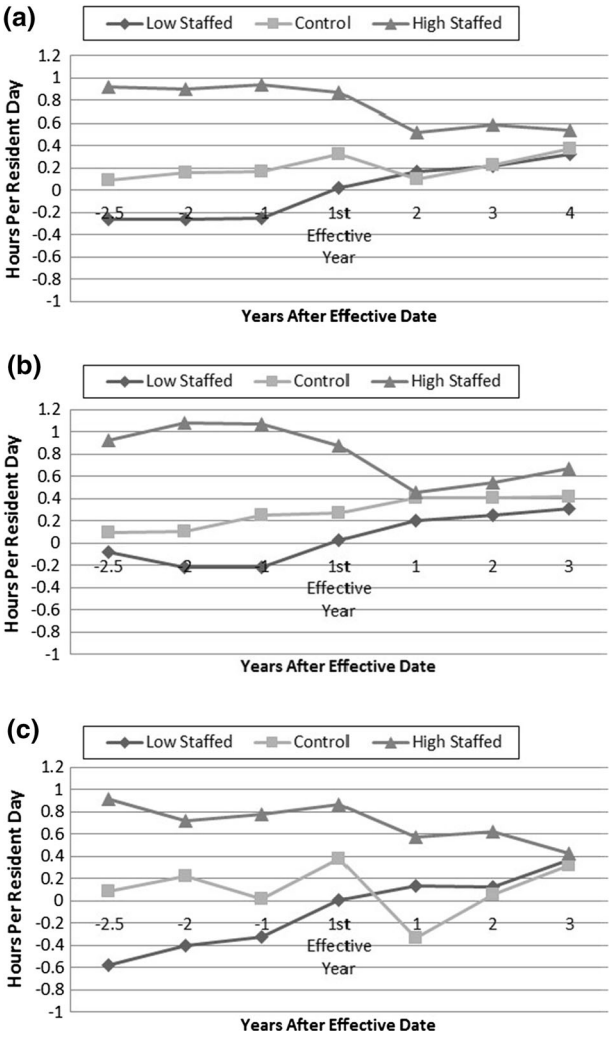

Fig. 1 **a** Total nurse staffing levels relative to regulatory requirement (NM & VT). **b** Total nurse staffing levels relative to regulatory requirement (New Mexico). **c** Total nurse staffing levels relative to regulatory requirement (Vermont). *Notes* Difference in average staffing levels compared to the regulatory standard introduced on the effective date for nursing homes that remain open for the entire study period

econometric models that formally test the common trend assumptions find no statistical difference in trends during the pre-regulation period across the three groups.

There are also other issues with Eq. (1) that need to be addressed: First, the effect of the regulation can be different in New Mexico and Vermont. To determine if regressions should pool the observations for the two states or if instead each state should be analyzed separately, a series of Chow tests are performed. If the Chow test suggests the regression should be pooled, only the specification that pools the

two states are reported; but if the Chow tests find different effects for New Mexico and Vermont, three regressions are reported: the pooled regression and separate regressions for each state. Second, the inclusion of the facility fixed effect causes the variable $Treat_{it}^{k}$ to drop out of the equation. When fixed effects are included in the model, we are able to identify the difference-in-difference coefficient estimate, but we are no longer able to identify the average difference in the treatment groups that are identified by β_1^k. Third, in difference-in-differences equations standard errors can be biased towards finding statistically significant effects (Bertrand et al. 2004). To correct for this, we present results of the difference-in-difference models that estimate standard errors using bootstrapping with 500 replications and that are clustered within each nursing home.

Also included in the model are a set of explanatory variables that may affect the outcomes of interest (X_{it}). Summary statistics for these and other variables are reported in Table 1.[11] Overall, the characteristics of nursing homes across the three staffing types tend to be consistent except in a few cases. High-staffed nursing homes are more likely to be owned by not-for-profits, are hospital based, and are less reliant on Medicaid. Interestingly, the control group does not include any government-operated facilities or those that are hospital-based.

4.2 Empirical Model of Exits

The second objective is determine whether staffing regulations lead to a pattern in which nursing homes exited the market. Of the 114 nursing homes that can be classified into staffing types, 10 closed within 4 years of the regulation's effective date. While we attempted to analyze the probability of exiting the market using a discrete choice model, the rarity of exits causes the models to be highly sensitive to the model specifications.[12] Therefore we report unadjusted exit rates by low-, control, and high-staffed groups and some other key explanatory variables (i.e., bivariate statistics).

5 Results

5.1 Nurse Staffing

Table 2 reports the results of Eq. (1) when the dependent variable is total nurse, RN, and licensed nurse staffing level measured in HPRD. For total staffing levels, Chow tests find that New Mexico and Vermont responded similarly to the new regulatory standards. Control facilities did not statistically change total staffing levels, but low-staffed nursing homes increase total staffing by an average of 0.31 HPRD. In

[11] Summary statistics are reported for all 582 observations. For licensed staffing regressions, the minimum licensed staff reported is zero. Since this is not allowed by law, these observations are excluded from regressions that use RN or licensed staff levels/composition as a dependent variable.

