Three Essays in Health Economics

by

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A dissertation submitted in partial fulfillment
of the requirements for the degree of
Doctor of Philosophy
(Health Services Organization and Policy)
in the University of Michigan
2018

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Dedication

For my wife, Lin, and children, Leah and Aiden.

Acknowledgements

First and foremost, I would like to thank my advisor, Professor Richard A. Hirth for chairing my dissertation committee. As my academic advisor, Professor Hirth has been supportive since I entered the doctoral program. I truly appreciate all his contributions of time and research ideas to guide me through each milestone of my Ph.D. journey. I am also grateful to my other committee members, Professor Edward C. Norton, Professor Jane Banaszak-Holl, and Professor Francine Lafontaine for invaluable guidance and support as my dissertation committee. I am fortunate to have been able to work with them. It has been a great honor for me to have all of them on my dissertation committee.

I am especially grateful to Professor Jane Banaszak-Holl who generously agreed to share data with me for this dissertation. I am also thankful to Dr. Edward Mortimore from Centers for Medicare and Medicaid Services for his help with accessing the health inspection records for nursing homes.

I would also like to thank Yubraj Acharya, Morris Hamilton, Anup Das, Betsy Cliff, Jordan Rhodes, and seminar participants at the University of Michigan for comments and discussions on earlier analyses. I acknowledge the generous funding support for my dissertation from the Rackham Dissertation Fellowship.

Finally, I want to thank my wife Lin Xie, my children Leah and Aiden, and my parents Xinjian Zheng and Cui'e Liu for their love, support, and encouragement to pursue my doctoral degree.

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Abstract

This dissertation contains three essays that explore how nursing homes respond to public reporting, changes in regulation and payments, as well as heterogeneity across organizational forms. More specifically, I focus on three important issues in the nursing home industry: public reporting, corporate chains, and financial performance. Having implications on the quality of care in the industry, these issues play important roles in shaping long-term care in the United States.

The first chapter evaluates the effects of simplified report cards for nursing homes on their financial performance. Starting in 2008, Centers for Medicare and Medicaid Services adopted a five-star quality rating system for nursing homes to provide consumers an easier way to compare facilities and encourage facilities to improve quality of care. Using a unique dataset containing the unpublished underlying quality scores and relevant thresholds used to assign the number of stars for each nursing home from 2008 to 2013, I implement a regression discontinuity design to estimate the effects of star ratings on nursing homes' financial performance. I find that both revenues and costs of the 5-star nursing homes are significantly higher than those of nearly identical 4-star facilities. Upon further investigation, the main effects are due to a shift toward a more favorable payer mix. In addition, the effects are stronger in more competitive markets. Overall, the results suggest that nursing homes do not gain financially by getting an additional star under the new public reporting system.

In the second chapter, I examine how practice patterns of nursing homes vary by chain affiliation. In 1998, Medicare implemented a Prospective Payment System (PPS) for post-acute care provided by nursing homes. Primarily based on therapy minutes, the PPS created an incentive for nursing homes to provide high-intensity therapy services. Accounting for more than 50% of nursing homes, chains may choose to affect affiliated facilities' practice patterns. This paper aims to examine whether the selection of therapy treatment levels for nursing home residents differs between independent and chain-acquired nursing homes from 2003 to 2009, using a Difference-in-Differences estimation approach. I find that independent facilities acquired by chains experience a 2.92 percentage point increase in the proportion of residents with the highest therapy treatment level. These chain effects may last years after acquisition. In addition, I find that the main effects are mostly due to acquisitions by large chains and for-profit chains. However, the increase in treatment intensity does not lead to a shorter length of stay.

In the third chapter, I investigate the predictors for chain acquisitions of independent nursing homes, focusing on the financial aspects of acquired targets. The purpose of this study is to understand the motivations behind chain acquisitions of independent nursing homes, with a focus on financial performance of the targeted facilities. I use a facility-year level discrete time logit model to predict the probability of an independent nursing home being acquired by a chain from 2000 to 2010. I find that chains are more likely to acquire nursing homes with worse financial performance. These findings raise important issues about the federal government's efforts to make ownership information transparent and to set up an effective transaction monitoring mechanism for the nursing home industry.

Chapter 1 Do better quality star ratings improve firms' financial performance? Evidence from the nursing home industry

1.1 Introduction

Economic theory suggests that asymmetric information could lead to market inefficiencies or even market failure (Akerlof, 1970). Due to uncertainty about quality and agency problems, healthcare markets can be particularly problematic (Arrow, 1963). To address this issue, the federal government has introduced various report cards for several industries within the healthcare sector. The objective of these report cards is to provide more information so consumers can make informed choices and providers have incentives to improve quality of care.

However, research suggests that this approach has limited effects on quality and consumer demand (Dranove et al., 2003; Stevenson, 2006; Werner et al., 2012). One possible explanation for the limited effectiveness of quality information releases is that the information in report cards may have been too complex to be useful to many consumers (Peters et al., 2007; Damman et al., 2009; Hibbard et al., 2010; Bardach et al., 2011; Findlay, 2016). In response to this concern, the federal government began to roll out a variety of simplified summary rating systems across nursing homes, dialysis facilities, home health agencies, and hospitals most recently.

It is important for both providers and the government to know whether this new reporting format works. Much of the existing work on public reporting has focused on its intended effects on consumer demand and provider response. However, public reporting may also have important financial implications for healthcare providers. For example, higher-rated providers could potentially attract more patients, shift toward a more favorable payer mix, or raise prices for

private-pay patients. Theoretically, these changes would lead to an increase in revenues. However, on the other hand, improving quality of care may also cost more for healthcare providers. Therefore, could healthcare providers reap financial benefits by performing well in report cards? Few studies have explored this issue. This paper aims to examine the relationship between public reporting and financial performance of healthcare providers to bridge gaps in the existing literature, using the data from nursing home industry.

This study focuses on report cards and financial performance in the nursing home industry for several reasons. First, in December 2008, the Centers for Medicare and Medicaid Services (CMS) adopted a summarized five-star rating design to its existing public reporting website — Nursing Home Compare, which publishes quality information for each nursing home that participates in Medicare or Medicaid. This new star design is expected to be much easier for consumers to understand. Compared to previous versions of nursing home report cards that presented detailed but complex quality metrics, the straightforward graphical presentation of five stars has a potential to generate a stronger effect for high-performing nursing homes. In the management and economics literature, existing empirical evidence generally supports the argument that consumers' perceived quality of firms, which is often based on some types of rankings, is positively associated with financial performance (McGuire et al., 1990; Deephouse, 2000; Roberts and Dowling, 2002; Raithel and Schwaiger, 2015). However, to date, few studies have addressed this issue focusing on the new public reporting system in the nursing home industry. The ease of interpretation and access to the five-star rating system has provided consumers with an opportunity to make informed choices based on nursing homes' performance. Given that previous findings on the effects of nursing home report cards have been modest (Stevenson, 2006; Werner et al., 2012), evaluating whether this new system yields different

results is of great importance. Second, due to changes in payment system, legal environment, and governmental budgetary constraints, many nursing homes have struggled financially during the past two decades. Because nursing homes provide care for frail elderly — one of the most vulnerable population groups in the United States, it is critically important for the society to pay attention to the financial health of nursing homes so quality of care can be sustained in the long run. If nursing homes could gain financial benefits by performing well in the report card, they will be more likely to be incentivized to engage with quality improvement.

Specifically, the main research question of this study is whether higher-rated nursing homes benefit financially from the five-star quality rating system. In addition, if there is an association, what are the main mechanisms? Does the effect vary across different nursing home markets depending on their competitiveness? Establishing a plausibly causal relationship between star ratings and financial performance is challenging. For example, a nursing home that faces strong demand due to its high quality might already have had higher revenues even in the absence of a higher star rating. To address the potential endogeneity of the star ratings, through a special request to CMS, I construct a unique dataset including the unpublished, continuous quality scores and thresholds used to assign the number of stars for each nursing home, and implement a regression discontinuity design to compare the financial performance of similar nursing homes with quality scores close to the star thresholds during the period from 2008 to 2013. I find that both revenues and costs are significantly higher for 5-star nursing homes, compared to their 4-star counterparts with comparable characteristics. The results are robust to a variety of bandwidth selections and different functional forms. In contrast, the star effects for nursing homes with scores close to other thresholds are either statistically insignificant or sensitive to bandwidth selections. No significant profit margin effect is found across any of the

four thresholds. Upon further investigation, the significant effects for 5-star nursing homes are mainly due to an increase in the proportion of private-pay residents. In addition, the effects of star ratings are stronger in more competitive markets. These results suggest that nursing homes do not gain financial benefits by earning an additional star under the new public reporting system.

1.2 Institutional background

1.2.1 Nursing home industry

In the United States, nursing homes provide both traditional long-term care services and short-term post-acute care for the elderly population. There are about 15,600 nursing homes serving roughly 1.4 million elderly on any given day (National Center for Health Statistics, 2015). Expenditure on nursing homes across the country was about $160 billion in 2014 and is projected to reach $270 billion in 2023 (CMS, 2014). Medicare and Medicaid combined pay nearly 80% of the total nursing home costs, while out-of-pocket payments account for the rest (Kaiser Family Foundation, 2013). Typically, Medicaid — the largest payer for nursing home services — pays for long-term stays, while Medicare — a more generous payer compared to Medicaid — pays for services related to short-term stays such as post-acute care. Nursing home care is a mixed industry in terms of profit status and chain membership of the facilities. Based on the On-line Survey, Certification, and Reporting system (OSCAR), approximately two thirds of nursing homes are for-profit facilities. The proportion of chain-affiliated facilities grew quickly from less than 40% to over 50% from the 1990s to early 2000s (Banaszak-Holl et al., 2002). Since then, chain-owned nursing homes have consistently accounted for more than 50% of nursing homes each year (Grabowski et al., 2016).

The quality of care in nursing homes has been an important policy issue for several decades (Institute of Medicine, 1986). In addition, the public image of the nursing home industry has been tainted by issues such as financial fraud (Department of Justice, 2016a, 2016b), high staff turnover rates (Castle and Engberg, 2005), and increasingly complex corporate structures (Stevenson et al., 2013; Harrington et al., 2015). To address asymmetric information between consumers and providers, the federal government uses report cards as a policy tool to help consumers choose nursing homes and to improve quality of care in the nursing home industry.

1.2.2 Use and design of report cards

Public reporting for nursing homes has existed for almost two decades since it was first introduced in 1998. Nursing Home Compare (NHC), which is a web-based nursing home report card, was launched by CMS (then known as the Health Care Financing Administration) in October 1998. Initially, only a few facility-level structural characteristics and information on health inspections were reported. The nurse staffing measure was added after 2000. After experimenting in six pilot states for six months, CMS introduced the Nursing Home Quality Initiative (NHQI) nationally in November 2002. In this version of the report card, quality indicators were introduced in addition to the existing health inspection and staffing information. Most recently in December 2008, CMS launched a newly designed five-star quality rating system that translates detailed and fragmented measures into more simplified and summarized stars ranging from one to five stars, with a higher number of stars indicating better quality.

The five-star quality rating system is one of the largest summary rating systems in the United States (Werner et al., 2016). The main goal of introducing this simplified summary rating system is to use straightforward and graphical information to better assist consumers in choosing nursing homes based on their needs. The star ratings are based on three components: health

inspection, staffing, and quality measures. For each of the three components, a nursing home is assigned a star rating based on its performance on that component. Then, a composite overall rating is calculated for each nursing home based on the star ratings in the three domains. Figure 1.1 presents a screenshot of Nursing Home Compare with star ratings presented. The underlying measures used to calculate the star ratings come from several sources. Information on health inspections is collected by state inspectors and validated by federal agencies. Staffing and quality measures are largely based on nursing homes' self-reported survey data and resident assessment data.

1.3 Prior studies

Most of the literature on the nursing home report card focused on its impact on consumer demand and quality of care. In general, the results have been modest and inconsistent. Stevenson (2006) reviewed the earlier literature and concluded that public reporting might experience more difficulties in promoting quality in nursing homes than for acute care settings. He argued that consumers' lack of awareness or understanding of the information on the report card is one of the most important reasons why report cards may not work as intended in the nursing home industry.

A majority of the literature evaluated the impacts of NHQI implementation in 2002. Werner et al. (2009a) used small nursing homes that were exempt from Nursing Home Compare as a control group to study the impact of public reporting on quality measures. They found small improvements in most of the reported quality measures but not in the broader unreported quality measures. Grabowski and Town (2011) found that NHC had a minimal impact on quality of care. However, nursing homes were more responsive in competitive markets. Werner et al. (2012) studied how choice of nursing homes was affected by public reporting and found minimal consumer response to information disclosure.

In addition to quality of care, patient sorting is another area of interest. Werner et al. (2011) examined changes in patient sorting and illness severity before and after NHC was implemented and found that public reporting improved patient matching to facilities. He and Konetzka (2015) examined demand rationing caused by public reporting and found that high-quality nursing homes with capacity constraints reduced admissions of less profitable Medicaid residents while increasing Medicare and private-pay admissions.

Only a few studies have evaluated the five-star rating system. Konetzka et al. (2015) found that the five-star rating system exacerbated disparities in quality of care by payer types. Specifically, dual-eligible residents who are qualified for both Medicare and Medicaid coverage had a substantially smaller likelihood of choosing high-quality homes, while non-dual-eligible residents experienced a larger shift toward highly rated nursing homes. Werner et al. (2016) applied a pre-post design to compare the impacts of the five-star rating system on consumer demand. Using data from 2005 to 2010, they found 5-star facilities gained more than 6% of their market share while 1-star facilities lost 8% after the new report card system was implemented.

Overall, the current literature on nursing home report cards largely focused on direct and intended effects such as residents demand and quality of care. Much less attention has been paid to indirect effects such as financial performance for nursing homes, even though financial health is critically important for quality of care as well as nursing homes' sustainability. Park et al. (2011) found that nursing homes had increased revenues and profit margins if they improved their publicly reported performance after the NHQI implementation. However, their study did not include a control group. Using data of nursing homes in Wisconsin from 2001 to 2003, Clement et al. (2012) found that low-quality nursing homes raised their prices by a small amount after the release of NHQI in 2002. Huang and Hirth (2016) used a pre-post design to analyze the

impact of nursing home five-star ratings on private prices of nursing homes located in five states. In contrast to Clement et al. (2012), they found that top-rated nursing homes were able to raise their private prices by 4.8% to 6% after implementation of the new star rating system. Using Virginia data in 2011, Clement and Khushalani (2015) did not find a significant association between overall five-star quality ratings and private prices. In a more recent study using the same data, Clement (2016) found that offering high-value long-term care services was unrelated to operating or total profit margin of nursing homes.

Studies in the existing literature have several limitations. Many studies lack an appropriate control group, which leads to less plausible causal estimation. This issue is particularly relevant for studies evaluating the new five-star rating system because all nursing homes participated in the program at the same time and no control group was available. Furthermore, among the handful of finance-related studies, the lack of expense information (i.e., only look at the price effects) and limited study scope (e.g., only use nursing homes in a few states) may also contribute to the inconsistent results. Lastly, within the context of large-scale summary rating systems recently implemented across various industries in the healthcare sector, relevant empirical evidence is limited.

This study aims to bridge the gap of the existing literature on the relationship between public reporting and financial performance of nursing homes by (1) exploiting the procedure of assigning the number of stars to tackle the empirical challenge of having no control group; (2) exploring one of the much less investigated yet important indirect effects — financial performance; (3) incorporating costs as well as revenues to present a full picture of financial performance, and (4) including a nationally representative sample.

1.4 Theoretical framework

Under the traditional and fragmented public reporting system, nursing homes may exploit the complexity and obscurity of the information presented in earlier versions of the report cards. For example, they might only make improvement on selected measures that are relatively easier to observe and readily understood by consumers (Werner et al., 2009a, 2009b; Mukamel et al., 2010). However, with the release of the new five-star rating system, the graphical and more straightforward information has the potential for consumers to better differentiate nursing homes based on their star ratings. Although detailed information on the specific underlying measures may have been available even before the new five-star rating system was implemented, the addition of a simplified summary rating in the form of stars could increase consumer awareness and understanding of the report card, leading to a more elastic demand for nursing home services with respect to the reported quality.

A simplified star rating system may help consumers better differentiate nursing homes based on star rating levels and therefore affect occupancy rates, private-pay prices, and payer mix of the facilities. First, nursing homes with higher star ratings may attract more consumers, leading to an increase in occupancy rates at these facilities. Second, high-performing nursing homes may choose to raise their prices for private-pay residents. In the nursing home industry, Medicare and Medicaid rates are administratively set by the federal and state governments. However, nursing homes could change their private-pay prices in response to changes in demand for their services. Third, higher-rated nursing homes may have a better payer mix of residents. For example, compared to lower-margin Medicaid residents who typically have fewer choices in nursing homes, higher-margin Medicare and private-pay residents often face fewer restrictions. In summary, these three possible effects due to differences in star ratings may lead to differences

in revenues for nursing homes. Therefore, I hypothesize that nursing homes with higher star ratings are more likely to generate higher revenues compared to lower-rated facilities.

