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The Effect of Closure on Quality: The Case of Rural Nursing Homes†

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Abstract: In the early 2000s, there were a significant number of closures in the nursing home industry. This paper analyzes the effect of rural nursing home closure on the quality of care provided by the nursing homes in the market that do not close. We develop a theoretical model that shows that the direction of quality change after a closure is dependent on how quality enters the demand and cost functions. Quality changes for competitor facilities that remained open and are within 15 miles of the closure are compared to quality changes in a comparison group of facilities that are further away. Overall, the quality of care provided by competitor facilities improved after the closure. These improvements are likely because of efficiency gains in the competitor facilities due to economies of scale. From a quality perspective, the potential increase in market power caused by a nursing home closure may not be a concern if the closure occurs in an area that has lower occupancy rates than the national average.

JEL Codes: I11, L10

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1. Introduction

The effect of market structure on quality or prices is studied for a wide variety of industries (Borenstein and Rose 1994; Keeler et al 1999; Davis 2005; Gerardi and Shapiro 2009). This literature suggests that higher levels of market concentration result in higher prices and lower quality. However, this result is not always generalizable to all industries. For example, the health care industry is highly regulated and firms face regulated and unregulated prices. Gaynor's (2006) review of the theoretical literature on hospital competition finds that if hospitals choose prices then how competition impacts quality is ambiguous. He also finds that if prices are regulated, increased competition improves quality. Empirically, whether prices are regulated or chosen by the hospital, the impact of competition on quality is mixed (Kessler and McClellan 2000; Ho and Hamilton 2000; Sari 2002; Gowrisankaran and Town 2003; Kessler and Geppert 2005). In fact, some work has found that increased market concentration is associated with improved quality (Popper et al 2004; Kessler and Geppert 2005; Mutter et al 2008).

Even less is known about the effect of market structure in the industry studied in this paper: the nursing home industry. Two early studies by Nyman (1988, 1994) looked at the relationship between price and market structure. Work by Zinn (1994) found higher levels of market concentration are associated with higher quality while Grabowski (2001) found no or weak relationships between quality and market concentration. All of these papers study a period in which nursing homes faced excess demand. That is, states restricted the ability of nursing homes to increase capacity and the demand for nursing home beds is greater than the supply in most areas of the United States. Since the 1990s, the use of nursing homes in the United States has declined (Bishop, 1999) and there is a need to study the impact of market structure on nursing home quality.

Within the health care sector, there is some evidence that more concentrated markets have higher quality. This result seems counter-intuitive, but one of the reasons for this result in the nursing home industry is economies of scale. Nursing homes make large investments in capacity, which is fixed in the short run. This forces providers to have large fixed costs that need to be spread out over multiple residents. When occupancy rates are low, the marginal cost of producing quality may be high because resources are spread thinly across the facility. However, as occupancy rates increase, the marginal cost of producing quality may become smaller at certain occupancy rates (Knox et al 2003). In addition, nursing homes are required to provide the same quality to all residents regardless of payment source (Grabowski et al 2008). Nursing homes receive fixed prices for residents paid for by Medicare and Medicaid. Therefore the increase in marginal revenue due to quality is only driven by private pay residents. At high levels of competition, a situation could exist in which facilities have lower occupancy and must reduce market quality because of economies of scale.

Since nursing homes can be significantly affected by regulated prices, changes in regulated reimbursement can cause some facilities to become unprofitable. This led to a significant number of nursing home closures from 1998 to 2004 after Medicare reduced the average reimbursement for skilled nursing home care (Bowblis, in press). These closures lead to exits that are exogenous to the private pay market process. As facilities exit the market, the marginal revenue of quality from private pay residents increases among surviving facilities while marginal cost should decrease. This could lead to an increase in the market quality even though concentration increases.

In this paper, we develop a theoretical model of nursing home quality to determine how market quality would change as the number of facilities in the market decrease. We show that market quality is largely determined by how quality enters the private pay demand function and cost function. Without making specific assumptions about the shape of these functions, how market quality is affected by the number of facilities is ambiguous.

To empirically test this theory, we use data on nursing homes from 1998 to 2004. Specifically, we identify isolated rural nursing homes markets that experienced a single nursing home closure during the study period. There are some studies that use closures to study the effect of a change in market structure but this paper is the first to study market structure's impact on quality by using closures in the nursing home industry.[1] By focusing on isolated rural nursing home closures, we are able to identify the effect of a single closure on quality decisions of other facilities and eliminate confounding effects caused by new facilities entering the market or multiple closures occurring in different periods. Following the work of Lindrooth et al (2003) we compare the quality of care provided by a treatment group of surviving facilities that are affected by the closure to a control group of surviving facilities that are not affected by a closure. We find that surviving facilities generally increased their quality after closure. To make sure that facilities that do not close have higher quality prior to closure, we test if facilities that close have similar quality to nearby facilities that do not close (i.e. surviving facilities). We find that facilities that closed have similar quality to facilities that did not close.