[12] We also estimates the models using linear probability models, logit and probit, but many of the control variables perfectly predicted the outcome. This made the models unstable and highly dependent on the controls that are included in the model.

Table 1 Summary Statistics

	Entire sample			Low-staffed	Control staffed	High-Staffed
	Mean (SD)	Min	Max	Mean (SD)	Mean (SD)	Mean (SD)
Dependent variables						
Total nurse staffing levels (HPRD)	3.046	0.762	7.559	2.656	2.933	3.507
	(0.837)			(0.736)	(0.575)	(0.834)
Registered nurse staffing levels (HPRD)	0.370	0.000	1.750	0.313	0.324	0.452
	(0.225)			(0.230)	(0.166)	(0.224)
Licensed nurse staffing levels (HPRD)	0.972	0.000	3.429	0.852	0.894	1.137
	(0.368)			(0.310)	(0.221)	(0.423)
% Total staff contracted	0.848	0.000	40.472	0.473	0.973	1.162
	(3.485)			(2.138)	(3.476)	(4.448)
% with facility-acquired pressure ulcers	3.414	−33.333	17.241	3.590	3.087	3.414
	(3.618)			(3.048)	(4.628)	(3.521)
% with facility-acquired contractures	15.157	−63.514	97.980	12.799	15.431	17.417
	(19.117)			(16.856)	(17.631)	(21.705)
% with facility-acquired physical restraints	6.291	−52.941	96.341	7.503	5.853	5.296
	(10.196)			(10.644)	(6.849)	(11.143)
% Using feeding tubes	2.948	0.000	15.000	3.050	3.015	2.806
	(2.599)			(2.524)	(2.732)	(2.605)
Explanatory variables						
Low staffed	0.397			1.000		
	(0.490)			(0.000)		
High staffed	0.388					1.000
	(0.488)					(0.000)
Post effective requirement	0.588			0.593	0.608	0.571
	(0.493)			(0.492)	(0.490)	(0.496)
Additional control variables						
Nonprofit ownership	0.296			0.182	0.176	0.478
	(0.457)			(0.387)	(0.382)	(0.501)
Government ownership	0.052			0.052	0.000	0.080
	(0.221)			(0.222)	(0.000)	(0.271)
Number of beds	91.897	15.000	369.000	93.143	91.616	90.779
	(48.028)			(58.315)	(38.202)	(40.904)
Chain membership	0.601			0.688	0.672	0.473
	(0.490)			(0.464)	(0.471)	(0.500)
Hospital-based facility	0.024			0.009	0.000	0.053
	(0.153)			(0.093)	(0.000)	(0.225)
Occupancy rate	89.496	5.000	100.000	87.782	92.315	89.689

Table 1 continued

	Entire sample			Low-staffed	Control staffed	High-Staffed
	Mean (SD)	Min	Max	Mean (SD)	Mean (SD)	Mean (SD)
	(10.949)			(11.887)	(5.293)	(11.926)
Percentage Medicare	8.468	0.000	100.000	8.310	7.593	9.113
	(10.644)			(12.224)	(5.573)	(11.038)
Percentage Medicaid	67.920	0.000	100.000	72.918	72.272	60.405
	(20.097)			(16.881)	(15.061)	(23.103)
Acuity index	9.773	6.583	14.392	9.591	9.899	9.890
	(1.003)			(1.048)	(1.060)	(0.894)
Percentage dementia	43.877	0.000	98.039	43.345	43.741	44.497
	(19.555)			(19.280)	(21.902)	(18.503)
Percentage psychiatric illness	12.596	0.000	67.273	13.626	13.292	11.157
	(11.685)			(12.470)	(11.886)	(10.597)
Percentage developmentally disabled	2.368	0.000	74.510	2.527	2.692	2.028
	(3.992)			(3.007)	(6.837)	(2.440)
Percentage chairfast	52.207	0.000	100.000	51.270	49.406	54.713
	(17.430)			(17.483)	(19.670)	(15.725)
Percentage bedfast	3.205	0.000	39.216	3.321	3.538	2.901
	(4.786)			(4.840)	(5.393)	(4.359)
State of New Mexico	0.586			0.688	0.560	0.496
	(0.493)			(0.464)	(0.498)	(0.501)
County with 2–3 facilities[a]	0.232			0.229	0.304	0.195
	(0.422)			(0.421)	(0.462)	(0.397)
County with 4–9 facilities	0.545			0.511	0.440	0.637
	(0.498)			(0.501)	(0.498)	(0.482)
County with 10+ facilities	0.146			0.143	0.200	0.119
	(0.353)			(0.351)	(0.402)	(0.325)
Observations	582			231	125	226
Number of nursing home facilities	104			42	21	41

Summary statistics (means and standard deviation in parentheses) are for all nursing homes in New Mexico and Vermont that have an OSCAR survey that were open for the entire study period. The minimum and maximum values for continuous variables for the entire sample are also reported. The subgroups of low, control, and high-staffed nursing homes are defined by the average staffing level in the 2-and-a-half years prior to the new staffing regulations became effective

[a] The reference group is a county with 1 facility

contrast, high-staffed nursing homes reduce staffing by 0.30 HPRD. These results are consistent with low-staffed nursing homes increasing staffing to satisfy the new standards and high-staffed nursing homes reducing staffing to levels that are closer to the standard.