Compared to revenues, the relationship between star ratings and expenses could be more complicated. Highly rated nursing homes typically perform better on certain measures related to quality of care. If providing higher quality of care is costly or maintaining a higher star rating requires sustainable investment in quality improvement, nursing homes with higher ratings could see an increase in costs. For example, improving nurse staffing ratios requires the hiring of more nurses, which would result in higher expenses. In addition, if higher-rated nursing homes attract more Medicare and private-pay residents but they also require more resources to provide appropriate care, costs may increase as well. On the other hand, nursing homes with higher star ratings may have better quality management with more efficient operations. For example, nursing homes could reduce costs while improving quality of care by limiting the use of physical restraints. In support of these theoretical arguments, existing empirical evidence showed that the relationship between quality of care and costs was mixed (Hussey et al., 2013). Therefore, I hypothesize that the star rating effect on costs is ambiguous. In addition, because profit margins are determined by both revenues and costs, as a result, the effect of an increase in star ratings on profit margins is ambiguous depending on whether the increase in revenues is offset by the possible increase in costs.

Furthermore, market competition could modify the relationship between star ratings and financial performance. Disclosure of quality information might have little effect on financial performance of facilities located in areas with limited competition. Residents would have limited choices in these markets. In addition, nursing homes would be less incentivized to improve their performance due to the inelastic demand with respect to quality in more concentrated markets. In

more competitive markets, the elasticity of demand with respect to quality could increase, leading to potentially stronger revenue effects of the report card. Moreover, economic theory suggests that costs would change in similar magnitudes as do revenues in more competitive markets in the long run. For example, in equilibrium (and perfect competition), costs would balance the revenues. Existing research supported the argument that market concentration might play an important role mediating the effects of public reporting in the nursing home industry (Grabowski and Town, 2011; Huang and Hirth, 2016). Therefore, I expect the financial impacts of star ratings on nursing homes to be stronger in more competitive markets.

In summary, I hypothesize that higher-rated nursing homes generate higher revenues than do lower-rated facilities. The difference in costs between higher- and lower-rated nursing homes is unclear. Accordingly, the effects of star ratings on profit margins are ambiguous. In general, the effects of star ratings on the financial performance of nursing homes are expected to be stronger in more competitive markets. In addition, to explore the mechanisms through which star ratings affect the financial performance, I expect occupancy rates and the proportion of private-pay or Medicare residents to be higher in higher-rated nursing homes.

1.5 Data

1.5.1 Star ratings

Information on five-star quality ratings for all Medicare/Medicaid certified nursing homes is downloaded from the NHC website. In addition, to complement the star rating data and accommodate the empirical strategy of this study, through a special request to CMS, I obtain unpublished data including detailed information on underlying health inspection scores and relevant thresholds used to assign the number of stars for nursing homes.

The NHC website maintains archived data documenting the overall rating as well as specific ratings for each Medicare/Medicaid certified nursing home in three domains: health inspection, staffing, and quality. For this study, I extract the detailed rating information for each nursing home in October of each year from 2008 to 2013. On average, there are about 15,453 nursing homes with their star rating information available each year.

1.5.2 Financial performance

The Medicare Cost Reports (MCRs) for skilled nursing facilities (CMS-2540-96 for fiscal years before 2010; CMS-2540-10 for fiscal years 2010 or later) from 2009 to 2014 are used to extract financial information. Each year, every Medicare-certified nursing home is required to file its cost report in order to receive Medicare reimbursements. The report includes detailed financial information such as revenues and expenses at the facility level. More specifically, the financial measures are drawn from the Statement of Revenues and Expenses (Worksheet G3).

Consistent with previous studies that used the MCRs data, I use operating revenues, operating expenses, and operating profit margins to evaluate nursing homes' overall financial performance. Operating revenues are defined as the total revenues related to direct patient care, excluding any contractual allowances and discounts or incomes from investment or donations. Operating expenses are costs related to direct patient care. Operating profit margin is derived as operating profits (operating revenues less operating costs) divided by the operating revenues. To standardize the measures across nursing homes of varying sizes, I divide the financial measures by the number of total resident days (Worksheet S-3) in a calendar year. In line with previous studies on nursing home financial performance (Bowblis and Brunt, 2014; Bowblis, 2015), the analytical sample is limited to nursing homes with a fiscal year starting on or after January 1st and ending on or before December 31st of the same calendar year, with a reporting period that is

equal to or longer than 360 days. This sample selection strategy is adopted because some factors such as wage index or base payment rates could be changed annually. To adjust for inflation, the annual consumer price index extracted from the U.S. Bureau of Labor Statistics is used to convert all the dollar values to 2014 dollars.

The MCR is well known for having outliers due to reporting errors (Kane and Magnus, 2001; Government Accountability Office, 2016). A golden standard to precisely detect those outliers does not exist but previous research on the financial performance of nursing homes adopted a relatively consistent approach to address this issue. In this study, I follow the previous literature (Bowblis, 2015; Huang and Hirth, 2016) and drop observations with missing or negative values in revenues and expenses where values should be positive. In addition, the observations at the top and bottom 1% values based on operating profit margins are dropped. To account for the skewness of the financial measures, the natural logs of operating revenues and operating expenses are used in the analysis.

1.5.3 Control variables

A set of control variables including facility-level structural measures and residents' demographic characteristics that could affect financial outcomes for nursing homes are obtained from OSCAR and the LTCfocus.org website from 2008 through 2013. Every 9 to 15 months, each federally certified nursing home receives an onsite inspection conducted by state agencies. Including a rich set of information on facilities' structural and staffing measures collected from these inspections, the OSCAR file represents approximately 96% of all nursing homes in the United States. Specifically, ownership status (i.e., for profit, not-for-profit), chain status, number of beds, occupancy rate, Activities of Daily Living (ADL) index, and payer mix variables are obtained from the OSCAR file. I use the total number of beds and county information to

construct a Herfindahl-Hirschman Index (HHI) by accounting for chain affiliations (Hirth et al., 2017) to measure market competition at the county level. Residents' demographic characteristics including age, gender, and race are extracted from the LTC focus, which gathers aggregated data from a variety of sources such as OSCAR and nursing home residents' assessment data.

1.5.4 Creation of analytical dataset

The study period is from 2008 to 2013, after the five-star quality rating system was implemented in 2008. The four datasets are linked using the unique federal provider identification number for each nursing home and year information. Hospital-based nursing homes are excluded because they often have a very different patient mix and severity compared to typical nursing facilities, and their financial information is embedded in their affiliated hospitals' cost reports. For similar reasons, government-owned nursing homes are excluded as well. In addition, nursing homes located in Alaska, Hawaii, and the District of Columbia are excluded because the data are not complete for these states. The analytical sample includes an average of 8,656 nursing homes each year from 2008 to 2013.

1.6 Empirical strategy

1.6.1 Regression discontinuity

Whereas most previous studies of the nursing home report cards used data from both pre- and post- periods, this study relies on the data after the five-star quality rating system was implemented because this new rating system was rolled out for all nursing homes at the same time in 2008, and therefore no control group existed before its implementation. A naive model that simply regresses financial measures on star ratings could potentially yield biased estimates due to the possible endogeneity of star ratings. For example, a nursing home that faces strong

demand due to its high quality might already have had higher revenues even in the absence of a higher star rating. In addition, the lack of an appropriate control group could cause bias in evaluating the impact of report cards. To address these issues, I implement a regression discontinuity (RD) design by taking advantage of recovering the true underlying continuous quality scores and relevant thresholds used to assign the number of stars for nursing homes. More specifically, I separately estimate the financial performance of nursing homes rated near the four cutoff points across the five star ratings over the period from 2008 to 2013.

First introduced by Thistlethwaite and Campbell (1960) and recently formalized by economists (Hahn et al., 2001; Imbens and Lemieux, 2008; Lee and Lemieux, 2010), the RD design is widely seen as a rigorous non-experimental approach to estimate treatment effects. The rating methodology provides a plausibly exogenous variation for nursing homes close to the thresholds between the scores used to assign stars. For example, two similar nursing homes ranked closely around the threshold of a star rating would be assigned a different number of stars depending whether their scores are slightly below or above the threshold. With the increasingly widespread implementation of simplified summary ratings across different sectors including healthcare, researchers have used RD designs with data from Yelp.com (Luca, 2011; Anderson and Magruder, 2012), dialysis facilities (Ramanarayanan and Snyder, 2012), and Medicare Advantage plans (Darden and McCarthy, 2015).

The RD design is similar to a randomized controlled trial but limits the study sample to a relatively narrower bandwidth around the thresholds. In this study, if the assignment into one additional star is random for nursing homes with underlying scores close to the threshold and other covariates are smooth across the threshold, the difference in financial performance if any should be attributed only to the discontinuous change in star ratings.

1.6.2 Assignment of star ratings

To better illustrate why the RD design fits this study, I detail the procedure of star assignment for nursing homes. As mentioned in Section 1.2.2, each nursing home on the NHC website is assigned a star rating in each of three domains: health inspection, staffing, and quality. In addition, an overall rating is calculated based on a nursing home's comprehensive performance in these three domains. However, because staffing and quality ratings are largely based on self-reported measures, the health inspection domain carries the most weight in the construction of the overall star rating. Specifically, the calculation of the overall rating starts from the health inspection rating.

Subsequently, a nursing home receives one additional star if its staffing rating is higher than three stars and greater than its health inspection star rating, but the facility gets one star subtracted if the staffing rating is only one star. Next, the resulting overall rating receives one additional star only if the quality rating is five stars, but one star gets subtracted if the quality rating is one only star. If the health inspection rating is one star, the overall rating cannot be changed by more than one star based on staffing and quality components. The overall star rating cannot be more than five stars or fewer than one star. If a nursing home receives no health inspection rating because it is too new to be rated, the facility does not receive an overall rating either.

This hierarchical procedure of assigning the overall rating illustrates the dominant role of health inspection rating in the calculation of the overall rating. Next, I detail the procedure of how a nursing home's health inspection rating is determined because it is important for the RD design in this study.

To become certified by Medicare or Medicaid, each nursing home is required to receive a standard onsite health inspection enforced by the local state agency every 9 to 15 months. A typical inspection lasts several days during which the inspection team assesses whether the nursing home is in compliance with hundreds of federal regulations ranging from detailed care process for its residents to kitchen/food services and safety. Numerical points are assigned to each health inspection violation based on its scope and severity. The total health inspection score for a nursing home is calculated based on its most recent three health inspection surveys, additional deficiencies from the most recent three calendar years of any complaint-based surveys that were conducted in addition to the regular surveys, and the number of revisits required to correct the violations. More recent surveys are given larger weights in the calculation of the total health inspection score. More specifically, the score from the most recent survey is assigned a weighting factor of 1/2, the score from the previous survey has a weighting factor of 1/3, and the score based on the second prior survey has a weighting factor of 1/6. A higher health inspection score indicates more severe quality issues.

On the NHC website, each nursing home is assigned an integer health inspection rating that ranges from 1 to 5 stars based on its percentile ranking of health inspection scores among all nursing homes within the same state. The top 10% of nursing homes receive 5 stars and the bottom 20% get only 1 star. The middle 70% of the nursing homes receive 2 to 4 stars with an equal interval between each star. In general, the ratings for all nursing homes are updated monthly. However, the rating for any given facility is held constant until there is a change in the health inspection score for that facility.

On the NHC website, both the overall and domain-specific star ratings are displayed for each nursing home. However, as shown in Figure 1.1, the display of the overall rating is more

prominent on the first line under the name of each nursing home. Therefore, consumers and nursing homes are likely to pay more attention to the overall ratings. Earlier studies on the new five-star system also focused on the overall ratings (Konetzka et al. 2015; Grabowski et al. 2016; Werner et al. 2016; Williams et al. 2016). Therefore, it is reasonable to assume that the overall rating plays the most important role across all domains in general.

For this study, I follow the previous studies and use the overall star rating for nursing homes. However, even though the overall star rating is largely determined by the health inspection domain, nursing homes with extreme staffing and/or quality ratings could receive overall star ratings that are different from their health inspection ratings. If the overall rating of a nursing home equals its health inspection rating, the thresholds in the health inspection domain determine the number of stars for both the health inspection and overall domains. From the perspective of the RD identification, a sample of nursing homes with health inspection ratings that equal the overall ratings accommodates the design well. On the other hand, the issue of generalizability arises when using this group of nursing homes. To address this concern, I compare the characteristics of all nursing homes and the nursing homes with overall ratings that equal their health inspection ratings. Table A1 shows the summary statistics for these two groups. As shown, the preferred sample accounts for slightly more than 50% of the full sample. However, all characteristics are extremely similar between the two groups of nursing homes, which alleviates the concern about the generalizability of the results using the preferred sample.

1.6.3 Main empirical model

Because there are five integer star ratings ranging from 1 to 5 stars, four thresholds are used to assign the number of stars to each nursing home. Instead of estimating a pooled RD treatment effect of one additional star increase using all nursing homes closed to the thresholds, I

consider the potential heterogenous effects of each star threshold (Cattaneo et al., 2016). More specifically, I separately estimate the effects of obtaining an additional star on nursing homes' financial performance for each of the four thresholds. Following Imbens and Lemieux (2008), by limiting the sample to a narrow bandwidth h to the left and right of the threshold, the main specification for each of the four thresholds is as follows:

$$Y_{it+1} = \beta_0 + \beta_1 I(R_{it} > \widehat{R_t}) + \beta_2 \tilde{R}_{it} + \beta_3 I(R_{it} > \widehat{R_t}) \times \tilde{R}_{it} + \beta_4 X_{it} + \delta_t + \theta_s + \varepsilon_{it} \quad (1)$$

where Y_{it+1} is the financial measure of interest for nursing home i in year $t+1$; $R_{i,t}$ is the underlying health inspection score used to assign a given star rating to nursing home i in year t; $\widehat{R_t}$ is the cutoff score between two adjacent star ratings in year t; $I(\cdot)$ is an indicator variable that takes the value of 1 if nursing home i gets one additional star (e.g., $R_{it} > \widehat{R_t}$) and 0 otherwise; $\tilde{R}_{it}$ is the centered score variable that equals the difference between the underlying score of nursing home i and the cutoff score; X_{it} is a set of time-varying covariates that may affect financial outcomes; δ_t is a set of year dummies to control for year trends; θ_s is the state fixed effect to account for the possible state variation in health inspection procedure; and ε_{it} is the random error term for nursing home i. Including the interaction term between $I(\cdot)$ and $\tilde{R}_{it}$ helps account for the fact that stars may affect not only the intercept but also the slope of the regression lines to both sides of the thresholds. Standard errors are clustered within each nursing home to account for potential auto-correlation of the errors. In this specification, β_1 is the coefficient of interest, which indicates the impact of one additional star due to the discontinuity around cutoff points, conditioning on the continuous health inspection score of each nursing home. I allow for a one-year lag between the star rating and the financial outcomes because it would take time for nursing home and consumer responses to the rating to affect financial outcomes.

As discussed in Section 1.4, a change in financial performance could come from several possible sources. Therefore, I further explore the mechanisms of the rating effects if any. Specifically, I examine whether a discontinuous change in star ratings would cause a change in occupancy rates or patient sorting along the payer mix dimension (e.g., higher-rated nursing homes attract more residents with favorable payers). In these analyses, I run the same RD regression by replacing financial outcomes with payer mix or occupancy rates.

To test the role of market competition, I break up the main analysis of the effects of star thresholds on financial outcomes by market competition levels. More specifically, using the guidelines from the Department of Justice and the Federal Trade Commission (DOJ and FTC, 2010), I conduct separate RD analyses for two types of markets: more competitive markets where HHIs are equal to or smaller than 2,500, and less competitive markets where HHIs are larger than 2,500.

1.6.4 Internal validity

Although the RD design is appealing for establishing the plausible causal inference, several factors should be examined to support the internal validity of the design. In this section, I discuss these threats and propose how to test them empirically.

1.1.1.1 Manipulation

One common concern with the RD design is the incentive for observations around the threshold to precisely manipulate their probabilities of receiving treatment. If nursing homes had the ability to change their quality scores around the threshold, the assumption of random distribution above and below the threshold would be violated and so would be the RD design. However, this is unlikely to occur in the setting of this study. First, health inspections are conducted objectively by state inspectors and verified by the federal agency. This is also one of

the reasons why I use health inspection ratings but not staffing or quality measures, which are subject to self-reporting issues. Indeed, one of the biggest criticisms of the five-star rating system is nursing homes' ability to self-report staffing or quality measures to improve ratings (Thomas, 2014). Second, the health inspection score of a nursing home is a weighted score based on its health inspection records in the past three years. It is implausible for a nursing home to precisely manipulate its scores for multiple years. Third, the health inspection rating is based on the distribution of health inspection scores for nursing homes within a state. Even if a nursing home somehow could manipulate its own health inspection scores, the facility would also need to know the health inspection scores for all other nursing homes within the same state to calculate its own percentile ranking. Therefore, it is implausible for a nursing home to manipulate its own position along the whole distribution. For these reasons, the identification assumption of the RD design in the setting of this study is theoretically conceivable.

To empirically rule out the possibility of nursing homes' precise manipulation of health inspection ratings, I conduct a density test proposed by McCrary (2008) for each of the four thresholds. Visually, this is a graph that plots the number of observations at each point along the health inspection percentile rankings. If there was no manipulation, there should be no discontinuity in the number of observations around the threshold.