2. Theoretical Model

Adopting the model in Cohen and Spector (1996), assume a market with *n* identical firms. The number of firms in the market at any given time is exogenously determined. This is

[1] All studies that look at the effect of closures on outcome in the health care sector are focused on the hospital industry. McNamara (1999) and Capps et al. (2010) study the impact of hospital closures on the welfare of the local community. Buchmueller et al. (2006) study the effect of hospital closures in Los Angeles County on distance traveled for care. Lindrooth et al. (2003) studies the impact of urban hospital closures on efficiency of competing facilities while Wu (2008) studies the impact of closure on prices.

not a strong assumption because the nursing home industry is heavily regulated and entry is often difficult, requiring specialized facilities and a licensure procedure. Each firm is able to segment the market between private and public Medicaid residents. Firm *i* charges private residents price p_i and receives a fixed price of M for each public resident. Firms can choose levels of private and public output (x_{1i} and x_{2i} respectively) to maximize output. Assume private demand for a given firm is not a function of the number of public consumers. Demand is also a function of the quality of a given home, q_i, the number of competing homes, n, and δ, a vector of demand related market factors. P will represent the inverse demand function, which is assumed to be increasing in quality and decreasing in quantity. Let C represent the cost function, which is increasing and convex in quantity and quality. Private and public patients enter the cost function identically. Let γ be a vector of cost related market factors. Further assume that C_{xq} is positive. The profit of a representative firm is given by:

$$\pi_i = x_{1i}P(x_1, q_i; \delta, n) + Mx_2 - C(x_{1i} + x_{2i}, q_i, \gamma) \qquad (1)$$

The first order conditions for profit maximization are:

$$\frac{\partial \pi}{\partial x_{1i}} = x_1 P_{x_1} + P - C_{x_1} = 0 \quad (2)$$

$$\frac{\partial \pi}{\partial x_{2i}} = M - C_{x_1} = 0 \qquad (3)$$

$$\frac{\partial \pi}{\partial q} = x_1 P_q - C_q = 0 \qquad (4)$$

2.1 Comparative Statics

Let R denote the revenue function for private pay customers. Then, based on the first order conditions, comparative static analysis implies that at the solution

$$\frac{dq}{dn} = \frac{C_{xx}(R_{xq}R_{xn} - R_{qn}R_{xx})}{-C_{xx}(R_{xq})^2 + R_{xx}(C_{xq})^2 + R_{xx}C_{xx}(R_{qq} - C_{qq})}. \qquad (5)$$

Assume that R_{xq} is positive, as a higher quality level will increase the additional revenue from another patient and vice versa. Assume that R_{xn} and R_{qn} are non-positive, as the returns to an additional customer or higher quality will be diminished in a more competitive market. Then, because the cost function is convex in quantity and marginal revenue is decreasing, the numerator will always be negative.

As a result, whenever the denominator is positive, quality will vary inversely with the number of firms in the market. Therefore, as firms exit a market, the remaining firms may choose to increase quality levels in equilibrium. This will depend on the nature of the demand and cost functions. Because $(R_{qq} - C_{qq})$ is negative by the second order conditions, quality is more likely to vary inversely with the number of firms when the cost function is less convex in quantity.

2.2 Example

Assume the market is made up of n identical firms. Each firm has total cost given by $C(x_1 + x_2, q) = c_{1i}(x_1 + x_2)^2 + c_{2i}q_i{}^2 + c_{3i}q_i(x_1 + x_2)$. This cost function satisfies the assumptions given in the more general model as it is convex in both quality and quantity and the cross partial is positive. This function is also allows for straightforward analysis as the parameters, c_{1i}, c_{2i}, and c_{3i}, break down the function into the cost attributable to quality and quantity and the interaction term. Intuitively, if the cost of quality is more independent of quantity it is more likely that remaining firms will increase quality as other firms exit the market. This may occur because as a firm exits, the demand faced by remaining firms will increase. If the costs of quality are relatively fixed with respect to quantity, then firms will be able to receive a higher return to quality investments. As the marginal revenue from quality increases, firms will choose higher equilibrium quality levels.