For specific nurse types, the pooled regressions find no statistically significant change for RN staffing and that high-staffed nursing homes reduced licensed

Table 2 Effect of new staffing regulation on total nurse, registered nurse and licensed nurse staffing levels

Variables	Total nurse (HPRD)	Registered nurse (HPRD)			Licensed nurse (HPRD)		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Post period	0.101	−0.003	0.065	−0.097	0.064	0.052	0.036
	(0.147)	(0.038)	(0.041)	(0.062)	(0.048)	(0.075)	(0.065)
Effect of regulation on low-staffed (low-staffed × post)	0.313**	0.001	−0.072*	0.105*	0.040	0.002	0.135**
	(0.130)	(0.037)	(0.043)	(0.064)	(0.032)	(0.048)	(0.062)
Effect of regulation on high-staffed (High-staffed × post)	−0.296**	−0.039	−0.095**	0.026	−0.098**	−0.126*	−0.088
	(0.117)	(0.033)	(0.044)	(0.057)	(0.050)	(0.075)	(0.066)
Nonprofit ownership	−0.219	0.125	0.115		0.111	0.106	
	(0.847)	(0.150)	(0.160)		(0.136)	(0.142)	
Number of beds	−0.018	−0.002	−0.006	0.003	−0.003	−0.007	0.002
	(0.018)	(0.002)	(0.004)	(0.014)	(0.006)	(0.010)	(0.017)
Chain membership	−0.233	−0.024	−0.018	−0.023	−0.076	−0.081	−0.075
	(0.221)	(0.043)	(0.102)	(0.055)	(0.059)	(0.154)	(0.073)
Occupancy rate	−0.014**	−0.004**	−0.006**	0.001	−0.011***	−0.011***	−0.008**
	(0.006)	(0.002)	(0.002)	(0.003)	(0.002)	(0.003)	(0.003)
Percentage Medicare	−0.002	0.003	0.003	0.001	0.005	0.006	0.004
	(0.008)	(0.003)	(0.004)	(0.002)	(0.004)	(0.006)	(0.005)
Percentage Medicaid	0.003	0.001	−0.000	0.001	0.002	0.002	0.002
	(0.003)	(0.001)	(0.002)	(0.002)	(0.002)	(0.002)	(0.003)
Acuity index	0.079	0.010	0.020	−0.008	0.006	0.043	−0.064**
	(0.063)	(0.014)	(0.019)	(0.023)	(0.021)	(0.028)	(0.028)
Percentage dementia	0.001	−0.000	−0.000	−0.000	−0.000	−0.001	0.000
	(0.002)	(0.000)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Percentage psychiatric illness	−0.001	0.000	−0.000	0.001	−0.001	−0.001	0.000

Table 2 continued

Variables	Total nurse (HPRD)	Registered nurse (HPRD)			Licensed nurse (HPRD)		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	(0.002)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.002)
Percentage developmentally disabled	−0.009	−0.000	0.005	−0.001	−0.001	−0.001	0.001
	(0.008)	(0.003)	(0.007)	(0.003)	(0.003)	(0.006)	(0.007)
Percentage chairfast	−0.003	−0.000	−0.001	0.001	0.001	−0.001	0.003*
	(0.003)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.002)
Percentage bedfast	−0.004	−0.002	−0.004	0.000	−0.002	−0.004	−0.000
	(0.010)	(0.003)	(0.005)	(0.003)	(0.002)	(0.004)	(0.003)
Constant	5.314***	0.762**	1.229**	−0.002	1.951***	2.098*	2.048
	(1.926)	(0.351)	(0.529)	(1.393)	(0.755)	(1.105)	(1.730)
States	NM & VT	NM & VT	NM	VT	NM & VT	NM	VT
Chow test (NM ≠ VT)	N	Y			Y		
Observations	582	580	340	240	580	340	240
R-squared	0.586	0.692	0.707	0.686	0.675	0.663	0.582

The table reports linear, fixed-effect panel regression models with a dependent variable of total nurse, registered nurse, or licensed nurse staffing levels (HPRD). All coefficient estimates are reported except for time trends and variables that were time-invariant. Regressions are run on the combined sample of New Mexico and Vermont. Chow tests were performed to determine if New Mexico and Vermont responded to the new staffing requirements in a statistically different manner. When these Chow tests found differences in any model specification for the dependent variable, we also report regressions for each state separately. Standard errors are bootstrapped using 500 replications and are clustered within facility

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

staffing levels by 0.10 HPRD. However, these pooled regressions hide the fact that New Mexico and Vermont respond differently to the new standards. For low-staffed nursing homes, the regulation is associated with lower RN staffing levels in New Mexico but higher levels in Vermont. For high staffed nursing homes, we find a similar effect, with New Mexico's nursing homes reducing RN staffing levels and Vermont not statistically changing RN staffing. These changes also translate into licensed staff. In New Mexico, high-staffed nursing homes reduce the use of licensed staff, but there is no statistically significant change for low-staffed facilities. Vermont shows the opposite pattern. High-staffed nursing homes have no statistically significant change in licensed staffing, though low-staffed nursing homes increase licensed staffing levels.