1.1.1.2 Covariates

As shown in the main specification (1), a set of covariates that may also affect financial outcomes are included. However, these covariates should, in theory, not be affected by the differences in the number of stars. Like a well-implemented randomized control trial, when designed appropriately, the treatment and control groups in the RD design should look similar along the baseline characteristics. I compare nursing homes' structural measures and residents'

demographic characteristics between the treatment and control groups to analyze whether they are balanced around the thresholds. In addition, to empirically test the smoothness across the thresholds, I regress each of these covariates as a dependent variable with specification (1). If the RD design is valid, there should be no observed discontinuity around the star threshold for any of these covariates.

1.1.1.3 Bandwidth selection and functional form

For the main analysis, I start with a bandwidth of 5 percentile points below and above each star threshold. However, it is necessary to test the sensitivity of the results by varying the bandwidth selections. A larger bandwidth is more likely to yield more precise estimates because more observations would be included, while a smaller bandwidth may generate more noise because fewer observations are included. Specifically, I vary the bandwidth selections from 2.5 to 7.5 percentile points with increments of 0.5 to examine the robustness of the estimations to each alternative bandwidth. In addition, based on the idea of mean square error (MSE), more formal procedures to choose an optimal bandwidth have been used in RD designs. Following Imbens and Kalyanaraman (2012) and Calonico et al. (2014), I implement an optimal bandwidth selection procedure proposed by Calonico et al. (2017) to generate the MSE-optimal bandwidths around each of the star thresholds. I then compare the point estimates based on these alternative bandwidths to test the robustness of the results.

In addition, the main specification is a local linear regression model. Even though it is recommended that a local linear model should be used (Hahn et al., 2001; Imbens and Lemieux, 2008; Lee and Lemieux, 2010) in an RD design with a narrow bandwidth, I test whether the main results are robust to alternative functional forms such as quadratic and cubic polynomials.

1.7 Results

1.7.1 Main results

Table 1.1 presents the characteristics of the nursing homes by overall star ratings from 2008 to 2013. In general, all three financial measures increase as the number of stars increases, except for nursing homes with two or three stars. For example, operating revenue per patient day increases from $244 for an average 1-star nursing home to about $320 for an average 5-star nursing home. Similarly, on average, operating cost per patient day increases from $241 for 1-star nursing homes to $313 for those with a 5-star rating. The average operating profit margin is relatively low across all nursing homes, ranging from 0.01 for 1-star nursing homes to 0.03 for 5-star facilities.

In terms of ownership mix, both the proportions of chain-affiliated and for-profit nursing homes decrease as the number of stars increases. In addition, nursing homes with higher star ratings have fewer beds, higher occupancy rates, slightly higher ADL index scores, and more Medicare but fewer Medicaid residents. In terms of residents' demographic characteristics, higher-rated nursing homes have more residents who are female, white, and of older age. On average, nursing homes across the star ratings operate in relatively competitive markets, with county HHIs ranging from 1,833 to 2,080.

The characteristics presented in Table 1.1 provides a general picture for all nursing homes in the sample. In contrast to other empirical approaches, the RD design focuses on and compares nursing homes with underlying scores that are close to the star thresholds. Table 1.2 compares the covariates for nursing homes with health inspection scores that are 5 percentile points above and below the threshold of each star. As shown, most of the covariates are well balanced across these thresholds. The good comparability of the characteristics between nursing homes with

similar health inspection scores but different star ratings provide support for the validity of the RD design in this study.

One of the advantages of RD design is its graphical presentation by simply plotting the variables of interest against the underlying score variable. In Figure 1.2, I plot the overall star rating against the continuous percentile rankings based on health inspection scores for nursing homes from 2008 to 2013 in the analytical sample. By design, there is a sharp discontinuity from 0 to 1 on the probability of receiving one additional star at each of the four thresholds used to assign the number of stars.

Next, I present a set of plots for raw means of financial measures against the continuous percentile rankings for nursing homes between 2008 and 2013. Figure 1.3 shows the relationship between nursing homes' operating revenue per patient day at year t+1 and their percentile rankings based on health inspection scores at year t for each of the four thresholds used to assign stars. The top panel includes figures for 5-star and 4-star thresholds from left to right, while the bottom panel presents figures for 3-star and 2-star thresholds from left to right, respectively. There is a discontinuous jump from approximately $300 to $320 on the operating revenue per patient day between 4-star and 5-star nursing homes across the 5-star threshold. In contrast, the operating revenues per patient day smoothly cross the other three thresholds without significant discontinuity.

Similarly, Figure 1.4 presents the relationship between nursing homes' operating expense per patient day and their percentile rankings based on the health inspection scores. The expense pattern is very similar to that of the revenue shown in Figure 1.3. Across the 5-star threshold, the average operating expense per patient day jumps from about $290 for 4-star nursing homes just below the threshold to slightly over $310 for 5-star nursing homes just above the threshold. In

general, nursing homes' operating expenses per patient day smoothly cross the other three star's thresholds. Given the similar patterns in Figures 3A and 3B, it is not surprising that there is no discontinuous change in operating profit margins around the threshold for any star as shown in Figure 1.5. These scatterplots foreshadow the formal RD estimates.

Table 1.3 presents the results from the main RD estimates using a local linear regression as shown in specification (1) with a bandwidth of 5 percentile points around each of the four thresholds. The model controls for a set of facility-level time-varying covariates, state fixed effects, and year trends. The star ratings show heterogeneous effects on the financial performance of nursing homes depending on the thresholds. Both the revenue and cost effects are statistically significant ($p < .05$) among nursing homes with health inspection scores around thresholds of 2 and 5 stars but not for nursing homes with scores that are close around thresholds of 3 or 4 stars. However, no significant effect is observed for nursing homes' profit margins across any of the four thresholds. Specifically, the operating revenue per patient day of 5-star nursing homes is about 5.1% higher ($p < .05$) than that of nearly identical facilities with 4 stars. However, these 5-star nursing homes just above the threshold also incur higher operating expense per patient day ($p < .05$) by about 4.4%, compared to their 4-star counterparts. Because these nursing homes with 5 stars not only generate higher operating revenues but also incur higher operating expenses in a similar magnitude, no statistically significant higher operating profit margins are observed compared to 4-star facilities just below the threshold. Similarly, the operating revenue per patient day and cost per patient day of 2-star nursing homes are 3.4% ($p < .05$) and 3.9% ($p < .05$) higher, respectively, than those of 1-star nursing homes. Again, no profit margin effect is observed for nursing home around the 2-star threshold.

1.7.2 Bandwidth selection and functional form

To test the robustness of the main results to different bandwidth selections around the thresholds, I apply a variety of bandwidth options ranging between 2.5 and 7.5 percentile points in increments of 0.5 to the left and right of each threshold. The full results are shown in Tables A2 through A5. To briefly summarize, the effects of the 5-star threshold on revenues and costs consistently remain statistically significant for all alternative bandwidth selections. However, the effects of the 2-star threshold on both revenues and costs become insignificant as the bandwidth shrinks to 4 or smaller percentile points. The effects of 3-star and 4-star thresholds remain statistically insignificant for any bandwidth selection. The effects on profit margin are insignificant across the star thresholds with any bandwidth.

In addition, I implement an MSE-optimal bandwidth selection procedure to find the appropriate bandwidths for each of the star thresholds. The resulting optimal bandwidths and associated point estimates are reported in Table A6. The suggested optimal bandwidths around each star threshold are all close to 5 percentile points. In addition, although the optimal bandwidths slightly differ across the thresholds, both the magnitudes and statistical significances of the point estimates are quantitatively close to the main results using the 5 percentile points across the thresholds.

Next, I test the robustness of the point estimates from the main results to alternative functional forms including a model with no covariates, a quadratic model, and a cubic model in addition to the local linear model. Tables A7 to A10 show the results from these models for each of the star threshold. Overall, the results are consistent across different functional forms. Therefore, following the recommendations by previous literature on the RD design (Hahn et al.,

2001; Imbens and Lemieux, 2008; Lee and Lemieux, 2010; Gelman and Imbens, 2014), I use the local linear regression throughout this study.

1.7.3 Possible mechanisms

The main results suggest that the number of stars has significant effects on both revenues and costs for nursing homes with scores close to the 5-star and 2-star thresholds but not the middle star levels. However, the effects of 2-star threshold are sensitive to the bandwidth selections. Furthermore, due to the similar magnitudes of star effects on both revenues and costs, there is no significant star effect on nursing homes' operating profit margins across the four thresholds. As suggested in Section 1.4, several mechanisms may help explain the main findings. Specifically, I explore the roles of payer mix and occupancy rates in mediating the relationship between star ratings and nursing homes' financial performance.

To examine the relationship between star ratings and payer mix of nursing homes, I run the RD local linear regression by replacing financial outcomes with payer mix variables. Table 1.4 shows the results. Compared to 4-star facilities, 5-star nursing homes have a higher proportion of private-pay residents by 1.49 percentage points ($p < .10$) and lower shares of Medicare and Medicaid residents by 0.47 and 1.02 percentage points insignificantly. Similarly, the proportion of private-pay residents in 2-star nursing homes is also higher by 1.49 percentage points ($p < .10$) compared to that in 1-star nursing homes. Similar to the main results of revenues and costs, there is no statistically significant shift in payer mix for nursing homes with two middle-star ratings. This suggestive evidence implies that a higher proportion of private-pay residents may partially contribute to the higher revenues for both 2-star and 5-star nursing homes compared to their counterpart facilities but with one fewer star.

Next, I examine the relationship between star ratings and occupancy rates. The results are reported in Table 1.5. Both 2-star and 5-star nursing homes have higher occupancy rates than their lower-rated counterparts, but the point estimates are not significantly different from zero. Interestingly, the average occupancy rate of 4-star nursing homes is 2.73 percentage points ($p <$ .01) higher than that of 3-star nursing homes. However, as shown in the main RD results, around the 4-star threshold, 4-star nursing homes do not gain higher revenues than their 3-star counterparts. In addition, the results on payer mix analysis suggest that 4-star nursing homes may attract more Medicaid residents than 3-star facilities, although the effect is not statistically significant. Therefore, the star rating effects on occupancy rates and payer mix of 4-star nursing homes offset each other, resulting in an insignificant star effect on the revenues of these facilities.

1.7.4 Role of market competition

As previously stated, the effects of star ratings on financial outcomes could be heterogeneous depending on the level of market competition. I examine the role of market competition by conducting the same RD analysis using sub-samples stratified by the levels of market competition (i.e., nursing homes located in more competitive markets [HHI $\leq$ 2,500] and less competitive markets [HHI > 2,500]). Table 1.6 presents the results. Not surprisingly, the main effects of star ratings on financial outcomes are concentrated among nursing homes in more competitive markets. For example, in more competitive markets, 5-star nursing homes not only generate higher revenues by 7.2% ($p < .05$) but also incur higher costs by 6.3% ($p < .05$) compared to their 4-star counterparts. However, the effects of the 5-star threshold in less competitive markets are imprecise statistically. Similarly, the effects of the other three thresholds in more competitive markets are consistent with the main results as shown in Table 1.3. In

addition, the effects of star ratings on profit margins remain insignificant across all star thresholds regardless of market competition levels.

1.7.5 Change in star ratings

One of the empirical challenges of this study is the timing between rating and financial measures. As stated earlier, nursing home ratings are generally updated once a month. The independent variable used in this study is the star ratings for each October from 2008 to 2013. Although a nursing home's rating does not change until new data become available for that facility, it is still possible that ratings in October are different from those in the other months until the next October. In those cases, it would cause complications to disentangle the rating effect on the financial performance of nursing homes. To address this concern, I restrict the sample to nursing homes without changed ratings and run the RD local linear regression. The results are shown in Table 1.7. The main effects of the star ratings clearly come from the nursing homes without rating changes within one year. For example, among the nursing homes with persistent star ratings, compared to their 4-star counterparts, the 5-star nursing homes generate higher operating revenues by approximately 9.7% ($p < .01$) but incur higher operating costs by 9.4% ($p < .01$). The profit margins are not affected by differences in the number of star ratings. The results on other thresholds are also consistent with the main results as shown in Table 1.3.

1.7.6 Robustness checks

In addition to showing the robustness of the main results to a variety of bandwidth selections and different functional forms in Section 1.7.2, I conduct two additional analyses to examine the internal validity of the RD design for this study. First, as stated previously, one important assumption for the RD design to be valid is that observations cannot precisely manipulate the assignment of the treatment. In Section 1.6.4.1, I detail the procedures for star

assignment and the implausibility for a nursing home to precisely manipulate its score to obtain an additional star. To complement these arguments, following McCrary (2008), I conduct a formal density test of nursing homes with scores around the threshold of each star. Figure A1 shows the results. The density of nursing homes around each star threshold is not discontinuous because none of the changes in density of nursing homes at any star threshold is statistically significant.

Another important assumption for a valid RD design is that the only discontinuity around the thresholds comes from the dependent variables of interest but not from other covariates. As previously shown in Table 1.2, most of the covariates are similar across each threshold. To further test the smoothness of these covariates across the star thresholds, I estimate the RD local linear regressions with each of the covariates as the dependent variable. Table A11 reports the results from this robustness check. None of the covariates is significantly affected by the star thresholds.

1.7.7 Falsification test

Furthermore, to test the robustness of the findings in this study, I empirically evaluate the relationship between star ratings and financial performance of nursing homes with a false implementation year. Through a special request to CMS, I obtain health inspection records for all nursing homes in the United States between 2005 and 2007 to calculate the would-be health inspection scores for nursing homes in 2007, which is one year before the five-star quality rating system was implemented. All detailed health inspection data were publicly available on the NHC website before 2008; however, there was no rating system in place at that time. Therefore, I can use the health inspection data in earlier years to calculate each nursing home's health inspection score and its percentile ranking within the state based on the published CMS algorithm and

assign a star rating to each nursing home. Then, I use the same RD design to test whether there is any jump around the cutoff points. If there is no jump, the main findings would be supported.

Figures A2 through A4 show the plots of financial measures in 2008 against the continuous percentile rankings based on weighted health inspection scores in 2007. There is no significant jump in financial outcomes around any star threshold. To more formally test this, I run the RD local linear regressions with the bandwidth of 5 percentile points around each threshold. The results are shown in Table A12. None of the star rating coefficients on any of the financial outcomes is statistically significant, which confirms the random distribution of financial outcomes around each of the thresholds that are shown in the Figures A2 through A4. By showing evidence that presenting the same quality information but without stars does not affect any of the financial measures in the year prior to 2008, this falsification test reassures that the significant and robust effects of 5-star threshold on operating revenues and costs are plausibly due to the five-star quality rating system that was implemented after 2008.

1.8 Discussion and Conclusion

Public report cards such as the five-star quality rating system for nursing homes are designed to alleviate information asymmetries so that consumers can choose healthcare providers of better quality and providers are motivated to improve their quality of care. However, quality improvement often comes with increased costs. In the nursing home industry, the majority of nursing homes are for-profit facilities. From a provider's perspective, it is critically important to ensure that any quality improvement is a sustainable practice long term. Whether providers are rewarded financially for performing well in report cards is an empirical question that is still relatively less investigated in prior studies focusing on the nursing home industry.

In this study, I evaluate the effects of the five-star quality rating system on nursing homes' financial performance from 2008 to 2013. Unlike most previous research on nursing home report cards, this study focuses on the format of the new five-star quality rating system and explores the heterogeneity in the information that is presented in the report card. Specifically, I exploit the procedures to assign star ratings, recover the underlying quality scores used to assign stars, and implement an RD design to establish a plausible causal relationship between star ratings and financial performance for nursing homes that are at the margin of the thresholds used to assign the number of stars.

I find that the number of stars has a significant effect on revenues and costs for nursing homes around the thresholds of 2 stars and 5 stars, but not for facilities around the middle-star thresholds. Specifically, 5-star nursing homes with inspection scores just above the threshold gain operating revenues per patient day by about 5.1% ($p < .05$) higher than their 4-star counterparts with inspection scores just below the threshold. However, this group of 5-star nursing homes also incur higher operating expenses per patient day by about 4.4% ($p < .05$) compared to otherwise similar 4-star facilities. Similarly, the operating revenues and costs of 2-star nursing homes are 3.4% ($p < .05$) and 3.9% ($p < .05$) higher than those of their nearly identical 1-star counterparts. However, in terms of profit margins, I do not find significant star effects for any group of nursing homes. The significant effects of the 5-star threshold are robust to a variety of bandwidth selections and different functional forms but the effects of the 2-star threshold become insignificant when the bandwidth is narrower around the threshold. Upon further investigation, the significantly higher revenues for nursing homes with scores just above the 2-star or 5-star thresholds are mainly due to a shift in payer mix, which is reflected by an

increase in the proportion of private-pay residents. In addition, the effects of star ratings are stronger in more competitive markets.