To see how the equilibrium quality level varies with the number of firms, we will look at three different demand specifications. This will demonstrate how the dynamics of the quality decision depend not only on the nature of the cost function, but also on the nature of the demand function. To begin, assume that demand is given by $P(x_1, q) = a - bx_{1i} - d\sum_{j\neq i} x_{1j} + eq_i$. In this setting, an increase in quality will cause a parallel shift outward of the inverse demand curve. Assuming an interior, symmetric solution, the optimal quality level will be given by:

$$q = \frac{c_3M(2b+d(n-1))-2c_1e(a-M)}{2c_1e^2-\left(4c_1c_2-c_3^2\right)(2b+d(n-1))}. \qquad (6)$$

As long as $4c_1c_2 > c_3^2$, firms will increase quality as *n* decreases. That is, when the costs of quality and quantity are more independent firms will increase quality as a response to the exit of another firm. When the costs of increasing quality are more dependent on quantity, the opposite is true. In those settings, as competing firms exit and demand increases for surviving firms, the marginal costs of providing quality will increase enough that firms will choose to reduce quality in equilibrium.

Next, assume that demand is given by $P(x_1, q) = (a - bx_{1i} - d\sum_{j\neq i} x_{1j})\, q_i$. In this setting, increases in quality will rotate the inverse demand curve out and up with a fixed point on the quantity axis. Here increases in quality will have a larger proportionate impact on the higher value consumers. The symmetric equilibrium quality level is determined by the equation

$2ac_1q\big(2b + d(n-1)\big)(aq - M) - 2c_1\big(b + d(n-1)\big)(aq - M)^2 - 4c_1c_2q^3(2b +$

$d(n-1))^2 - q^2\left(2b + d(n-1)\right)^2(Mc_3 - c_3^2 q) = 0$.[2] Depending on the nature of the demand and cost parameters, quality of remaining firms may increase or decrease as competing firms exit the industry. The relationship between quality and the number of firms is more ambiguous than in the previous case. Overall, it quality can increase or decrease as firms exit the industry, depending on the cost and demand functions as well as the Medicaid reimbursement rate and the equilibrium level of quality prior to the exit.

Finally, assume that demand is given by $P(x_1, q) = a - \frac{b}{q_i}x_{1i} - d\sum_{j\neq i} x_{1j}$. In this setting, increases in quality will rotate the inverse demand curve out and up with a fixed point on the price axis. Here increases in quality will have a larger proportionate impact on the lower value consumers. The symmetric equilibrium quality level is determined by the equation $2bc_1(a-M)^2 - 4c_1c_2q(2b + d(n-1)q)^2 - (2b + d(n-1)q)^2(Mc_3 - c_3^2 q) = 0$. Again using comparative statics, we can characterize the relationship between equilibrium quality and the number of firm.[3] This relationship will be negative and quality will increase as firms exit the industry if $4c_1c_2 > c_3^2$ and $M > q$. Again, when the costs of quality and quantity are more independent firms will increase quality as a response to the exit of another firm. In addition, when the Medicaid reimbursement rate is higher, it is more likely that quality will increase as firms exit the industry. When costs of quality and quantity are more interdependent and when the Medicaid reimbursement rate is lower, then we can expect quality to fall as firms exit the market.

[2] Comparative statics yields the relationship between quality and the number of firms as $\frac{dq}{dn} = \frac{-[2c_1dM(aq-M)+(2b+d(n-1))(-2q^3d\left(4c_1c_2-c_3^2\right)-2q^2Mc_3d]}{[4a^2bc_1q+d(n-1)(2ac_1M)+\left(2b+d(n-1)\right)^2\left(-3q^2\left(4c_1c_2-c_3^2\right)-2qc_3M\right)]}$.

[3] Now, $\frac{dq}{dn} = \frac{[8c_1c_2q^2d(2b+d(n-1)q)+(2qd(2b+d(n-1)q)(Mc_3-c_3^2q)]}{-[\left(4c_1c_2-c_3^2\right)(2d+d(n-1)q)^2+8c_1c_2qd(n-1)(2b+d(n-1)q)+2d(n-1)(2b+d(n-1)q)(Mc_3-c_3^2q)]}$.

The purpose of these examples is not to characterize the nursing home industry. Rather, they demonstrate how the relationship between industry structure and product quality can vary. Depending on the nature of a firm's cost function and the demand for nursing homes, firms may choose to increase or decrease quality as competing firms exit the industry. The results also assume a symmetric equilibrium. In reality, different nursing homes will face different demand and cost functions. It is quite possible that in response to a closure by a competing facility, some surviving facilities will increase quality while others will decrease quality.

3. Empirical Strategy

The dataset used in the analysis is the Online Survey Certification and Reporting (OSCAR) System. OSCAR is a uniform database of state nursing home regulatory reviews that are required of all Medicare/Medicaid certified nursing homes as part of a yearly re-certification review process. On-site surveys are completed every nine to fifteen months and contain information on nursing home structure, case-mix, staffing, quality, and resident census information. Zip-codes obtained from OSCAR are merged with Rural-Urban Commuting Area Codes (RUCA) to identify rural facilities using a categorization similar to the Office of Management and Budget metro definition but at the sub county-level (WWAMI Rural Health Research Center, 2010).