To verify these results, we examine the percentage of RNs and licensed nurses to total nurse staffing (Table 3). Interestingly, Chow tests find the behavior of New Mexico and Vermont nursing homes to be similar in terms of composition. The only statistically significant change is that low-staffed nursing homes have a smaller percentage of licensed nurse to total nurse staff. These results, when combined with the fact that low-staffed nursing homes increase staffing levels, suggest that low-staffed nursing homes in New Mexico cut RN staffing levels and hired CNAs to meet the regulatory requirement. In Vermont, RNs and LPNs are hired in low-staffed nursing homes, but the increase in these nurse types did not offset the hiring of CNAs. For high-staffed nursing homes, all facilities cut back on RN and LPNs, but the percentage of staff that is devoted to licensed staffing remains at similar levels.

In order to control costs, nursing homes may enter into contracts with companies that will provide nurses. The percentage of total staff that is contracted is small (<1 %), and this is due to most nursing homes not using any contracted staff during the study period (89.5 % of observations). When contracted staff is utilized, on average, 8 % of nurses are contracted, with one facility contracting up to 40.4 % of all nurses. The third column of Table 3 shows the effect of staffing regulations on the percentage of nurses that are contracted. Low- and high-staffed nursing homes reduce the use of contracted staff, but the effect is only statistically significant for high-staffed facilities. For these high-staffed facilities, the regulation is associated with a 1.9 percent point reduction in the use of contracted staff. This would be consistent with cutting the contracted nurses before cutting full-time employees to reduce overall staffing levels.

In terms of other variables that predict staffing outcomes, the only statistically significant effect that is consistent across most model specifications is the occupancy rate. Nursing homes with higher occupancy rates have lower staffing levels, have compositions that consist of CNAs rather than licensed staff, and use fewer contracted nurses. Some case-mix variables impact staffing outcomes, but the results are mixed and depend on the outcome. The fact that most control variables are statistically insignificant is due to the fixed effects capturing most of the variation across facilities. To see if other control variables also influence staffing levels we examined random effect models (data not shown). For staffing outcomes, facilities with lower occupancy rates, residents with greater physical need (i.e., higher acuity index scores), and in more competitive markets employ more nurses.

Table 3 Effect of new staffing regulations on nurse composition and use of contracted nurses

Variables	Percentage of all nurse staffing (%)		
	Registered nurses (1)	Licensed nurses (2)	Contracted (3)
Post period	0.568	3.215	0.969
	(1.540)	(2.123)	(0.947)
Effect of regulation on low-staffed (low-staffed × post)	−2.389	−4.273**	−1.096
	(1.828)	(2.174)	(0.871)
Effect of regulation on high-staffed (high-staffed × post)	−0.169	0.468	−1.897*
	(1.308)	(2.123)	(1.015)
Nonprofit ownership	7.883	11.296	11.800
	(7.864)	(10.848)	(10.370)
Number of beds	0.019	0.042	−0.086
	(0.078)	(0.285)	(0.079)
Chain membership	0.360	1.207	1.045
	(2.574)	(3.301)	(1.158)
Occupancy rate	−0.076	−0.237***	−0.034*
	(0.048)	(0.053)	(0.018)
Percentage Medicare	0.046	0.079	−0.004
	(0.043)	(0.058)	(0.014)
Percentage Medicaid	−0.014	0.005	−0.007
	(0.037)	(0.037)	(0.011)
Acuity index	−0.206	−0.799	0.446*
	(0.610)	(0.743)	(0.249)
Percentage dementia	−0.020	−0.005	−0.007
	(0.025)	(0.033)	(0.009)
Percentage psychiatric illness	−0.006	−0.063*	0.016
	(0.024)	(0.037)	(0.016)
Percentage developmentally disabled	0.074	0.054	−0.030
	(0.172)	(0.153)	(0.039)
Percentage chairfast	0.013	0.058	−0.021*
	(0.035)	(0.040)	(0.011)
Percentage bedfast	−0.002	0.043	0.010
	(0.229)	(0.203)	(0.029)
Constant	18.043	49.390*	5.271
	(11.773)	(29.603)	(7.074)
States	NM & VT	NM & VT	NM & VT
Chow Test (NM ≠ VT)	N	N	N
Observations	580	579	582

Table 3 continued

Variables	Percentage of all nurse staffing (%)		
	Registered nurses (1)	Licensed nurses (2)	Contracted (3)
R-squared	0.513	0.366	0.462