In general, the findings of this study contribute to the existing literature on public reporting in the nursing home industry. They also complement existing studies that focused on the new five-star quality rating system. Huang and Hirth (2016) found that the private prices of top-ranked nursing homes are 4.8% to 6% higher than those of lower-rated homes. In another study, Werner et al. (2016) concluded that the rating system significantly increased the demand for higher-rated nursing homes but decreased the demand for lower-rated facilities. The new five-star quality rating system was also found to increase the disparity between dual- and non-dual-eligible residents in accessing nursing homes with better star ratings (Konetzka et al., 2015). In an earlier study (Grabowski and Town, 2011), nursing homes facing stronger competition were found to improve their quality more than facilities in less competitive markets. To some extent, this study confirms these findings by prior work. In addition, this study emphasizes the important role of how information is presented in the report card and shows that it matters, at least among the top-rated nursing homes.

An increase in revenues in response to a higher rating is not surprising. However, the finding of a similar magnitude of increased expenses and thus no significant profit effect fills the gap to previous studies that focused only on price effects. Even though the overall relationship between cost and quality of care could be positive (Gertler and Waldman, 1992), the discontinuous jump in costs around the 5-star threshold is puzzling. There are four possible explanations from different perspectives for this increase in costs. First, the jump in costs implies that it is costly for 5-star nursing homes to provide high quality of care to additional private-pay residents even though their payment rates are higher. Indeed, nursing home care requires

intensive labor input. For example, highly rated nursing homes need higher staffing levels as well as appropriate medical equipment to ensure that their residents receive high quality of care. Second, in the field of corporate finance, the pecking-order model of financing hierarchy (Myers and Majluf, 1984) predicts that firm managers tend to have a preference ranking over financing sources, which typically starts with internal funds, followed by debt, and then equity. The creation of this preference is mainly due to the information asymmetry between managers and investors. Within the context of this study, increased revenues due to higher star ratings may help relieving nursing homes' financial constraints. For example, those 5-star nursing homes with scores that are just above the threshold may use extra revenues to enhance staffing levels and improve amenities so that they can maintain a competitive advantage, which lead to an increase in costs. Similarly, from the behavioral economics perspective, nursing homes with scores that are just above the thresholds may have a tendency toward loss aversion. These nursing homes could have stronger motivations to invest in quality improvement and to maintain a higher rating status because they are more afraid of lowering their star ratings. Lastly, from the perspective of business strategy (Collis and Montgomery, 1997), successful firms typically focus on how to establish their competitive advantages to ensure long-term asset growth and prosperity but not necessarily short-term profits. For example, higher-rated nursing homes may consider strategies such as attracting more residents and improving payer mix to better position these facilities against competition long term.

Another nuanced finding of this study is the heterogeneous star rating effects depending on the star thresholds. Specifically, financial measures are more responsive at the 5-star threshold, compared to other thresholds. From the consumers' perspective, this implies that consumers are more likely to differentiate top-ranked nursing homes from other facilities with lower star

ratings. The necessary condition for the report card to be effective is to ensure that consumers use the information. However, due to barriers such as time constraints, consumers may only be able to engage with the information that is presented in the report card to the extent that they take the 5-star as a sure sign of superior quality. Therefore, designers of the report card should consider how to better differentiate nursing homes with middle or lower star ratings.

The lack of effect of star ratings on profit margins raises the question why nursing homes would be incentivized to obtain higher star ratings if this does not bring financial benefits. From the government's perspective, this is an important issue. The success of report cards relies on the engagement from not only consumers but also providers. Typically, decisions on quality improvement are made by nursing homes. The majority of nursing homes are for-profit facilities and their priority is to gain profits. To my knowledge, currently there is no nationwide financial incentive that directly rewards nursing home performance. However, in fiscal year 2019, CMS will start a Value-Based Purchasing Program that rewards participating skilled nursing facilities with incentive payments based on their performance on the 30-day hospital readmission measure. The experience from that program will have important implications on whether the federal government should consider tying financial incentives to nursing homes' performance in the report card.

As is true for any empirical work, this study has several limitations. First, the RD design is known to have limited external validity even with its strong internal validity. In this study, the identification of the main effects, also known as the local average treatment effects, comes from the nursing homes with inspection scores that are close to the thresholds of star assignment. Accordingly, the financial effects of star ratings among nursing homes with underlying quality scores that are far away from the thresholds are not estimated. In addition, to better

accommodate the RD design and avoid plausible manipulation of the underlying scores in quality and staffing domains (Thomas, 2014), I limit the study sample to nursing homes with health inspection star ratings that equal their overall ratings. Even though the good comparability of the selected observable measures between these two groups of nursing homes alleviate the concerns about sample selection, the unobserved characteristics among these nursing homes still raise the issue of generalizability. Second, I obtain the health inspection and star rating data from CMS for the months of October during the study period. Although nursing homes' ratings generally do not change unless new inspection data are available, it is still an empirical question to test whether the main results from this study are robust to the star rating data in other months. Third, the reliability and accuracy of the MCR data have been an issue for researchers and public stakeholders who are interested in using the data because the data are not routinely audited and subject to limited verification. Because Medicare does not reimburse nursing homes based on cost reports, nursing homes generally put limited efforts into ensuring the accuracy of the information in the reports. Although the data used in this study are carefully cleaned, issues such as reporting errors cannot be fully eliminated. Fourth, this study focuses on the financial effects of star ratings for nursing homes. Although the theoretical framework suggests several mechanisms through which star ratings could affect financial outcomes, I could only explore the roles of payer mix and occupancy rates due to the data limitations. Future studies that use similar empirical identification strategies should explore other important pathways such as the number of admissions and private prices.

In conclusion, the main results of this study suggest that the new five-star quality rating system shows limited effects on nursing homes' financial performance. Among all four thresholds that are used to assign the number of stars, only the 5-star threshold has significantly

positive and robust effects on both the revenues and costs of 5-star nursing homes. However, profit margins are not affected by any of the star rating levels. In the past few years, the trend of replacing detailed and fragmented quality measures with a simplified summary rating system has increased within the healthcare sector. Given that most of the rating systems are relatively new (e.g., the five-star rating system for hospitals that was initiated in 2016), both the direct and indirect effects of this type of star rating system remain a promising research area for future studies.

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1.10 Figures

Figure 1. 1 Example of Nursing Home Compare Five-Star Quality Report System (as of November 2017)

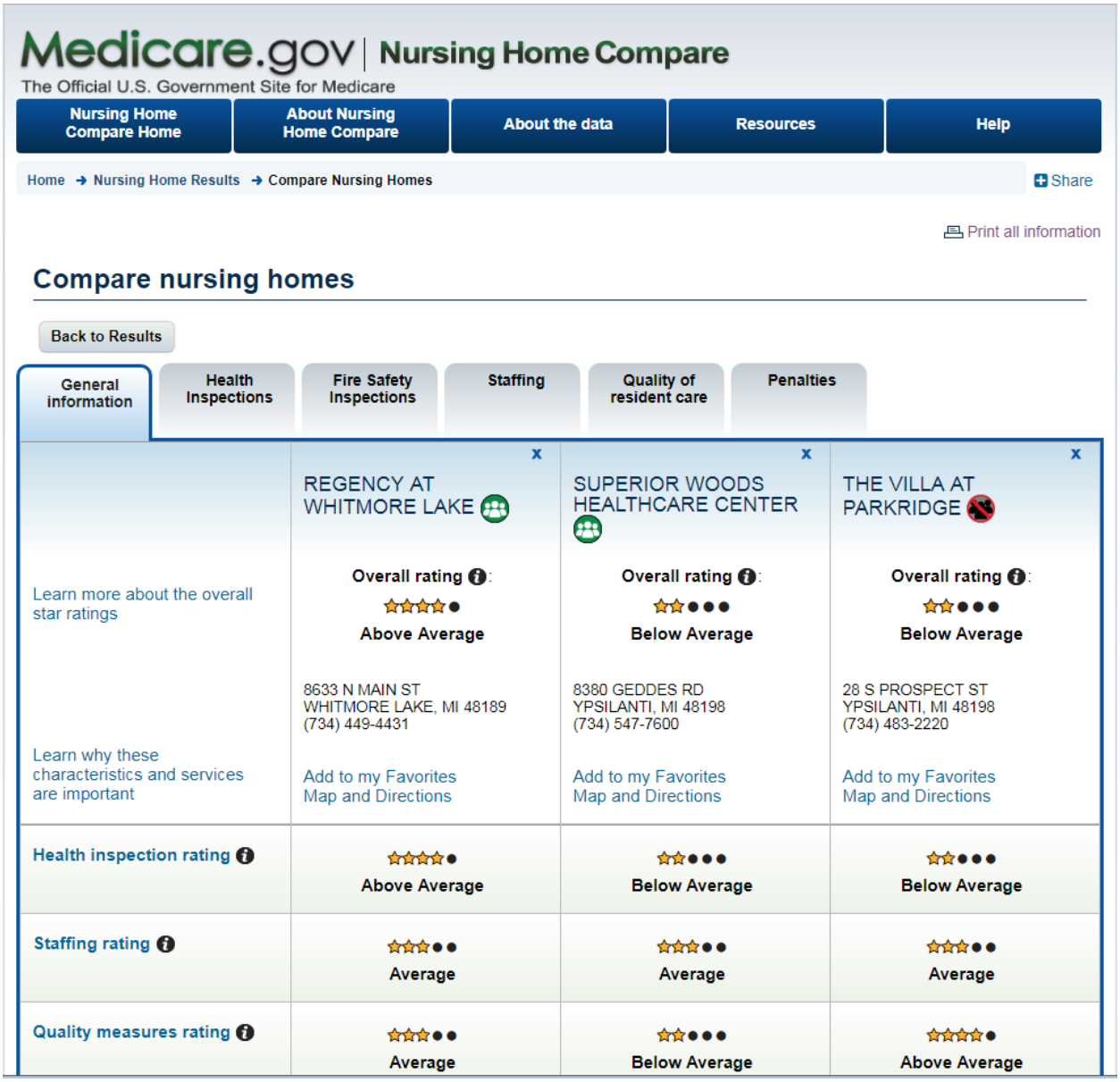


Figure 1. 2 Relationship between star ratings and health inspection scores

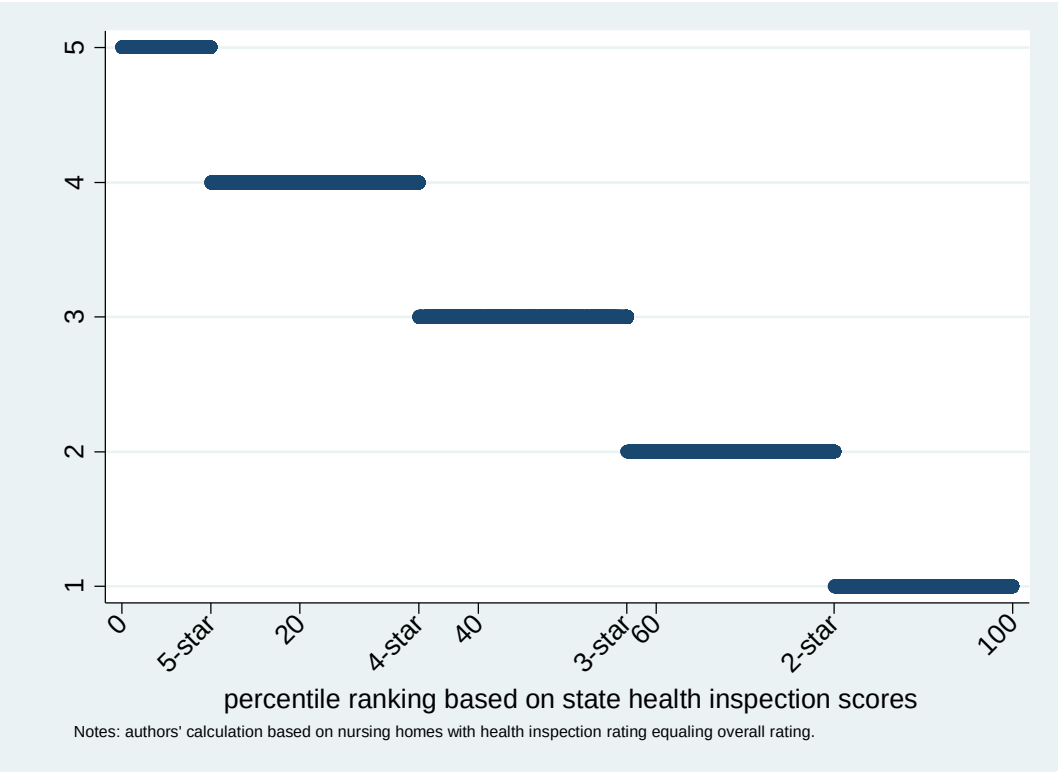
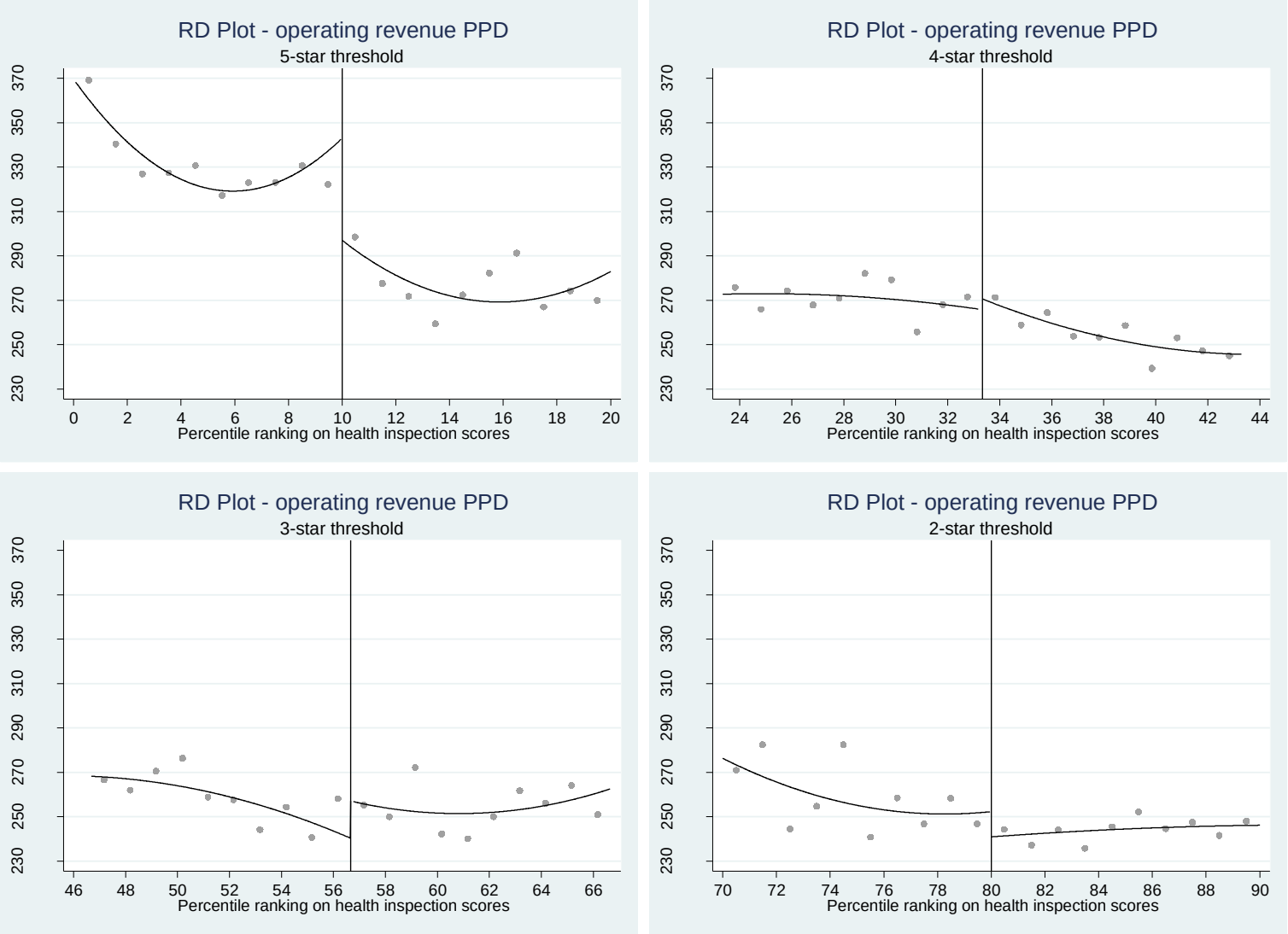
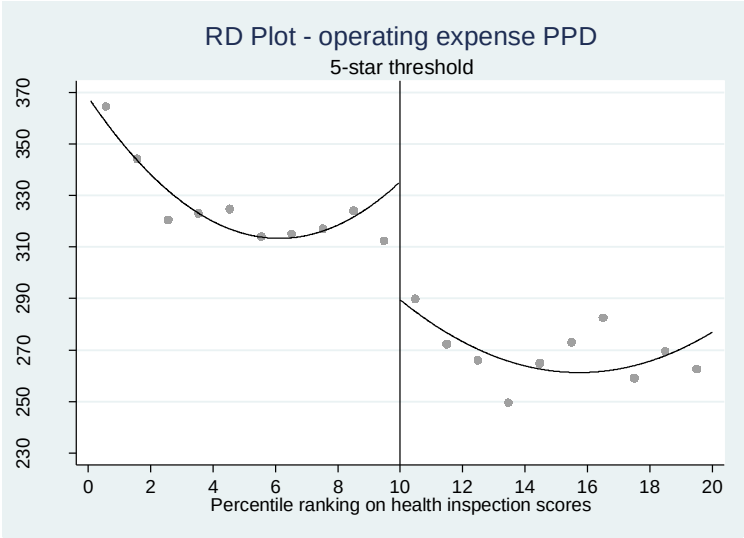