The OSCAR data for the years of 1998 to 2007 are used to identify all rural facilities that closed from 1998 to 2004. A facility is closed if there are no additional OSCAR surveys for at least three full calendar years. Although the average facility is surveyed on twelve month intervals, some facilities can have gaps between surveys of sixteen months. The use of three years provides a conservative time frame to verify the facility closed and is the method used by

Bowblis (in press) to identify closures. Each of these rural nursing home closures are indexed by the subscript j.

Once all rural nursing home closures are identified, the possible set of competitor and comparison facilities for nursing home closure j needs to be determined. Although there are multiple papers that have addressed the issue of geographic market definition in the hospital industry, there is still disagreement on how to appropriately define geographic markets in the health care sector (Dranove and White, 1994).[4] Since patient flow data is unavailable for the nursing home industry, an approach similar to Lindrooth et al. (2003) is employed. A competitor nursing home is defined as any nursing home within 15 miles of closed facility j.[5] These facilities are the 'treatment' facilities. A comparison or 'control' group of facilities are nursing homes within 15 to 30 miles and 30 to 45 miles away from closed facility j.

By comparing the change in quality of these two groups prior to the closure and after the closure, we can identify the change in quality that is due to the closure and eliminate the quality impacts of unobservable factors that affect all facilities. To make sure facilities are impacted by only one closure and to guarantee facilities can only be in the competitor or the comparison group, the sample of closures is restricted to rural nursing homes that did not have another closure within 60 miles. This guarantees that the effect of the closure can be identified and that comparison facilities are not impacted by closures in distant markets. Sensitivity checks that use smaller distances between closures and different sizes for the comparison group find similar results.

The reduced-form equation estimated to determine if closures impact surviving facility quality uses the entire study period of 1998 to 2004 and is restricted to only facilities that did not

[4] See Lindrooth (2008) for a review in the hospital industry and Grabowski (2008) for the nursing home industry.
[5] Fifteen miles is used because it is the size of the market used by Grabowski and Stevenson (2007) in their analysis of nursing home industry.

close. Let Q_{ijt} represent the quality of care provided by nursing home i, in period t that is potentially impacted by the closure of nursing home j. The equation estimated is:

$$Q_{ijt} = f\left(Competitor_{ijt}, Post_{ijt}, Competitor_{ijt} * Post_{ijt}, X_{ijt}, \mu_j, \tau_t\right) \qquad (7)$$

where the $Competitor_{ijt}$ variable is a binary indicator for the facility being in the competitor group, $Post_{ijt}$ is a binary indicator for being in the post-closure period, X_{ijt} is a set of facility characteristics, μ_j is a fixed effect for closure j, and τ_t is a set of year dummies. The coefficient estimate of interest is for the interaction of the competitor and post variables.

Quality is multi-dimensional requiring the use of various nursing home quality measures. Nursing home quality that measures resident outcomes includes the percentage of residents with pressure ulcers. The quality measures associated with the care practices used by nursing homes include the proportion of residents that use catheters, are physically restrained, and use feeding tubes. In addition to resident outcomes and nursing home care practice, quality is also measured as the number of regulatory deficiency citations received. For all of these quality measures, a higher value indicates lower quality. Staffing levels and composition can also be used to as a quality indicator. Staffing is measured as the total nursing staff hours per resident day, and percentage of nursing staff that is a registered nurse and licensed (i.e. registered nurse or licensed practical nurse) are also included. A greater proportion of staff that is a registered nurse or licensed nurse, and higher number of hours of staff time indicate higher quality of care. Most of the quality regressions are estimated using a tobit model because the quality measures are censored. The number of deficiencies is estimated using negative binomial regression while linear regressions are used for staffing outcomes. All regressions report standard errors that adjust for heteroscedasticity.

Included in the vector of facility characteristics is: ownership status; number of beds; member of multi-facility organization; hospital-based facility; percentage of Medicaid and Medicare-paying residents; occupancy rate; physical case-mix; percentage of residents with dementia, psychiatric illness, depression, and mental retardation/developmentally disabled; and percentage of residents whom are bedfast and chairfast. In non-staffing quality measure regressions, the total nursing staff hours per resident variable are also included as a control.