The table reports linear, fixed-effect panel regression models with a dependent variable of nurse staff composition or contracted nurses as a percentage of all nurses. All coefficient estimates are reported except for time trends and variables that were time-invariant. Regressions are run on the combined sample of New Mexico and Vermont. Chow tests were performed to determine if New Mexico and Vermont responded to the new staffing requirements in a statistically similar manner. When these Chow tests found differences in any model specification for the dependent variable, we also report regressions for each state separately. Standard errors are bootstrapped using 500 replications and are clustered within facility

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

Facilities also employ more RNs and licensed nurses with better reimbursed payer-mixes (i.e., a greater proportion of Medicare residents and a lower proportion of Medicaid residents). In the case of contracted staffing, the effects of market competition is U-shaped, with monopoly facilities and those in the most competitive markets using more contracted staff.

5.2 Quality

As noted in the previous section, staffing regulations are associated with an increase in total and licensed staff among low-staffed facilities and a decline among high-staffed facilities. If staffing level and composition are important for high quality, we would expect quality to improve at low-staffed facilities and to deteriorate at high-staffed nursing homes. This is tested by examining four quality measures.

Table 4 reports the regression results for these quality outcomes, for which Chow tests find that New Mexico and Vermont behave in similar manners. Two of the four measures of quality are statistically impacted by the staffing regulation—contractures and physical restraints. High-staffed facilities have a statistically significant reduction in the prevalence of both conditions (i.e., improved quality), with effect sizes of −7.65 percentage points and −5.01 percentage points, respectively. While the results clearly show an improvement in these two outcomes, these results are contrary to expectations. Additionally, all other quality measures show no statistically significant impact of new staffing mandates; therefore there is little definitive evidence that the implementation of staffing regulations improved resident outcomes as expected.

Unlike the staffing outcomes, the control variables explain quality even controlling for fixed effects. Generally, worse quality is associated with nursing homes that have fewer bedfast residents, fewer residents with dementia, and higher physical acuity. Though the result is only statistically significant for the facility-

Table 4 Effect of new staffing regulations on quality

Variables	% of Residents			
	Facility-acquired pressure ulcers	Facility-acquired contractures	Facility-acquired physical restraints	Feeding tubes
	(1)	(2)	(3)	(4)
Post period	0.093	7.260	−3.582	−0.404
	(1.074)	(4.879)	(2.540)	(0.531)
Effect of regulation on low-staffed (low-staffed × post)	0.030	−2.226	−3.029	0.188
	(1.079)	(3.824)	(1.955)	(0.530)
Effect of regulation on high-staffed (high-staffed × post)	−1.021	−7.651*	−5.012***	0.216
	(1.050)	(4.471)	(1.862)	(0.532)
Nonprofit ownership	−2.827	−3.575	11.545	1.493
	(2.709)	(7.321)	(7.496)	(0.973)
Number of beds	−0.090*	−0.054	−0.121	0.033
	(0.052)	(0.226)	(0.190)	(0.060)
Chain membership	−2.290**	−2.179	−2.775	−0.535
	(0.894)	(7.401)	(5.002)	(0.743)
Occupancy rate	−0.044**	−0.013	−0.045	0.003
	(0.021)	(0.115)	(0.060)	(0.022)
Percentage Medicare	−0.056**	−0.113	−0.096	−0.018
	(0.025)	(0.149)	(0.070)	(0.022)
Percentage Medicaid	0.017	0.004	−0.010	−0.004
	(0.014)	(0.074)	(0.051)	(0.010)
Acuity index	0.074	3.758**	1.229	0.576***
	(0.290)	(1.738)	(1.420)	(0.194)
Percentage dementia	−0.021**	−0.162**	0.010	−0.005
	(0.010)	(0.068)	(0.022)	(0.005)
Percentage psychiatric Illness	0.029	−0.122*	0.079	0.009
	(0.019)	(0.071)	(0.059)	(0.009)
Percentage Developmentally disabled	−0.342	0.038	0.282*	−0.019
	(0.230)	(0.287)	(0.168)	(0.036)
Percentage chairfast	0.027*	0.014	−0.051	−0.016*
	(0.015)	(0.085)	(0.071)	(0.009)
Percentage bedfast	−0.092	−0.393**	−0.345***	−0.002
	(0.064)	(0.180)	(0.106)	(0.030)
Constant	16.880***	−4.253	16.209	−4.891
	(6.475)	(33.240)	(22.889)	(6.757)
States	NM & VT	NM & VT	NM & VT	NM & VT

Table 4 continued

Variables	% of Residents			
	Facility-acquired pressure ulcers	Facility-acquired contractures	Facility-acquired physical restraints	Feeding tubes
	(1)	(2)	(3)	(4)
Chow test (NM ≠ VT)	N	N	N	N
Observations	582	582	582	582
R-squared	0.442	0.481	0.384	0.570

The table reports linear, fixed-effect panel regression models with a dependent variable of a quality measure. All coefficient estimates are reported except for time trends and variables that were time-invariant. Regressions are run on the combined sample of New Mexico and Vermont. Chow tests were performed to determine if New Mexico and Vermont responded to the new staffing requirements in a statistically similar manner. When these Chow tests found differences in any model specification for the dependent variable, we also report regressions for each state separately. Standard errors are bootstrapped using 500 replications and are clustered within facility

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

acquired pressure ulcer measure, chain membership is associated with better quality. This is suggestive that standardized care plans across multiple facilities may help better to identify and prevent these adverse health outcomes. Use of random effects confirmed the fixed effects results. These random effects models also find no difference or higher quality among nursing homes in more competitive markets.