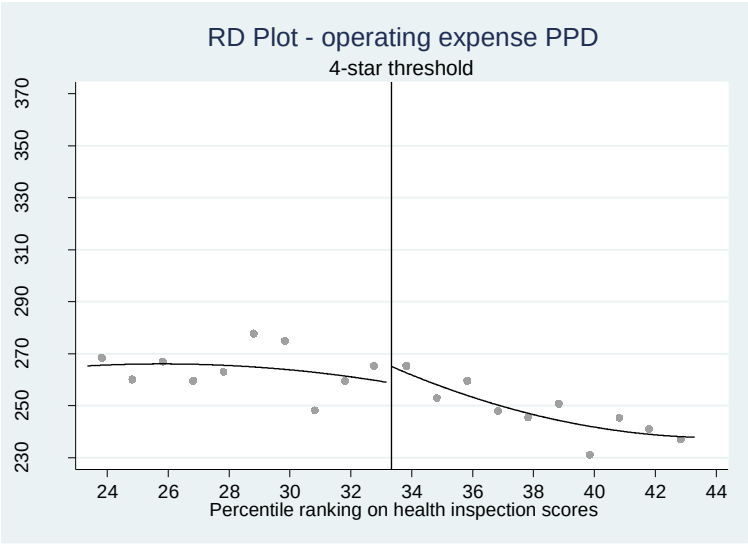
Figure 1. 3 RD plots - operating revenue per patient day

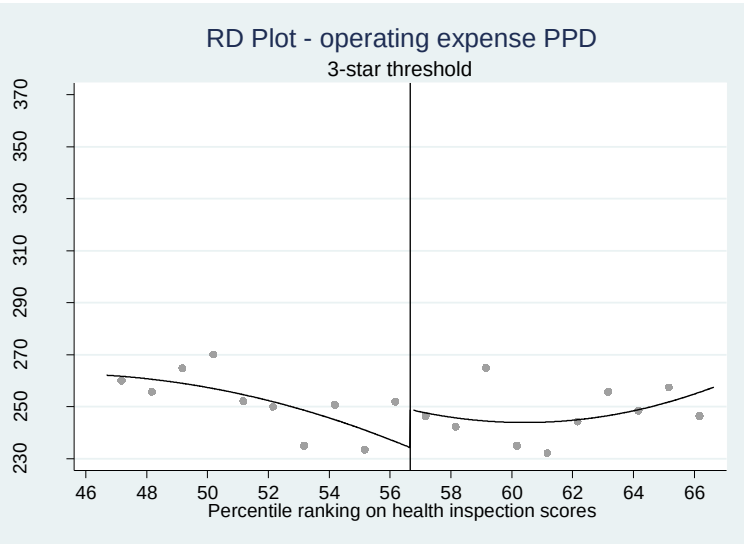


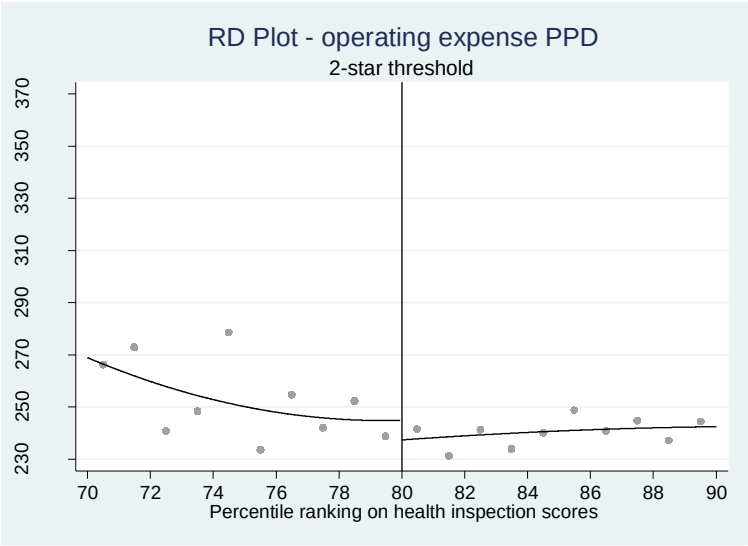
Notes: Each dot represents the sample average on operating revenue per patient day within each percentile based on health inspection scores. The vertical line represents the star threshold. The curve lines represent polynomial fit lines based on the data. All dollar amounts are CPI adjusted to 2014 dollars.

Figure 1. 4 RD plots - operating cost per patient day



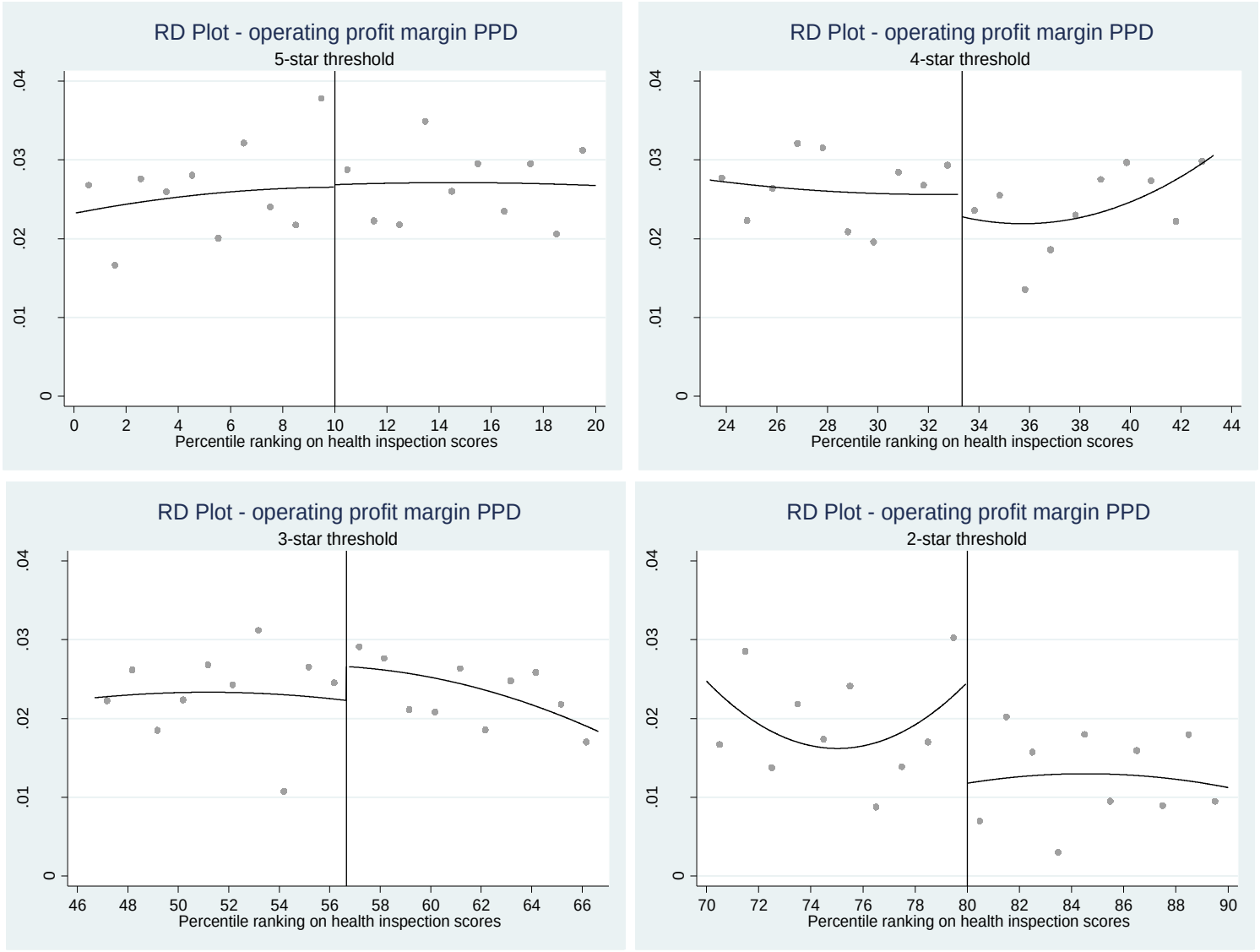






Notes: Each dot represents the sample average on operating expense per patient day within each percentile based on health inspection scores. The vertical line represents the star threshold. The curve lines represent polynomial fit lines based on the data. All dollar amounts are CPI adjusted to 2014 dollars.

Figure 1. 5 RD plots - operating profit margin per patient day



Notes: Each dot represents the sample average on operating profit margin per patient day within each percentile based on health inspection scores. The vertical

line represents the star threshold. The curve lines represent polynomial fit lines based on the data. All dollar amounts are CPI adjusted to 2014 dollars.

1.11 Tables

Table 1. 1 Characteristics of nursing homes by overall stars 2008-2013

Number of overall star ratings	1		2		3		4		5	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Operating revenue PPD	243.72	118.93	257.54	183.75	254.87	132.39	271.11	157.36	319.51	268.34
Operating cost PPD	241.44	119.26	251.33	180.78	248.01	132.89	263.69	160.80	313.47	284.65
Operating profit margin	0.01	0.09	0.02	0.08	0.02	0.08	0.03	0.08	0.03	0.08
Chain-owned	0.64	0.48	0.61	0.49	0.61	0.49	0.56	0.50	0.51	0.50
For-profit	0.90	0.30	0.87	0.34	0.85	0.35	0.79	0.41	0.72	0.45
Number of beds	127.06	56.95	120.59	58.43	113.65	54.56	105.21	56.08	96.26	60.79
ADL index	16.08	2.75	16.33	2.75	16.31	2.75	16.40	2.66	16.62	2.80
Average age	77.66	6.13	79.14	6.07	80.39	5.50	81.99	5.23	83.30	5.19
% Female	66.13	11.11	67.97	11.26	69.87	10.77	72.00	10.15	73.76	10.25
% White	78.58	21.57	79.86	21.88	82.84	21.18	86.22	19.43	87.82	18.91
% Medicare	13.67	8.70	14.66	10.46	14.80	10.30	15.49	11.87	16.48	14.08
% Medicaid	67.53	15.16	64.64	17.26	63.04	17.44	58.83	20.12	54.02	23.59
Occupancy rate	80.72	14.18	83.11	13.33	83.64	13.57	84.73	12.95	86.55	12.27
County HHI	1833.29	2188.61	1881.27	2320.84	2080.23	2449.42	2078.40	2450.00	1907.02	2288.27
Observations	6595		4622		4349		6551		3550	

Notes: Nursing homes (1) located in AK, DC or HI or (2) owned by government or (3) hospital-based are excluded. All dollars are converted to 2014 dollar using the CPI index.

Table 1. 2 Characteristics of nursing homes close to star thresholds by overall stars 2008-2013

	2-star threshold		3-star threshold		4-star threshold		5-star threshold	
Number of overall star ratings	1	2	2	3	3	4	4	5
Chain-owned	0.62	0.63	0.59	0.61	0.61	0.57	0.54	0.51
	(0.48)	(0.48)	(0.49)	(0.49)	(0.49)	(0.50)	(0.50)	(0.50)
For-profit	0.89	0.88	0.86	0.86	0.83	0.82	0.76	0.74
	(0.31)	(0.33)	(0.34)	(0.35)	(0.36)	(0.40)	(0.41)	(0.45)
Number of beds	128.00	124.66	117.03	118.90	111.79	109.22	97.55	96.92
	(63.45)	(62.26)	(54.95)	(55.04)	(58.93)	(55.81)	(54.34)	(60.54)
ADL index	16.27	16.24	16.42	16.37	16.38	16.43	16.38	16.60
	(2.68)	(2.69)	(2.76)	(2.70)	(2.71)	(2.57)	(2.75)	(2.94)
Age	78.50	78.79	79.65	80.32	80.62	81.58	82.22	82.90
	(5.68)	(6.09)	(5.88)	(5.38)	(5.56)	(5.30)	(5.20)	(5.60)
% Female	67.43	67.25	68.60	69.61	70.44	71.19	72.73	73.18
	(10.41)	(11.34)	(11.18)	(11.05)	(10.53)	(10.26)	(10.36)	(10.62)
% White	79.50	78.48	80.50	81.91	83.81	85.52	86.82	87.56
	(21.11)	(22.51)	(21.53)	(21.65)	(21.50)	(19.89)	(18.46)	(18.90)
Observations	1466	1107	861	945	845	1523	1265	2031

Notes: Nursing homes (1) located in AK, DC or HI or (2) owned by government or (3) hospital-based are excluded. The sample represents nursing homes with health inspection scores within 5 percentile points around each threshold of the star ratings. Standard deviations are reported in parentheses.

Table 1. 3 Main RD results

Threshold in year t	Financial measures in year t+1			
	Log operating revenue PPD	Log operating cost PPD	Operating profit margin PPD	N
5 stars	0.051**	0.044**	0.0070	3162
	(0.022)	(0.022)	(0.0059)	
4 stars	-0.028	-0.031	0.0027	2368
	(0.023)	(0.024)	(0.0067)	
3 stars	-0.0029	-0.00080	-0.0016	1806
	(0.023)	(0.023)	(0.0076)	
2 stars	0.034**	0.039**	-0.0052	2573
	(0.016)	(0.016)	(0.0068)	

Notes: The sample is limited to nursing homes with health inspection scores within 5 percentile points around each star threshold. All estimates use local linear regression. Standard errors are reported in parentheses. Nursing homes that are (1) owned by government or (2) hospital-affiliated or (3) located in AK, DC or HI are excluded. Standard errors are clustered at the nursing home level. Constant terms, covariates, year dummies and state fixed effects are estimated but not reported. Covariates include profit status, chain affiliation, bed size, ADL index and residents' demographic characteristics including age, gender and race. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 1. 4 Effects of star ratings on payer mix

Threshold	Payer mix measures in year t+1			
in year t	% Medicare	% Medicaid	% Private-pay	N
5 stars	-0.47	-1.02	1.49*	3162
	(0.76)	(1.15)	(0.86)	
4 stars	-0.89	1.08	-0.19	2368
	(0.90)	(1.41)	(1.06)	
3 stars	-0.04	-0.64	0.68	1806
	(0.90)	(1.36)	(1.03)	
2 stars	-0.69	-0.80	1.49*	2573
	(0.69)	(1.09)	(0.86)	

Notes: The sample is limited to nursing homes with health inspection scores within 5 percentile points around each star threshold. All estimates use local linear regression. Standard errors are reported in parentheses. Nursing homes that are (1) owned by government or (2) hospital-affiliated or (3) located in AK, DC or HI are excluded. Standard errors are clustered at the nursing home level. Constant terms, covariates, year dummies and state fixed effects are estimated but not reported. Covariates include profit status, chain affiliation, bed size, ADL index and residents' demographic characteristics including age, gender and race. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 1. 5 Effects of star ratings on occupancy rate

Threshold in year t	Occupancy rate in year t+1	N
5 stars	0.91	3162
	(0.59)	
4 stars	2.73***	2368
	(0.97)	
3 stars	-1.40	1806
	(1.03)	
2 stars	0.41	2573
	(0.93)	

Notes: The sample is limited to nursing homes with health inspection scores within 5 percentile points around each star threshold. All estimates use local linear regression. Standard errors are reported in parentheses. Nursing homes that are (1) owned by government or (2) hospital-affiliated or (3) located in AK, DC or HI are excluded. Standard errors are clustered at the nursing home level. Constant terms, covariates, year dummies and state fixed effects are estimated but not reported. Covariates include profit status, chain affiliation, bed size, ADL index and residents' demographic characteristics including age, gender and race. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 1. 6 Heterogeneous RD estimates varied by market competition

Threshold in year t	Financial measures in year t+1			
	Log operating revenue PPD	Log operating cost PPD	Operating profit margin PPD	N
More competitive market (HHI ≤ 2500)				
5 stars	0.072**	0.063**	0.0095	2297
	(0.028)	(0.028)	(0.0071)	
4 stars	-0.031	-0.041	0.0098	1687
	(0.029)	(0.030)	(0.0080)	
3 stars	-0.023	-0.019	-0.0029	1306
	(0.028)	(0.028)	(0.0090)	
2 stars	0.033*	0.040**	-0.0061	1942
	(0.019)	(0.019)	(0.0079)	
Less competitive market (HHI > 2500)				
5 stars	-0.015	-0.012	-0.0034	865
	(0.024)	(0.024)	(0.010)	
4 stars	-0.052*	-0.041	-0.011	681
	(0.031)	(0.030)	(0.013)	
3 stars	0.052*	0.049	0.0036	500
	(0.031)	(0.032)	(0.015)	
2 stars	0.024	0.032	-0.0082	631
	(0.026)	(0.027)	(0.014)	