One concern in using the difference-in-difference estimation technique in equation (7) is facilities that do not close and are in the treatment group could have significantly higher quality than those facilities that close. This could potentially bias the difference-in-difference estimator. To test the validity of the difference-in-difference estimator, we estimate a model that compares the quality of care provided by nursing homes that close to nursing homes in the treatment group prior to closure. The following reduced form equation is estimated for the period of 1998 until the closure of the nursing home:

$$Q_{ijt} = f\left(Closed_{ijt}, X_{ijt}, \mu_j, \tau_t\right) \qquad (8)$$

where the $Closed_{ijt}$ variable is a binary indicator for the facility closing in the study period, and the other variables have the same definitions as equation (7). The coefficient estimate of interest is the coefficient for the closed binary indicator variable. The difference-in-difference estimation is considered to be valid if the coefficient estimate of the closed variable is statistically insignificant.

4. Results

As discussed in the previous section, we first test if the quality of care provided by closed facilities is similar to competitor facilities that did not close. Summary statistics reported in

Table 1 do not find any pattern in quality differences between the two groups, although there are some differences in facility characteristics. A greater percentage of facilities that close are government owned and have fewer beds than facilities that do not close. Further, facilities that close are more likely to be a hospital-based facility and have a lower occupancy rate than facilities that survive. The coefficient estimates for the closed indicator variable in equation (8) are reported in Table 2. Similar to the summary statistics, there is no pattern in terms of quality differences between closed and competitor facilities. Only one coefficient estimate is statistically significant with closed facilities having a greater composition of nurse staff that is licensed. The lack of quality differences between closed and competitor facilities suggest that the difference-in-difference estimate used in equation (7) will not be biased by poor quality facilities being more likely to exit the market.

The summary statistics for the competitor and two comparison groups prior to and after the closure are reported in Table 3. Comparing the pre- and post-closure averages reveals no significant patterns in the level of quality or changes in quality between the various groups of facilities. The second half of Table 3 reports the summary statistics for the explanatory variables. The competitor and comparison groups look similar except in two cases. In the first case, the competitor group is less likely to be a non-profit facility than the comparison group. In the second case, the occupancy rate of the competitor group in the pre-closure period is 83.0% compared to 88.9% and 86.9% for the comparison groups. In the post-closure period, the occupancy rates are essentially the same for all three groups.

The analysis of the summary statistics does not make it obvious if quality in the competitor group improved or declined relative to the comparison groups. Therefore, it is necessary to conduct the multivariate difference-in-difference analysis. The coefficient estimates of the difference-in-difference estimator are reported in Table 4. All models define the competitor group as nursing homes within 15 miles of the closure, but each model has different comparison groups. In Models 1 and 2, the comparison group is facilities that are 15 to 45 miles away from the closed facility. Models 3 and 4 use facilities that are 15 to 30 miles away from the closed facility as the comparison group while Models 5 and 6 use facilities 30 to 45 miles away as the comparison group.

The signs of all of the coefficient estimates are consistent with the closure improving quality. The strongest statistical significance is found in the pressure ulcers quality measure. The proportion of residents with pressure ulcers declined 1.1 to 1.6 percentage points after the closure. The effect of closure on pressure ulcers is large considering 6.5% of residents had pressure ulcers in the pre-closure competitor sample. The use of feeding tubes also declined in the competitor group compared to the comparison group of facilities that are 30 to 45 miles of the closure. Feeding tube use declined by 1.1 percentage points compared to a base of 2.9% of residents in the pre-closure competitor sample.

In the summary statistics, facilities in the competitor group had a larger increase in the number of deficiencies after the closure than the comparison groups. In the multivariate results, compared to the comparison group, the change in the number of deficiencies was in the competitor group is negative. The staffing quality measures indicate that quality is higher in the competitor group after the closure except in one case. None of the staffing quality measures are statistically significant.

5. Conclusion

In the health care sector, the counter-intuitive result of higher levels of concentration resulting in higher quality has been found. This paper develops a theoretical model that shows that how quality enters into the private pay demand function and cost function could result in higher or lower quality as the number of facilities decrease. By studying isolated rural nursing home closures, we empirically test if facilities that compete with a facility that close increase or decrease their quality after closure. We find that competitors of closed facilities increase their quality after the closure.

Although we are not able to know the specific cause of the increase in market quality, we are able to identify which mechanisms may cause this result. The first mechanism is private pay demand for nursing home care increases among surviving facilities after the closure. This increased demand, conditional on the how quality enters the demand curve, can increase the marginal revenue of quality. The second mechanism is through economies of scale. After the closure occupancy rates of surviving facilities increase and facilities with higher occupancy rates being more efficient (Sloan et al. 2003). Further, there is some evidence that improvements in occupancy rates can lead to higher quality without significant changes in the marginal cost of providing care (Knox et al. 2003). The net result is that increases in concentration due to closure leads to higher market quality.