5.3 Exits

The final effect that we examine is whether the new regulatory standards are associated with exits from the market. Out of the 114 nursing homes in the sample, only 10 (8.8 %) exit the market, with an equal number of exits in New Mexico and Vermont (Table 5). Across the three staffing types, the control facilities have the lowest exit rate at 4.6 %, followed by low-staffed (8.7 %) and high-staffed (10.9 %). While there is variation in the exit rate among the three staffing types, by state and number of competitors, we did not find any of these factors to be significant bivariate predictors of exits. The only factor that is found to predict exits is whether the nursing home is hospital based (p-value <0.001—data not shown). A total of five exits occurred among the eight hospital-based facilities in the sample compared to five exits out of 106 freestanding facilities.

We also estimated probit, logit and linear probability models to determine which factors influence exits from the market. These results were highly sensitive to the model specification. All regressions find no statistical difference in exits for low and high-staffed nursing homes. The only consistent result across our regression models is that hospital-based facilities are more likely to exit the market than are free-standing nursing homes.

Table 5 Effect of new staffing regulations on exit rates

	Sample size	# of exits	Entire sample (%)	Low-staffed (%)	Control staffed (%)	High-staffed (%)	*p*-value
Overall rate	114	10	8.77	8.70	4.55	10.87	0.689
New Mexico	69	5	7.25	3.23	7.69	12.00	0.452
Vermont	45	5	11.11	20.00	0.00	9.52	0.304
County with 1 Facility	10	2	20.00	16.67	0.00	33.33	0.732
County with 2–3 Facilities	27	2	7.41	8.33	14.29	0.00	0.566
County with 4–9 Facilities	61	4	6.56	8.70	0.00	7.14	0.641
County with 10+ Facilities	16	2	12.50	0.00	0.00	28.57	0.230

The number of nursing homes that remain open and that exit the market during the study period are reported. The *p*-value in the last column determines if the proportions of facilities that exit between each staffing level category are statistically different from each other

5.4 Sensitivity Analyses

A number of robustness checks and alternative specifications are estimated to determine the sensitivity of the results. A summary of these sensitivity analyses are reported in Table 6.

We first examine how sensitive the results are to the categorization of nursing homes into low, control, and high-staffed types. The main specification defines types as low-staffed if the facility is below the standard and high-staffed if it is 10 % above the standard using the average level of staffing in the pre-regulation period. In alternative specifications, we also utilize the first survey in the dataset, the last survey at least 1 year prior to the effective date of the regulation, and the last survey prior to the effective regulation. Additional sensitivity analyses utilize alternative definitions of the three types: for example, defining the control facilities as being $\pm$ within 5, 10, and 15 % of the new standard. These sensitivity analyses resulted in varying effect sizes though the results are generally consistent in terms of direction and statistical significance.

We also explore how sensitive the results are to the control variables that are included in the model. In our main specifications, the models include fixed effects, time trends, and control variables. The first alternative specification utilizes state-specific time trends instead of a common time trend. The second alternative utilizes a random effects model instead of a fixed effects model, whereas the third alternative only includes time trends and fixed effects (i.e., we drop the control variables). Across all outcome variables and alternative specifications, the results are highly consistent with the main specifications. All coefficient estimates for the difference-in-difference variables are in the same direction and in most cases the coefficients also have the same level of statistical significance. However, there are two exceptions: First, the effect for high-staffed nursing homes is statistically

Table 6 Sensitivity checks performed

Sensitivity concern	Finding
Definitions of low and high-staffed types	Alternative definitions results in varying effect sizes though the direction of the effects are consistent with the main specifications
Utilized common time trends	State-specific time trends are statistically similar to the main specifications. The effect for contractures was no longer statistically significant at 10 % level
Utilized fixed effects specification	Using random effects resulted in coefficient estimates for the policy variables have the same signs as the main specifications. The effects for licensed staff composition and contracted nurses became statistically insignificant at 10 % level
Control variable selection	Estimating model with no control variables resulted in the same conclusions as main specifications
Effect of regulation did not vary with time	Estimating model allowing the effect of regulation to vary with year since regulation became effective found no trends for most dependent variables. Only contracted staff and contractures are found to have statistically different effects in post period
Some dependent variables are proportions	Estimating fractional logit models resulted in same conclusions as the main specifications
Some dependent variables are truncated at zero	Estimating tobit models resulted in quality outcomes with same conclusions as the main specifications. Effects for contracted staff were in the same direction but effects became larger and statistically insignificant
Control group may react to regulation	Pre-trends for the dependent and explanatory variables are statistically similar. No break in trend between the pre and post periods for explanatory variables among control staffed facilities
Control group is same state with policy change	Estimated model using other states as a control group. Results are generally consistent with the main specifications. Detailed results are reported in Table 7

insignificant when state-specific time trends are utilized. The second exception is that licensed staff composition and contracted staff become statistically insignificant in the random-effects regressions.