Notes: The sample is limited to nursing homes with health inspection scores within 5 percentile points around each star threshold. All estimates use local linear regression. Standard errors are reported in parentheses. Nursing homes that are (1) owned by government or (2) hospital-affiliated or (3) located in AK, DC or HI are excluded. Standard errors are clustered at the nursing home level. Constant terms, covariates, year dummies and state fixed effects are estimated but not reported. Covariates include profit status, chain affiliation, bed size, ADL index and residents' demographic characteristics including age, gender and race. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

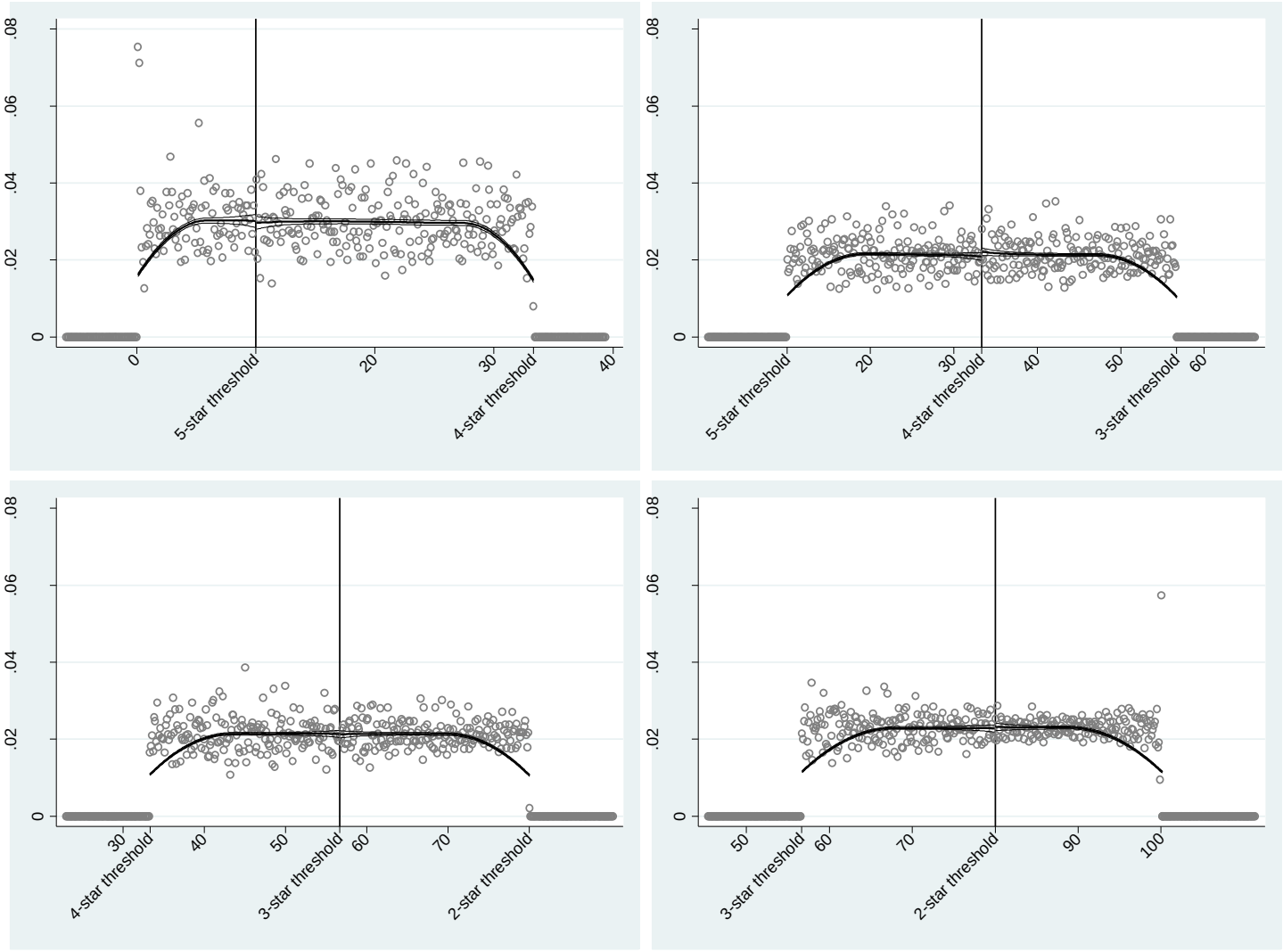
Table 1. 7 RD estimates on nursing homes without changes in overall ratings

Threshold	Financial measures in year t+1			
in year t	Log operating revenue PPD	Log operating cost PPD	Operating profit margin PPD	N
5 stars	0.097***	0.094***	0.0031	1762
	(0.035)	(0.034)	(0.0093)	
4 stars	0.040	0.047	-0.0074	993
	(0.036)	(0.036)	(0.011)	
3 stars	0.019	0.024	-0.0042	608
	(0.037)	(0.038)	(0.014)	
2 stars	0.067***	0.065***	0.0020	1119
	(0.021)	(0.021)	(0.010)	

Notes: The sample is limited to nursing homes with health inspection scores within 5 percentile points around each star threshold. In addition, these nursing homes did not experience changes in their overall ratings within a calendar year. All estimates use local linear regression. Standard errors are reported in parentheses. Nursing homes that are (1) owned by government or (2) hospital-affiliated or (3) located in AK, DC or HI are excluded. Standard errors are clustered at the nursing home level. Constant terms, covariates, year dummies and state fixed effects are estimated but not reported. Covariates include profit status, chain affiliation, bed size, ADL index and residents' demographic characteristics including age, gender and race. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

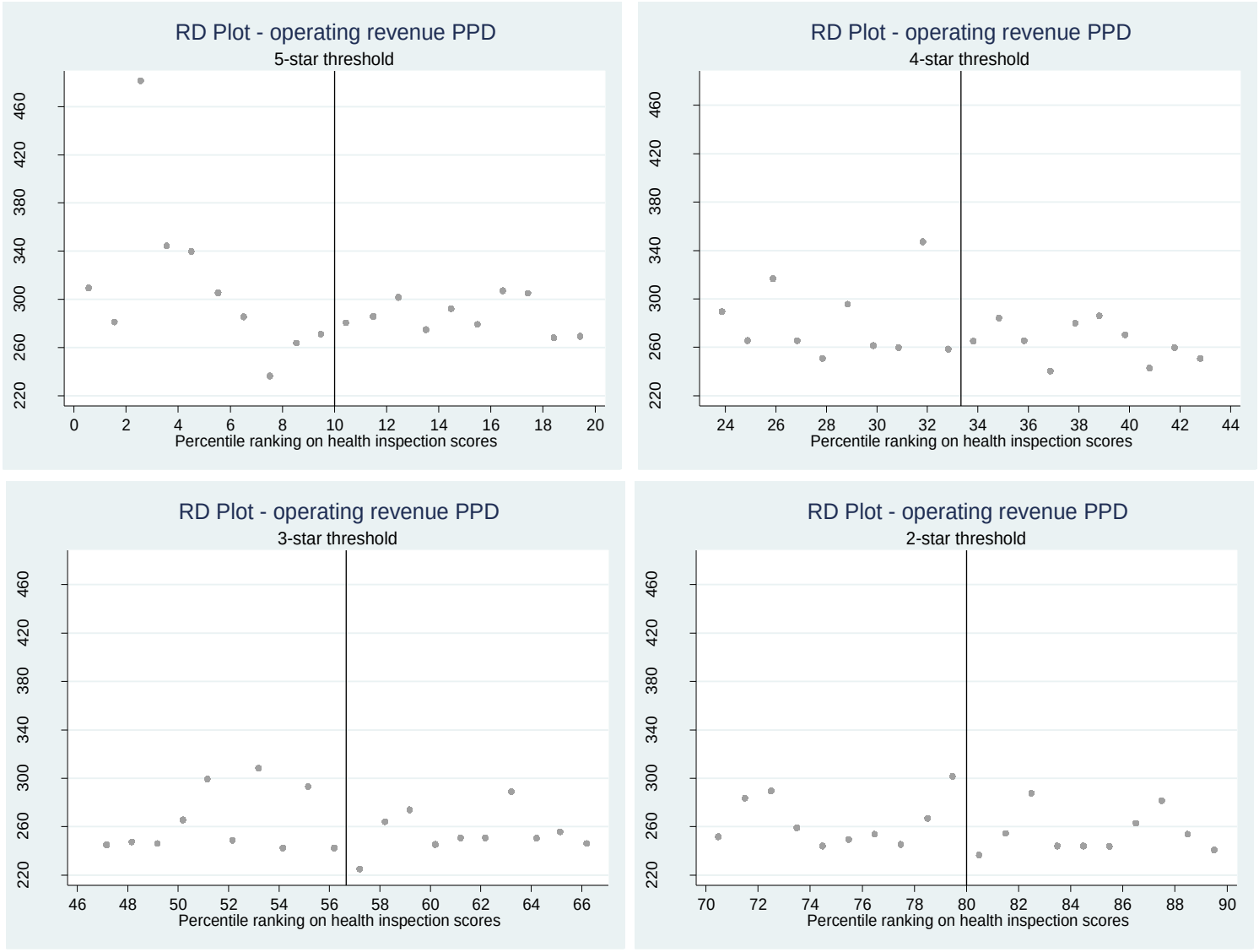
1.12 Appendix

Figure A 1. McCrary density tests



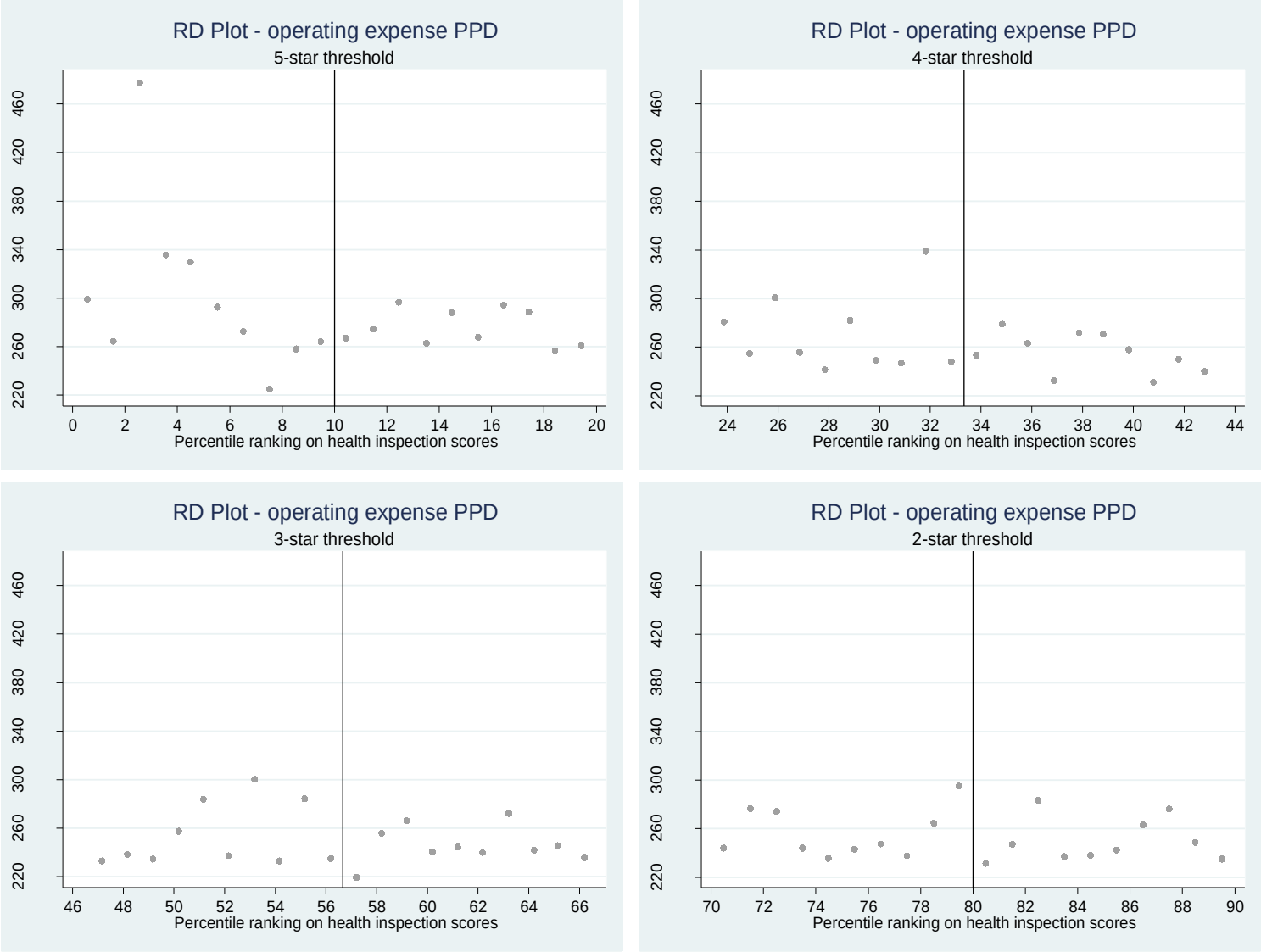
Notes: These figures are based on the McCrary (2008) tests for discontinuity in density at each of the star threshold. In general, these tests look for evidence of manipulation of star assignment around each threshold. More specifically, each figure is the scatterplot of nursing homes' percentile ranking based on their health inspection scores around the star thresholds. The solid line is a local polynomial smoother fitting the distribution. In addition, the 95% confidence intervals of the estimators are shown above and below the solid line.

Figure A 2. RD plots - operating revenue per patient day (based on simulated stars in 2007)



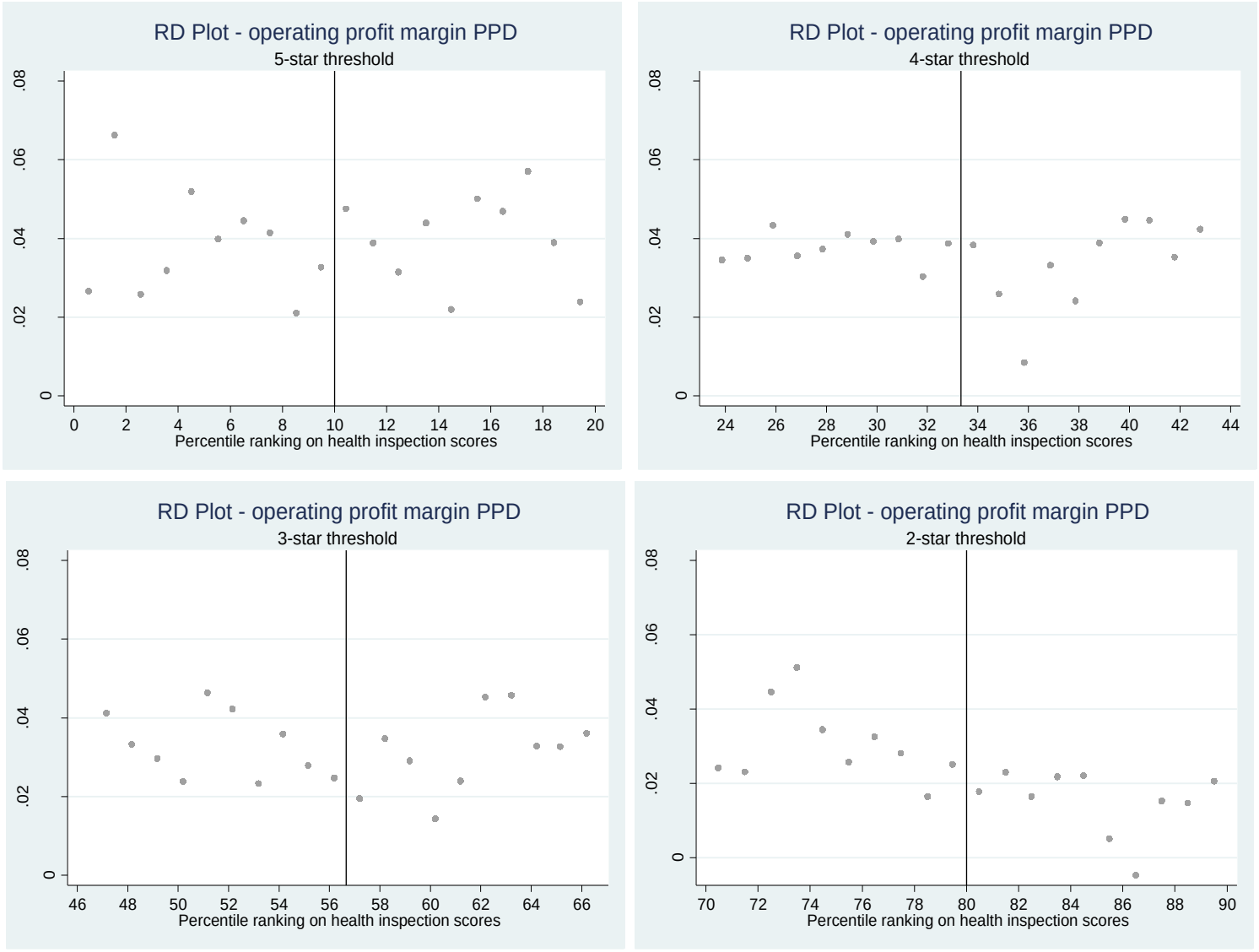
Notes: Each dot represents the sample average on operating revenue per patient day within each percentile based on health inspection scores. The vertical line represents the star threshold. All dollar amounts are CPI adjusted to 2014 dollars.