From a quality perspective, the potential increase in market power caused by a nursing home closure may not be a concern if the closure occurs in an area that has lower occupancy rates than the national average. However, caution is warranted in generalizing this result because the study sample was rural facilities in isolated areas. Although rural nursing home closures may not be a concern for antitrust regulators in terms of quality, further research is needed to understand the price and access effects of these closures and to determine if these quality effects exist in urban areas. Moreover, it is not necessarily the case that improved quality is economically efficient. It could be the case that surviving firms are providing an inefficiently high level of care in response to the exit of a competitor.

From a policy perspective, the impact of quality changes in response to a closure could be significant. While the nursing home industry rarely faces antitrust scrutiny, as a regulated industry, other concerns can arise. Sometimes the government will take over a failing facility in order to protect competition within a market. However, competition in and of itself should not be the goal of government intervention unless the reduced competition severely limits access to care. If a closure increases efficiency within the remaining firms, the welfare improving effect of the closure could dominate any negative impact from increased market power. If it is the case that demand increases as competitors exit, efficiency improves as demand increases, and enough capacity exists to absorb the demand of the closing firm, then it is likely that closure of a failing firm is welfare improving. Like any industry, the idiosyncratic nature of a particular nursing home market will ultimately determine the welfare effects of firm exit within the market. Although much of the focus of regulators is on the impact of competition on price, it can also impact quality. Our results suggest that even though quality is increased in equilibrium and overall firm efficiency improves, it may be the case that consumer welfare improves even as prices increase.

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Table 1: Summary Statistics of Closed Facilities and Treatment Facilities Prior to Closure

		Pre-Closure	
	Entire Sample	Surviving Facilties	Closed Facilities
Dependent Variables			
% Pressure Ulcers	0.063	0.065	0.059
	(0.051)	(0.046)	(0.059)
% Catheters	0.060	0.052	0.076
	(0.066)	(0.045)	(0.091)
% Physically Restrained	0.145	0.152	0.132
	(0.160)	(0.154)	(0.171)
% Feeding Tubes	0.030	0.029	0.032
	(0.041)	(0.036)	(0.050)
# of Deficiencies	7.000	7.011	6.980
	(7.148)	(6.578)	(8.128)
Total Staffing Hours Per Resident Day	3.298	3.120	3.627
	(1.184)	(0.629)	(1.763)
% Registered Nursing Staff	0.154	0.133	0.193
	(0.106)	(0.080)	(0.133)
% Licensed Nursing Staff	0.344	0.314	0.401
	(0.119)	(0.066)	(0.165)
Explanatory Variables			
Nonprofit Facility	0.383	0.382	0.386
	(0.487)	(0.487)	(0.489)
Government Facility	0.157	0.108	0.248
	(0.364)	(0.311)	(0.434)
Number of Beds	77.324	89.129	55.584
	(46.694)	(40.887)	(49.056)
Member of Multi-facility Organization	0.404	0.441	0.337
	(0.492)	(0.498)	(0.475)
Hospital-based Facility	0.233	0.124	0.436
	(0.424)	(0.330)	(0.498)
% Medicaid-paying Residents	0.614	0.630	0.585
	(0.216)	(0.178)	(0.272)
% Medicare-paying Residents	0.102	0.072	0.157
	(0.206)	(0.106)	(0.310)
Occupancy Rate	0.794	0.830	0.728
	(0.186)	(0.147)	(0.229)
Case-mix (Acuindex)	9.738	9.802	9.619
	(1.192)	(1.086)	(1.365)
% Residents with Dementia	0.429	0.444	0.401
	(0.166)	(0.136)	(0.208)
% Residents with Psychiatric Illness	0.144	0.142	0.148
	(0.151)	(0.131)	(0.182)
% Residents with Depression	0.407	0.422	0.380
	(0.220)	(0.200)	(0.252)
% Residents with MR/DD	0.028	0.024	0.037
	(0.039)	(0.025)	(0.056)
% Residents whom are Bedfast	0.047	0.037	0.064
	(0.065)	(0.048)	(0.087)
% Resident whom are Chairfast	0.526	0.546	0.488
	(0.198)	(0.183)	(0.219)
Micropolitian Area	0.376	0.484	0.178
	(0.485)	(0.501)	(0.385)
Number of Observations	287	186	101

The table reports the mean and standard deviation (in parentheses) for the entire sample, suriving facilities in the treatment group (within 15 miles of the closure) and closed facilities for the pre-closure period.