The main specifications use a standard pre-post indicator variable to capture the effect of the new regulatory standards. To determine if nursing homes took time to respond to the policy, we modify the pre-post indicator variable into a set of dummy variables which allow the effect of the post period to be different each year after the effective date of the regulation. A series of F-tests determine if the effect of the regulation should be different by year or treated the same for all years in the post period. The contracted staff and contractures regression are the only model in which nursing home behavior varies in the post period. For contracted staff, low-staff nursing homes decrease the use of contracted staff only in the 4th year after the effective date of the regulation. Among high-staffed nursing homes, there is no decline in the use contracted staff until one full year into the post period. For contractures, high-staffed nursing homes have a general trend of continuous improvement in quality until 3 years into the post-regulatory period, but in the 4th year contracture rates return to pre-regulation levels.

Table 7 Sensitivity analysis utilizing other states as a reference group

	Total nurse staffing levels (HPRD)	RN nurse staffing levels (HPRD)	Licensed nurse staffing levels (HPRD)	Nurse composition: Registered Nurses (%)	Nurse composition: Licensed Nurses (%)	Total staff Contracted (%)	Facility-acquired Pressure Ulcers (%)	Facility-acquired Contractures (%)	Facility-acquired Physical Restraints (%)	Feeding tubes (%)
Post period for reference states	0.000	−0.086***	−0.062*	−2.591***	−2.560**	−0 284	0.153	5.367***	−0.747	0.235
	(0.074)	(0.019)	(0.032)	(0.659)	(1.125)	(0 509)	(0.306)	(1.580)	(0.619)	(0.278)
Effect of regulation on low-staffed (low-staffed * Post)	0.376	0.058	0.180**	0.101	2.177	0 977	0.677	−9.722	−8.130	0.134
	(0.240)	(0.055)	(0.085)	(2.152)	(3.145)	(0 927)	(1.097)	(7.198)	(4.982)	(0.707)
Effect of regulation on control staffed (control staffed × post)	0.057	0.052	0.098	2.280	5.625*	1 408	0.696	−5.517	−5.975	−0.181
	(0.250)	(0.055)	(0.087)	(2.140)	(3.127)	(1 169)	(1.409)	(6.806)	(4.250)	(0.635)
Effect of regulation on high-staffed (high-staffed × post)	−0.209	0.018	0.007	2.145	5.510*	−0 301	−0.606	−13.198*	−9.894**	0.208
	(0.217)	(0.054)	(0.078)	(1.993)	(3.232)	(0 872)	(1.097)	(7.216)	(4.676)	(0.551)
Difference between low and control staffed	0.319**	0.006	0.082**	−2.179	−3.448	−0.431	−0.019	−4.205	−2.155	0.315
Difference between high and control staffed	−0.266**	−0.034	−0.091*	−0.135	−0.115	−1.709*	−1.302	−7.681*	−3.919**	0.389
Observations	5053	5031	5025	5031	5021	5053	5053	5053	5053	5053
R-squared	0.689	0.840	0.774	0.672	0.422	0.419	0.296	0.428	0.470	0.757

The table reports linear, fixed-effect panel regression models with various dependent variables. The first row reflects the change in the dependent variable in the post-regulation period for a group of reference states (Nebraska, Rhode Island, upstate New York, and Utah). The next three rows report the effect of being in the post period for the low, control, and high-staffed nursing homes in New Mexico and Vermont relative to the reference states. To make the results comparable to the main specification, the coefficient estimates for the low-staffed and high-staffed are compared to the control staffed nursing homes. All regressions also control for state-specific time trends, fixed-effects and control variables. Standard errors are bootstrapped using 500 replications and are clustered within facility

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

Another set of sensitivity analyses test the robustness of using a linear fixed-effects model. First, a number of the dependent variables are proportions. To determine if the results are sensitive to using a linear specification, fractional logit models are estimated when appropriate.[13] The coefficient estimates of the difference-in-difference variables have statistically similar results to using linear models. A second issue is that some dependent variables have values truncated at zero—especially the contracted staff and the feeding tube quality measure. To determine sensitivity to truncation, Tobit models are estimated.[14] The only model that is sensitive to truncation is the contracted staff measure, which has effects of regulation that are larger than the main specification and statistically insignificant.