Figure A 3. RD plots - operating cost per patient day (based on simulated stars in 2007)



Notes: Each dot represents the sample average on operating expense per patient day within each percentile based on health inspection scores. The vertical line represents the star threshold. All dollar amounts are CPI adjusted to 2014 dollars.

Figure A 4. RD plots - operating profit margin per patient day (based on simulated stars in 2007)



Notes: Each dot represents the sample average on operating profit margin per patient day within each percentile based on health inspection scores. The vertical line represents the star threshold. All dollar amounts are CPI adjusted to 2014 dollars.

Table A 1. Characteristics of nursing homes 2008-2013

	Full Sample (all nursing homes)		Preferred Sample (health inspection star = overall star)	
	Mean	SD	Mean	SD
Health inspection rating	2.73	1.26	2.84	1.41
Operating revenue PPD	268.93	180.17	265.57	171.82
Operating cost PPD	263.31	183.20	259.97	175.67
Operating profit margin	0.02	0.08	0.02	0.08
% Medicare	14.98	11.33	14.89	11.02
% Medicaid	61.96	19.66	62.16	19.11
Occupancy rate	83.28	13.59	83.47	13.50
Chain-owned	0.59	0.49	0.59	0.49
For-profit	0.83	0.38	0.83	0.37
Number of beds	112.92	57.82	113.79	58.14
ADL index	16.31	2.78	16.32	2.74
Average age	80.23	6.15	80.28	6.01
% Female	69.39	11.28	69.65	11.07
% White	82.28	21.33	82.76	20.98
County HHI	1928.62	2330.96	1956.53	2341.86
Observations	49971		25667	

Nursing homes (1) located in AK, DC or HI or (2) owned by government or (3) hospital-based are excluded. Standard deviations are reported in parentheses.

Table A 2. RD results with alternative bandwidth selections – 5-star threshold

Alternative bandwidths in year t	Financial measures in year t+1			
	Log operating revenue PPD	Log operating cost PPD	Operating profit margin	N
2.5	0.059*	0.062*	-0.0025	1537
	(0.033)	(0.033)	(0.0092)	
3	0.058**	0.057**	0.0017	1830
	(0.028)	(0.028)	(0.0078)	
3.5	0.066**	0.060**	0.0063	2173
	(0.026)	(0.026)	(0.0069)	
4	0.055**	0.046*	0.0094	2503
	(0.025)	(0.025)	(0.0065)	
4.5	0.057**	0.049**	0.0088	2786
	(0.023)	(0.023)	(0.0062)	
5	0.051**	0.044**	0.0070	3162
	(0.022)	(0.022)	(0.0059)	
5.5	0.056***	0.051**	0.0056	3450
	(0.022)	(0.021)	(0.0056)	
6	0.051**	0.045**	0.0064	3825
	(0.021)	(0.021)	(0.0053)	
6.5	0.054***	0.048**	0.0069	4111
	(0.020)	(0.020)	(0.0051)	
7	0.059***	0.054***	0.0052	4424
	(0.020)	(0.019)	(0.0049)	
7.5	0.056***	0.050***	0.0056	4766
	(0.019)	(0.019)	(0.0047)	

Notes: All estimates use local linear regression. Standard errors are reported in parentheses. Nursing homes that are (1) owned by government or (2) hospital-affiliated or (3) located in AK, DC or HI are excluded. Standard errors are clustered at the nursing home level. Constant terms, covariates, year dummies and state fixed effects are estimated but not reported. Covariates include profit status, chain affiliation, bed size, ADL index and residents' demographic characteristics including age, gender and race. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table A 3 RD results with alternative bandwidth selections – 4-star threshold

Alternative bandwidths in year t	Financial measures in year t+1			
	Log operating revenue PPD	Log operating cost PPD	Operating profit margin	N
2.5	-0.039	-0.033	-0.0076	1150
	(0.035)	(0.035)	(0.010)	
3	-0.019	-0.0095	-0.011	1393
	(0.031)	(0.031)	(0.0085)	
3.5	-0.024	-0.017	-0.0068	1655
	(0.028)	(0.028)	(0.0078)	
4	-0.026	-0.025	-0.0016	1887
	(0.026)	(0.026)	(0.0074)	
4.5	-0.027	-0.025	-0.0018	2152
	(0.024)	(0.025)	(0.0070)	
5	-0.028	-0.031	0.0027	2368
	(0.023)	(0.024)	(0.0067)	
5.5	-0.017	-0.024	0.0071	2633
	(0.021)	(0.022)	(0.0063)	
6	-0.019	-0.025	0.0056	2856
	(0.020)	(0.020)	(0.0061)	
6.5	-0.020	-0.026	0.0059	3103
	(0.019)	(0.020)	(0.0058)	
7	-0.025	-0.030	0.0048	3341
	(0.019)	(0.019)	(0.0057)	
7.5	-0.015	-0.021	0.0058	3561
	(0.018)	(0.019)	(0.0055)	

Notes: All estimates use local linear regression. Standard errors are reported in parentheses. Nursing homes that are (1) owned by government or (2) hospital-affiliated or (3) located in AK, DC or HI are excluded. Standard errors are clustered at the nursing home level. Constant terms, covariates, year dummies and state fixed effects are estimated but not reported. Covariates include profit status, chain affiliation, bed size, ADL index and residents' demographic characteristics including age, gender and race. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table A 4. RD results with alternative bandwidth selections – 3-star threshold

Alternative bandwidths in year t	Financial measures in year t+1			
	Log operating revenue	Log operating cost	Operating profit margin	N
2.5	-0.0045	0.0058	-0.0096	907
	(0.029)	(0.029)	(0.010)	
3	0.022	0.024	-0.00096	1092
	(0.029)	(0.029)	(0.0095)	
3.5	0.015	0.022	-0.0067	1258
	(0.026)	(0.026)	(0.0089)	
4	0.015	0.021	-0.0055	1457
	(0.025)	(0.025)	(0.0084)	
4.5	-0.0013	0.0054	-0.0062	1625
	(0.024)	(0.024)	(0.0079)	
5	-0.0029	-0.00080	-0.0016	1806
	(0.023)	(0.023)	(0.0076)	
5.5	-0.0071	-0.0043	-0.0023	1991
	(0.022)	(0.022)	(0.0072)	
6	-0.0051	-0.00053	-0.0039	2187
	(0.021)	(0.021)	(0.0069)	
6.5	-0.00073	0.0026	-0.0027	2363
	(0.021)	(0.021)	(0.0066)	
7	-0.00037	0.0032	-0.0030	2577
	(0.020)	(0.020)	(0.0063)	
7.5	-0.0030	-0.00074	-0.0016	2797
	(0.019)	(0.019)	(0.0062)	

Notes: All estimates use local linear regression. Standard errors are reported in parentheses. Nursing homes that are (1) owned by government or (2) hospital-affiliated or (3) located in AK, DC or HI are excluded. Standard errors are clustered at the nursing home level. Constant terms, covariates, year dummies and state fixed effects are estimated but not reported. Covariates include profit status, chain affiliation, bed size, ADL index and residents' demographic characteristics including age, gender and race. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table A 5. RD results with alternative bandwidth selections – 2-star threshold

Alternative bandwidths in year t	Financial measures in year t+1			
	Log operating revenue	Log operating cost	Operating profit margin	N
2.5	0.015	0.015	0.000082	1255
	(0.022)	(0.021)	(0.010)	
3	0.017	0.021	-0.0034	1512
	(0.020)	(0.020)	(0.0092)	
3.5	0.011	0.018	-0.0077	1782
	(0.019)	(0.019)	(0.0084)	
4	0.022	0.030*	-0.0084	2038
	(0.018)	(0.018)	(0.0077)	
4.5	0.028*	0.032*	-0.0045	2323
	(0.017)	(0.017)	(0.0072)	
5	0.034**	0.039**	-0.0052	2573
	(0.016)	(0.016)	(0.0068)	
5.5	0.033**	0.040**	-0.0066	2844
	(0.016)	(0.016)	(0.0065)	
6	0.031**	0.038**	-0.0065	3097
	(0.016)	(0.016)	(0.0062)	
6.5	0.027*	0.034**	-0.0066	3392
	(0.015)	(0.015)	(0.0059)	
7	0.027*	0.031**	-0.0037	3652
	(0.014)	(0.014)	(0.0057)	
7.5	0.028**	0.032**	-0.0034	3940
	(0.014)	(0.014)	(0.0055)	

Notes: All estimates use local linear regression. Standard errors are reported in parentheses. Nursing homes that are (1) owned by government or (2) hospital-affiliated or (3) located in AK, DC or HI are excluded. Standard errors are clustered at the nursing home level. Constant terms, covariates, year dummies and state fixed effects are estimated but not reported. Covariates include profit status, chain affiliation, bed size, ADL index and residents' demographic characteristics including age, gender and race. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table A 6. Main RD results with MSE-optimal bandwidth selection

Threshold in year t	Financial measures in year t+1			MSE-optimal bandwidth	N
	Log operating revenue PPD	Log operating cost PPD	Operating profit margin PPD		
5 stars	0.052**	0.045**	0.0068	4.938	3136
	(0.022)	(0.022)	(0.0059)		
4 stars	-0.022	-0.029	0.0068	6.299	3011
	(0.020)	(0.020)	(0.0059)		
3 stars	-0.0068	-0.0047	-0.0016	5.278	1903
	(0.022)	(0.022)	(0.0073)		
2 stars	0.035**	0.041**	-0.0064	5.614	2899
	(0.016)	(0.016)	(0.0064)		

Notes: The sample is limited to nursing homes with health inspection scores within the MSE-optimal bandwidth around each star threshold. All estimates use local linear regression. Standard errors are reported in parentheses. Nursing homes that are (1) owned by government or (2) hospital-affiliated or (3) located in AK, DC or HI are excluded. Standard errors are clustered at the nursing home level. Constant terms, covariates, year dummies and state fixed effects are estimated but not reported. Covariates include profit status, chain affiliation, bed size, ADL index and residents' demographic characteristics including age, gender and race. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table A 7 Comparison of RD estimates between different functional forms (5-star threshold)

Functional forms	(1)	(2)	(3)	
	Log operating revenue PPD	Log operating cost PPD	Operating profit margin	N
No covariates	0.057**	0.050**	0.0074	3296
	(0.024)	(0.025)	(0.0061)	
Linear	0.051**	0.044**	0.0070	3162
	(0.022)	(0.022)	(0.0059)	
Quadratic	0.065**	0.061*	0.0054	3162
	(0.033)	(0.033)	(0.0093)	
Cubic	0.063**	0.055*	0.0082	3162
	(0.028)	(0.028)	(0.0069)	

Notes: All estimates use a bandwidth of 5 percentile points around the score threshold of each star. Standard errors are reported in parentheses. Nursing homes that are (1) owned by government or (2) hospital-affiliated or (3) located in AK, DC or HI are excluded. Standard errors are clustered at the nursing home level. Constant terms, year dummies and state fixed effects are estimated but not reported. Covariates include profit status, chain affiliation, bed size, ADL index and residents' demographic characteristics including age, gender and race. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table A 8 Comparison of RD estimates between different functional forms (4-star threshold)

Functional forms	(1)	(2)	(3)	
	Log operating revenue PPD	Log operating cost PPD	Operating profit margin	N
No covariates	-0.029	-0.030	0.0010	2450
	(0.024)	(0.025)	(0.0067)	
Linear	-0.028	-0.031	0.0027	2368
	(0.023)	(0.024)	(0.0067)	
Quadratic	-0.034	-0.016	-0.019*	2368
	(0.035)	(0.035)	(0.0098)	
Cubic	-0.033	-0.034	-0.00043	2368
	(0.027)	(0.027)	(0.0075)	

Notes: All estimates use a bandwidth of 5 percentile points around the score threshold of each star. Standard errors are reported in parentheses. Nursing homes that are (1) owned by government or (2) hospital-affiliated or (3) located in AK, DC or HI are excluded. Standard errors are clustered at the nursing home level. Constant terms, year dummies and state fixed effects are estimated but not reported. Covariates include profit status, chain affiliation, bed size, ADL index and residents' demographic characteristics including age, gender and race. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table A 9 Comparison of RD estimates between different functional forms (3-star threshold)

Functional forms	(1)	(2)	(3)	
	Log operating revenue PPD	Log operating cost PPD	Operating profit margin	N
No covariates	0.0081	0.0083	0.00020	1870
	(0.024)	(0.023)	(0.0077)	
Linear	-0.0029	-0.00080	-0.0016	1806
	(0.023)	(0.023)	(0.0076)	
Quadratic	0.024	0.033	-0.0089	1806
	(0.031)	(0.031)	(0.011)	
Cubic	0.022	0.026	-0.0028	1806
	(0.027)	(0.027)	(0.0089)	

Notes: All estimates use a bandwidth of 5 percentile points around the score threshold of each star. Standard errors are reported in parentheses. Nursing homes that are (1) owned by government or (2) hospital-affiliated or (3) located in AK, DC or HI are excluded. Standard errors are clustered at the nursing home level. Constant terms, year dummies and state fixed effects are estimated but not reported. Covariates include profit status, chain affiliation, bed size, ADL index and residents' demographic characteristics including age, gender and race. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table A 10. Comparison of RD estimates between different functional forms (2-star threshold)

Functional forms	(1) Log operating revenue PPD	(2) Log operating cost PPD	(3) Operating profit margin	N
No covariates	0.031*	0.034**	-0.0031	2664
	(0.017)	(0.017)	(0.0069)	
Linear	0.034**	0.039**	-0.0052	2573
	(0.016)	(0.016)	(0.0068)	
Quadratic	0.033**	0.038**	-0.0051	2573
	(0.016)	(0.016)	(0.0068)	
Cubic	0.012	0.011	0.0019	2573
	(0.031)	(0.031)	(0.015)	

Notes: All estimates use a bandwidth of 5 percentile points around the score threshold of each star. Standard errors are reported in parentheses. Nursing homes that are (1) owned by government or (2) hospital-affiliated or (3) located in AK, DC or HI are excluded. Standard errors are clustered at the nursing home level. Constant terms, year dummies and state fixed effects are estimated but not reported. Covariates include profit status, chain affiliation, bed size, ADL index and residents' demographic characteristics including age, gender and race. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table A 11. RD estimates on baseline covariates

Threshold in year t	Baseline covariates in year t+1							
	Bed size	For-profit	Chain-owned	ADL index	Age	% Female	% White	N
5 stars	5.68	-0.025	0.013	-0.19	-0.37	-1.05	-0.17	3162
	(3.88)	(0.030)	(0.036)	(0.17)	(0.36)	(0.72)	(1.29)	
4 stars	-3.92	-0.0028	0.0062	0.058	0.90*	1.25	2.26	2368
	(4.95)	(0.032)	(0.042)	(0.19)	(0.47)	(0.91)	(1.65)	
3 stars	7.18	0.0032	-0.020	0.082	0.13	0.24	-1.19	1806
	(4.75)	(0.031)	(0.044)	(0.21)	(0.53)	(1.07)	(1.87)	
2 stars	1.12	-0.015	0.043	-0.29	-0.060	-0.23	0.033	2573
	(4.51)	(0.024)	(0.036)	(0.18)	(0.44)	(0.86)	(1.61)	

Notes: The sample is limited to nursing homes with health inspection scores within 5 percentile points around each star threshold. All estimates use local linear regression. Standard errors are reported in parentheses. Nursing homes that are (1) owned by government or (2) hospital-affiliated or (3) located in AK, DC or HI are excluded. Standard errors are clustered at the nursing home level. Constant terms, year dummies and state fixed effects are estimated but not reported. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table A 12. Main RD results using 2007 simulated ratings

Threshold in 2007	Financial measures in 2008			
	Log operating revenue	Log operating cost	Operating profit margin	N
5 stars	-0.011	0.015	-0.026**	647
	(0.055)	(0.056)	(0.012)	
4 stars	-0.034	-0.037	0.0033	794
	(0.044)	(0.043)	(0.012)	
3 stars	0.034	0.036	-0.0026	867
	(0.036)	(0.036)	(0.011)	
2 stars	0.045	0.038	0.0083	875
	(0.036)	(0.037)	(0.011)	

Notes: The sample is limited to nursing homes with health inspection scores within 5 percentile points around each star threshold. All estimates use local linear regression. Standard errors are reported in parentheses. Nursing homes that are (1) owned by government or (2) hospital-affiliated or (3) located in AK, DC or HI are excluded. Standard errors are clustered at the nursing home level. Constant terms, covariates, year dummies and state fixed effects are estimated but not reported. Covariates include profit status, chain affiliation, bed size, ADL index and residents' demographic characteristics including age, gender and race. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Chapter 2 The effects of chain acquisitions on practice patterns: Evidence from the nursing home industry

2.1 Introduction

Medicare covers post-acute care such as skilled nursing care and therapy services for qualifying beneficiaries admitted to nursing homes. As of 2015, about 1.7 million Medicare fee-for-service beneficiaries received skilled nursing services and Medicare paid approximately $29.8 billion for these services (Medicare Payment Advisory Commission, 2017). Currently, the Centers for Medicare and Medicaid Services (CMS) uses a Prospective Payment System (PPS) to pay for Medicare-eligible skilled nursing services. By design, the Medicare PPS for nursing homes rewards high intensity care.