Table 2: Quality Differences Between Closed Facilities and Treatment Facilities Prior to Closure

Quality Measure	Model 1	Model 2
% Pressure Ulcers	0.002	0.001
	(0.012)	(0.012)
% Catheters	0.019	0.022
	(0.016)	(0.016)
% Physically Restrained	-0.006	-0.015
	(0.031)	(0.032)
% Feeding Tubes	-0.017	-0.017
	(0.018)	(0.018)
# of Deficiencies	0.107	0.052
	(0.155)	(0.155)
Total Staffing Hours Per Resident Day	-0.176	
	(0.167)	
% RN Nursing Staff	0.013	
	(0.016)	
% Licensed Nursing Staff	0.038**	
	(0.019)	
Includes Total Nurse Staffing Hours Per Resident Day		X

The sample includes closed and treatment group facilities in the period prior to the closure (n = 287). The table reports the coefficient estimates for the difference in the quality of closed facilities compared to the treatment facilities for various quality measures. All regression control for ownership, number of beds, member of multi-facility organization, hospital-based facility, % of Medicaid and Medicare-paying residents, occupancy rate, case-mix, year fixed effects, and closure fixed effects. Dependent variables that are censored are estimated using Tobit while the deficiency dependent variable is estimated using negative binomial regression. Standard errors robust to heteroscadasticity are reported in parentheses.

* p<0.10 ** p<0.05 *** p<0.01

Table 3: Summary Statistics of Impact of Closure on Surviving Facilities

		Pre-Closure			Post-Closure		
	Entire Sample	Treatment (0-15 Miles)	Control 1 (15-30 Miles)	Control 2 (30-45 Miles)	Treatment (0-15 Miles)	Control 1 (15-30 Miles)	Control 2 (30-45 Miles)
Dependent Variables							
% Pressure Ulcers	0.056	0.065	0.051	0.053	0.063	0.053	0.058
	(0.041)	(0.046)	(0.035)	(0.039)	(0.046)	(0.040)	(0.041)
% Catheters	0.058	0.052	0.055	0.058	0.054	0.061	0.063
	(0.045)	(0.045)	(0.056)	(0.041)	(0.041)	(0.041)	(0.046)
% Physically Restrained	0.090	0.152	0.109	0.096	0.093	0.063	0.057
	(0.116)	(0.154)	(0.129)	(0.126)	(0.096)	(0.071)	(0.079)
% Feeding Tubes	0.041	0.029	0.029	0.038	0.039	0.038	0.057
	(0.061)	(0.036)	(0.040)	(0.057)	(0.050)	(0.044)	(0.086)
# of Deficiencies	6.240	7.011	5.513	5.636	9.022	6.163	5.971
	(5.520)	(6.578)	(4.826)	(4.858)	(8.473)	(4.804)	(4.496)
Total Staffing Hours Per Resident Day	3.223	3.120	3.138	3.204	3.170	3.295	3.330
	(0.857)	(0.629)	(0.810)	(0.866)	(1.032)	(0.807)	(0.890)
% Registered Nursing Staff	0.122	0.133	0.131	0.119	0.136	0.108	0.115
	(0.083)	(0.080)	(0.085)	(0.079)	(0.103)	(0.078)	(0.076)
% Licensed Nursing Staff	0.331	0.314	0.322	0.324	0.356	0.327	0.344
	(0.125)	(0.066)	(0.092)	(0.106)	(0.172)	(0.126)	(0.153)
Explanatory Variables							
Nonprofit Facility	0.397	0.382	0.430	0.449	0.287	0.367	0.379
	(0.489)	(0.487)	(0.496)	(0.498)	(0.454)	(0.483)	(0.486)
Government Facility	0.134	0.108	0.148	0.130	0.138	0.138	0.139
	(0.341)	(0.311)	(0.356)	(0.337)	(0.346)	(0.346)	(0.346)
Number of Beds	89.341	89.129	95.734	87.734	87.884	92.760	86.659
	(51.087)	(40.887)	(63.670)	(50.716)	(40.028)	(58.885)	(47.067)
Member of Multi-facility Organization	0.458	0.441	0.278	0.479	0.508	0.490	0.513
	(0.498)	(0.498)	(0.449)	(0.500)	(0.501)	(0.501)	(0.500)
Hospital-based Facility	0.153	0.124	0.179	0.158	0.127	0.133	0.164
	(0.360)	(0.330)	(0.384)	(0.366)	(0.334)	(0.340)	(0.370)
% Medicaid-paying Residents	0.656	0.630	0.685	0.649	0.661	0.672	0.650
	(0.180)	(0.178)	(0.155)	(0.194)	(0.179)	(0.181)	(0.176)
% Medicare-paying Residents	0.087	0.072	0.073	0.090	0.084	0.101	0.092
	(0.125)	(0.106)	(0.101)	(0.153)	(0.068)	(0.152)	(0.111)
Occupancy Rate	0.864	0.830	0.889	0.869	0.857	0.852	0.867
	(0.138)	(0.147)	(0.124)	(0.137)	(0.140)	(0.142)	(0.137)
Case-mix (Acuindex)	9.917	9.802	9.861	9.788	10.040	9.932	10.096
	(1.283)	(1.086)	(1.277)	(1.406)	(1.018)	(1.218)	(1.315)
% Residents with Dementia	0.473	0.444	0.483	0.452	0.486	0.505	0.487
	(0.169)	(0.136)	(0.146)	(0.182)	(0.170)	(0.172)	(0.173)
% Residents with Psychiatric Illness	0.141	0.142	0.126	0.129	0.166	0.158	0.147
	(0.118)	(0.131)	(0.106)	(0.109)	(0.135)	(0.131)	(0.114)
% Residents with Depression	0.414	0.422	0.362	0.383	0.481	0.458	0.431
	(0.203)	(0.200)	(0.187)	(0.195)	(0.203)	(0.217)	(0.204)
% Residents with MR/DD	0.035	0.024	0.036	0.037	0.029	0.039	0.037
	(0.067)	(0.025)	(0.060)	(0.064)	(0.039)	(0.043)	(0.098)
% Residents whom are Bedfast	0.039	0.037	0.042	0.044	0.034	0.032	0.038
	(0.055)	(0.048)	(0.055)	(0.060)	(0.044)	(0.050)	(0.057)
% Resident whom are Chairfast	0.543	0.546	0.523	0.518	0.578	0.561	0.562
	(0.185)	(0.183)	(0.177)	(0.195)	(0.181)	(0.186)	(0.174)
Micropolitian Area	0.260	0.484	0.190	0.215	0.414	0.276	0.193
	(0.439)	(0.501)	(0.393)	(0.411)	(0.494)	(0.448)	(0.395)
Number of Observations	1878	197	273	559	188	201	460