Finally, a concern with the main model specification is that the new regulation is a common shock that may impact all nursing homes, including the control facilities. If the control facilities respond to the shock, even indirectly by changing capacity or the type of patients that they admit, the assumptions of a difference-in-difference analysis may not hold. To address this issue, we compare pre-treatments trends for all three types among the explanatory variables. We find no significant differences. Additionally, we estimate whether there are any trends in the explanatory variables for the control facilities over the entire study period. We find no statistically significant trends. Taken together, this suggests that the control facilities are a proper control group.[15]

To verify this further, as a final sensitivity check, we follow a method that is utilized by Chen and Grabowski (2015). This method used nursing homes in other states that do not change staffing regulations as a reference group. We start by identifying four states that are geographically close to New Mexico and Vermont that did not have or change any minimum nurse staffing regulations during the study period. These states are Nebraska, Rhode Island, upstate New York, and Utah. We then estimate a difference-in-difference model that used these four states as the reference group; the results of these regressions are reported in Table 7.

The first row reports the change in each dependent variable for the reference states in the post-regulation period. In the post period, nursing homes in these reference states saw increases in facility-acquired contractures and decreases in RN and licensed staffing levels/composition. The effect of the low-staffed and high-staffed nursing homes relative to the reference states are reported in the second and fourth rows. The general direction of the effects for the low-staffed nursing homes is consistent with the main specifications, though most of the coefficient estimates are not statistically significant. The results for the high-staffed nursing homes also have the directions of effects that are consistent with the main specifications, except that

[13] In the case of the three facility-acquired quality measures, negative values may arise if the nursing home is able to improve the health of a resident. Therefore, in these models we restrict the sample to observations with non-negative quality.

[14] Since negative values may arise for facility-acquired quality measures, we also estimate Tobit models on the assumption that all quality measures are truncated at zero. The results are not sensitive to truncation.

[15] Furthermore, we estimate separate models for low, control, and high-staffed nursing homes and compare the effects of all control variables across all three types. The effect of all of the control variables are found to be statistically similar.

RN and licensed nurse outcomes do not change relative to the reference states. This may be due to the changes in staffing patterns in the reference states in the post period.

To determine if this is causing the result, Table 7 also reports the difference for nursing homes only in New Mexico and Vermont by taking the difference between the low-staffed and high-staffed nursing homes relative to the control-staffed nursing homes. These differences have effects in directions that are consistent with the main specification. The only difference is that low-staffed nursing homes are now statistically significant for licensed nurse staffing levels and the effect for staffing composition is no longer statistically significant.

6 Conclusion

The use of minimum quality standards on the use of inputs is a regulatory tool that has been used in multiple contexts (Hotz and Xiao 2011). This article uses the implementation of new minimum staffing regulations in the states of New Mexico and Vermont to study the effect of minimum quality standards on the staffing, quality, and exit decisions of low- and high-staffed nursing homes.

We find that low-staffed nursing homes improve quality in the regulated dimension as expected. An important result is how low-staffed nursing homes respond in terms of staff composition. In New Mexico, low-staffed nursing homes reduced the use of RNs but kept licensed staff at similar levels. This suggests that nursing homes substituted RN for lower-cost LPNs. In contrast, low-staffed nursing homes in Vermont increased the use of RNs and LPNs. Clearly, this result shows that firms can respond differently to minimum quality standards in non-regulated dimensions. While we do not know why New Mexico and Vermont behave differently, there may be multiple equilibriums based on the institutional details that affect each state. Consistent with the results from Scarpa (1998) and Chen and Serfes (2012), we find that high-staffed nursing homes eventually reduce total staffing levels, leading to less dispersion in staffing levels.

We also find that these regulations do not affect quality measures that are not directly regulated, such as quality of care.[16] This is consistent with a number of studies (Cook et al. 2012; Lin 2014; Matsudaira 2014a; Chen and Grabowski 2015) which question how effective changes in staffing levels are in improving quality. Clearly, these new regulations affect staffing levels and are associated with increased costs for many nursing homes; but in the absence of significant improvements in quality, staffing regulation increase the regulatory burden in the nursing home industry. These regulations potentially have unintended consequences, such as limiting choice as some potential nursing home residents may be willing to trade-off lower staffing levels for lower prices.

While the theoretical literature also suggests that low or high types will exit the market first, we find that these facilities have no statistically higher probability of

[16] While we find two statistically significant effects for high-staffed nursing homes, these findings contradict expectations as these facilities reduced staffing but saw improvements in quality.

exiting. This may be due to the rarity of exit in these states and the fact that exits were more common among hospital-based facilities—which tended to be high-staffed and were adversely effected by a Medicare reimbursement policy change in 1998. Another explanation may be that the low-staffed facilities were more likely to be owned by for-profits in the pre-regulatory period, and used low staffing levels to increase profits. For example, the implementation of the new staffing regulation increased staffing levels in these facilities, reducing profits, but these nursing homes were able to offset some of these costs by reducing non-nurse inputs (Bowblis and Hyer 2013; Chen and Grabowski 2015). This would allow these facilities to operate at higher nurse staffing levels and remain open.

Overall, the results of this paper suggest that if the intention of the regulation is to assure a minimum level of staffing and reduce the dispersion in staffing levels across the state, minimum nurse staffing regulations have achieved this goal. However, these positives could be offset by unintended consequences.

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