The table reports the mean and standard deviation (in parentheses) for the entire sample, and the pre- and post- closure period for both treatment and control groups. The sample includes facilities that are within 60 miles of only one closed rural facility. The treatment group is facilities that are within 15 miles if a closed facility while control group 1 is facilities within 15 to 30 miles and control group 2 is facilities within 30 to 45 miles of the closed facility.

Table 4: Results of Impact of Closure on Surviving Facilities

Quality Measure	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
% Pressure Ulcers	-0.013**	-0.013**	-0.011*	-0.011*	-0.016***	-0.016***
	(0.005)	(0.005)	(0.006)	(0.006)	(0.005)	(0.005)
% Catheters	-0.006	-0.006	-0.008	-0.008	-0.008	-0.008
	(0.006)	(0.006)	(0.007)	(0.007)	(0.006)	(0.006)
% Physically Restrained	-0.018	-0.018	-0.003	-0.003	-0.024	-0.023
	(0.015)	(0.015)	(0.017)	(0.017)	(0.016)	(0.016)
% Feeding Tubes	-0.009	-0.009	-0.010	-0.010	-0.011*	-0.011*
	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)
# of Deficiencies	-0.199**	-0.186**	-0.160	-0.155	-0.192**	-0.179*
	(0.092)	(0.092)	(0.107)	(0.107)	(0.095)	(0.095)
Total Staffing Hours Per Resident Day	0.082		-0.012		0.109	
	(0.093)		(0.106)		(0.100)	
% RN Nursing Staff	0.006		0.017		0.005	
	(0.009)		(0.012)		(0.009)	
% Licensed Nursing Staff	0.012		0.026		0.006	
	(0.015)		(0.017)		(0.016)	
Includes Total Nurse Staffing Hours Per Resident Day		X		X		X
Comparison Group of 15 to 30 Miles of Closure	X	X	X	X		
Comparison Group of 30 to 45 Miles of Closure	X	X			X	X

The table reports the coefficient estimates and standard errors of the difference-in-difference estimator for the competitor group in the post closure period. The sample includes facilities that are within 60 miles of only one closed rural facility. The competitor groups are facilities within 15 miles of a closed facility and and comparison group varies with each regression. All regression control for ownership, number of beds, member of multi-facility organization, hospital-based facility, % of Medicaid and Medicare-paying residents, occupancy rate, case-mix, year fixed effects, and closure fixed effects. In the non-staffing quality measure regressions, total nursing staff and staffing error variables are also included. Dependent variables that were censored are estimated using Tobit while the deficiency dependent variable is estimated using negative binomial regression. Standard errors robust to heteroscadasticity are reported in parentheses.

* p<0.10 ** p<0.05 *** p<0.01