In particular, it is well documented that nursing homes have been exploiting this reimbursement method by putting more residents into the more profitable reimbursement categories, even though patient characteristics did not change much. For example, from 2010 to 2015, the Office of Inspector General (OIG) of the U.S. Department of Health and Human Services published a series of reports (OIG, 2010; OIG, 2012; OIG, 2015) documenting the increasingly aggressive billing practice patterns by nursing homes during the 2000s. In August 2015, the Wall Street Journal (Weaver et al., 2015) published a story describing how the Medicare PPS incentivizes nursing homes to pursue excessive amounts of therapies for residents to get higher payment rates. Shortly after that, another report published in the New York Times (Pear, 2015) also focused on the issue of nursing homes billing for more therapy than patients need, citing findings from the aforementioned OIG reports. “The current payment system created

an incentive for nursing homes to provide as much therapy to a resident as that resident can tolerate" said a CMS official (Pear, 2015).

Anecdotal speculations such as media reports or lawsuits suggest that large for-profit nursing home chains might systematically game the system (Weaver et al., 2015; Pear, 2015; Department of Justice, 2016a; Department of Justice, 2016b). In the past two decades, chains, defined as owning two or more facilities, have played an increasingly important role in shaping the nursing home industry, similar to their increasing presence in other industries within the healthcare sector (Cuellar and Gertler, 2005; Pozniak et al., 2010; Stevenson et al., 2015; Huang and Kim, 2017). Focusing on nursing homes, a recent study (Grabowski et al., 2016) documented tremendous chain-related ownership changes that occurred in the past two decades. Because more than 50% of the nursing homes in the United States are owned by chains, the potential impacts of chains on quality of care (Harrington et al., 2001; Banaszak-Holl et al., 2002), nurse staffing (Harrington et al., 2012) and nursing homes' financial health (Weech-Maldonado et al., 2012; Cadigan et al., 2015) have been concerns for policymakers and researchers alike.

However, empirical evidence on whether chain affiliation affects the practice patterns of nursing homes have been relatively sparse. This study aims to fill this gap in the literature. More specifically, I use national nursing home data from 2003 to 2009 to compare relevant practice patterns between independent nursing homes and their chain-acquired counterparts. Furthermore, I explore the possible heterogeneous effects depending on profit status and chain size of the acquiring chains.

2.2 Background

2.2.1 Nursing homes in the United States

In the United States, there are about 15,600 nursing homes serving roughly 1.4 million elderly on any given day (National Center for Health Statistics, 2015). Expenditures on nursing facilities across the country were about $160 billion in 2014 and projected to reach $270 billion in 2023 (Centers for Medicare and Medicaid Services, 2014). Medicare and Medicaid together pay nearly 80% of the total nursing home costs, while out-of-pocket payments account for the rest (Kaiser Family Foundation, 2013). Typically, Medicaid – the largest payer for nursing home services – pays for long-term stays, while Medicare – the more generous payer compared to Medicaid – pays for services related to short-term stays such as post-acute care. The nursing home industry is mixed in terms of profit status and chain membership of the facilities. Based on the data used in this study, about two thirds of the nursing homes are for-profit facilities. Corporate chains have become an important organization form in the nursing home industry. The proportion of chain-affiliated nursing homes grew steadily from less than 40% in early 1990s to over 50% in early 2000s (Banaszak-Holl et al., 2002). Since then, chain-owned nursing homes consistently account for more than 50% of the nursing homes in the United States each year (Grabowski et al., 2016). The quality of care in nursing homes has been characterized as being low for a long time (Institute of Medicine, 1986). In addition, the public image of nursing home industry is jeopardized by issues such as financial fraud (Department of Justice, 2016a; Department of Justice, 2016b), high staffing turnover rate (Castle and Engberg, 2005) and increasingly complex corporation structure (Stevenson et al., 2013; Harrington et al., 2015).

2.2.2 Medicare PPS

Medicare Part A covers post-acute short-term stays for elderly patients in the nursing homes for up to 100 days. The covered services include skilled nursing care, rehabilitation and other services. To be eligible for Medicare Part A benefits, the beneficiary must be admitted to a nursing home within one month following a qualifying hospital stay and must require skilled nursing services related to her/his hospital stay on a daily basis. The qualifying beneficiary does not have out-of-pocket payment for the first 20 days of the stay. Then, from days 21 up to 100, the copayment is about $164.50 per day (Medicare Payment Advisory Commission, 2017).

Prior to 1998, Medicare used a cost-based reimbursement method for eligible nursing homes services. Under that scheme, providers were reimbursed based on actual costs of care and thus had little incentive to control costs or improve efficiency. For example, ancillary services such as physical and occupational therapies were subject to little review of use by CMS, then known as the Health Care Financing Administration. Between 1989 and 1996, the number of Medicare beneficiaries in nursing homes almost doubled from 636,000 to 1.1 million. The average Medicare nursing home payment per day increased drastically from $98 in 1990 to $292 in 1996. The rapid growth of Medicare expenditure for skilled nursing care eventually led to the major payment reform in July 1998.

In 1998, Medicare changed its reimbursement for nursing home services from a cost-based approach to the PPS with the main objective being to incentivize providers to improve their operational efficiency. Specifically, instead of paying for nursing home services based on actual costs, the Medicare PPS pays a fixed amount for each day of nursing home service adjusting for case mix and types of services using the Resource Utilization Group (RUG) system, regardless actual expenses incurred. Upon admission to nursing homes, residents are classified into a

variety RUGs based on their care and resource needs during a seven-day assessment period. This classification method is used to determine how much Medicare pays the nursing homes each day.

As of 2009, there were 53 RUGs within eight categories including both therapy and non-therapy RUGs. Therapy RUGs are for residents who need physical, speech or occupational therapies while non-therapy RUGs are for beneficiaries who need skilled nursing care other than therapy services. Based on the number of therapy minutes incurred and the degree of functional limitations of the patient, therapy RUGs are categorized into five levels: ultra high, very high, high, medium and low. In general, the greater the minutes of therapy, the higher level of therapy RUG is assigned.

Each year, CMS updates the base payment rates using a market-basket index to reflect fluctuation in prices of goods and services. Typically, Medicare payment rates for therapy RUGs are higher than for non-therapy RUGs. Moreover, the reimbursement rate increases with the assigned level of RUGs from low through ultra high. Table 2.1 shows the average Medicare payment rates, costs, average profits, and marginal profits of the therapy-component by level of therapy for nursing homes in 2012. For example, according to the OIG report published in 2015 (OIG, 2015), the average payment of the therapy-component associated with ultra high RUGs was $231 in FY2012 while the average rates of the therapy-component for medium or low therapy RUGs were only $67 and $37, respectively. Because the average marginal profits monotonically increase when categorizing a patient from a lower level to a higher level of therapy category, the Medicare PPS for nursing homes creates a strong financial incentive to more aggressively bill for higher therapy levels.

To some extent, the Medicare PPS for nursing home services is not a true prospective system. First, unlike the diagnosis-related group system in the hospital industry or the episode-

based system for home health services, Medicare PPS pays nursing homes on a daily basis. Second, the payment rate largely depends on the minutes of therapy provided to the resident over a seven-day look-back period. Although CMS implemented several measures to prevent fraud, reduce waste and monitor payment accuracy, clear clinical guidelines in determining the appropriate therapy minutes and treatment intensity for residents are still lacking. As a result, nursing homes have some control of both the intensity level of the therapy and length of stay — both of which determine the amount of Medicare payment nursing homes will receive for providing these services.

2.3 Prior studies

A majority of the relevant studies focused on the evaluation of the Medicare PPS by comparing nursing home performance before and after the policy changes. Using a study sample of residents admitted to nursing homes in Michigan and Ohio in 1998 and 1999, Wodchis (2004) found the introduction of Medicare PPS in 1998 was associated with increased likelihood for patients being assigned to the most profitable RUGs. Furthermore, Wodchis et al. (2004) concluded that Medicare PPS for skilled nursing facilities (SNFs) reduced the relative risk of discharge to home and to death for Medicare residents, compared to non-Medicare residents. White (2005) found that nurse staffing levels dropped significantly after the PPS implementation and the effect was stronger among for-profit nursing homes. He did not find a significant association between PPS and quality of care. Grabowski et al. (2011) found that Medicare PPS led to a significant increase in both rehabilitative services and therapy minutes but no change in length of stay. Bowblis and Brunt (2014) suggested that nursing homes upcoded residents by putting a greater proportion of the patients into the RUGs with higher reimbursement rates through providing additional therapy minutes. In a more recent work, Bowblis et al. (2016)

found that not-for-profit nursing homes are less likely to engage in upcoding behaviors than their for-profit counterparts. Furthermore, they found the difference varies depending on the for-profits' market share. Jung et al. (2016) found that more therapy hours in nursing homes after the PPS appeared to improve outcomes, except for patients with the greatest need. Examining the similar up-coding issue in the home health industry, Kim and Norton (2015) found that entrants in the home health market were more likely to adopt strategic practice patterns to maximize their profits than were incumbents. Kim and Norton (2017) also found that for-profit home health agencies were more likely to adopt strategic practice patterns than were not-for-profits. Huang and Kim (2017) found chain-owned home health agencies, especially for-profit chains, are more likely to target a specific number of therapy visits to maximize their profits, compared to independent agencies. In the hospital setting, Koch et al. (2017) found that physicians who were acquired by health systems were more likely to deliver care in their acquiring system's hospitals.

2.4 Theoretical framework

2.4.1 Profit status

Nursing home industry is a mixed-ownership industry including both for-profit and not-for-profit nursing homes (Hirth, 1999; Norton, 2000; Grabowski and Hirth, 2003). Economic theories suggest that for-profit nursing homes maximize their profits by setting price, quality and quantity of services at an optimal level where their marginal revenues equal marginal costs (Norton, 2000; Sloan, 2000). Driven by their organizational objectives, for-profit nursing homes distribute their profits to shareholders. Unlike their for-profit counterparts, not-for-profit nursing homes do not necessarily pursue the goal of profit maximization. They are not allowed to distribute their profits to shareholders. In addition, not-for-profit nursing homes typically enjoy several tax-related benefits such as exemption from corporate income and property taxes. In

return, not-for-profits must serve a public good. Therefore, not-for-profit nursing homes may use generated profits to reinvest into areas such as facility renovation and quality improvement. Because not-for-profit nursing homes do not serve for shareholders' interests, they may have greater incentives to improve quality (Hansmann, 1980; Hirth, 1999; Sloan, 2000). In the context of financial incentives of putting more residents into more profitable RUGs, not-for-profits might focus more on providing optimal and appropriate care than for-profits. On the other hand, for-profits could be more incentivized to provide more unnecessary but lucrative services.

2.4.2 Chain affiliation

Because a majority of nursing home chains are for-profit organizations, profit maximization is their top priority. With pressure from their stakeholders (Kitchener et al., 2008), chains might face stronger incentives to seek and exploit aggressive billing behaviors than independent nursing homes. Theoretically, corporate owners could use standardization as a universal process to streamline administrative and clinical processes across facilities within the chains (Banaszak-Holl et al., 2002; Kamimura et al., 2007). Such standardization strategy could reduce managerial costs and ease resource dependencies. For example, standardization within nursing home chains could be implemented in areas such as service provision and staffing levels and mix. Typically, operational targets of many chain-owned nursing homes are set at the corporate level. Therefore, chaining would facilitate knowledge learning and sharing between facilities. In addition, chain size could also play an important role. Compared to smaller chains or independent nursing homes, large chains have more resources, capacity and economic of scales in achieving information sharing, standardization and knowledge transferring (Banaszak-Holl et al., 2002; Pozniak et al., 2010).

From the strategic perspective, it is possible for chains to form a culture to pursue profits by systematically exploiting more lucrative therapy reimbursement codes. Indeed, in some high-profile Medicare fraud lawsuit cases, the Department of Justice alleged the nursing home chains that they "had a corporate strategy to maximize the daily minutes and the number of days it billed to Medicare at the 'ultra high level' of therapy" (Department of Justice, 2016a), and that they "created a corporate culture that improperly incentivized therapists and others to increase the amount of therapy provided to patients to meet planned targets for Medicare revenue" (Department of Justice, 2013).

Nursing homes can provide therapy services through (1) their own staff therapists or (2) outsourcing to special therapy services companies. Compared to independent facilities, chains are more likely to have in-house therapists or to have bigger leveraging power if they hire therapy companies or to even own therapy services companies. Having more control in the provision of therapy services by having their own therapy service operations, chains could put pressure on therapists to maximize their therapy services billings.

The plausible mechanisms stated above suggest chain-owned nursing homes are more likely to have a systematic scheme to strategically exploit Medicare reimbursement on therapy services. However, the relationship between chain affiliation and aggressive billing behaviors could be more complicated than suggested. For example, chains need to consider the risks of strict regulatory monitoring, media and public scrutiny, as well as possible litigation or loss of certifications from government payment programs. Furthermore, nursing home chains generally do not have a good reputation because of extensive negative reports. They might not want to further damage their reputations by gaming the payment system. In addition, providing highly intensive therapy services requires a certain number of therapists. Putting pressure on therapists

to provide additional and unnecessary therapy services to meet the thresholds of RUG codes with higher reimbursement rates could (1) jeopardize the relationship between therapists and nursing homes and (2) put the therapist's license at risk. Given the fact that nursing home chains do not have a very good reputation in general, chains could be more cautious in exploiting the Medicare reimbursement scheme.

Therefore, although some theoretical arguments suggest chain-owned nursing homes are more likely to be involved in aggressive billing behaviors, a few caveats might limit the extent to which chains would exploit the Medicare reimbursement scheme.

2.5 Hypotheses

To sum up, the Medicare PPS creates financial incentives for nursing homes at two dimensions. In terms of the reimbursement scheme, both the Medicare per diem's average and marginal profits are considerably higher for high-intensity therapy RUGs than for lower-intensity RUGs. The lack of clarity in explaining clinical guidelines for therapy minutes creates financial incentives for nursing homes to pursue a more aggressive billing strategy by putting more residents into the more profitable RUGs.

In terms of a nursing home stay, because Medicare PPS reimburses skilled nursing services at a per diem rate, not based upon an episode or a stay, it creates another incentive for nursing homes to increase the length of stay for Medicare beneficiaries. However, this incentive faces at least two challenges. First, if nursing homes provide residents with more intensive therapy services per week, the length of stay could be shortened due to the increase in treatment intensity, assuming these services are effective. Second, the copayment for Medicare beneficiaries starts to kick in after the first 20 days of stay. Therefore, nursing home residents would bear additional financial burden if their lengths of stay increase. In addition, from a

broader perspective, another incentive for nursing homes to keep the length of stay short is the recent initiatives such as pay-for-performance (Ryan et al., 2015) and Hospital Value-based Purchasing Program (Norton et al., 2018), which encourage the care coordination between hospitals and post-acute care providers.

The differences in organizational form and objective could lead to heterogeneous responses between independent and chain-owned nursing homes. Although chains have strong incentives to strategically exploit Medicare reimbursement scheme on therapy RUGs, they also face risks such as stricter public scrutiny or damages to their reputations, which might limit the extent to which strategic billing practices could be implemented.

In this study, I examine the practice patterns by focusing on both the change in distribution of RUG Medicare days (e.g., % ultra high RUG days, % very high RUG days, etc.) and the overall therapy-related profits within a nursing home over time. This way, I can explore any shifts among RUG distribution or changes in profits due to a change in chain ownership. Therefore, the following hypotheses related to practice patterns are proposed.

Hypothesis 1. With a few caveats, chain-owned nursing homes are more likely to put more residents into RUGs with higher reimbursement rates, and to generate higher profits.

Hypothesis 2. Any effect of chain ownership on strategic practice patterns is stronger in for-profit chains than in not-for-profit chains.

Hypothesis 3. Any effect of chain ownership on strategic practice patterns is stronger in larger chains than in smaller chains.

Hypothesis 4. The chain effect on length of stay for Medicare beneficiaries in nursing homes is ambiguous.

2.6 Empirical strategy

2.6.1 General model

To compare changes in practice patterns between chain-owned and independent nursing homes, I track each nursing home over time and take advantage of changes in chain ownership (e.g., chain acquisition of independent nursing homes) within each facility due to acquisitions. More specifically, to explore the effects of chain acquisition of independent nursing homes on their practice patterns (Hypotheses 1 and 4), I estimate a Difference-in-Differences (DID) model in which the pre-post changes in practice patterns for independent nursing homes that were acquired by chains and the pre-post changes in practice patterns for independent nursing homes that did not experience acquisition are compared. More specifically, in this event study setting, I estimate regression models including a chain acquisition indicator, a vector of time-varying nursing home structural characteristics, the nursing home fixed effects and year dummies. The model specification is described below:

$$Y_{it} = \beta_1 Chain_{it} + \gamma X_{it} + \theta_i + \lambda_t + \varepsilon_{it} \qquad (1)$$

where Y_{it} is the measure for practice patterns (either the change in proportion of different types of RUG days and overall therapy related profits for Hypothesis 1 or the change in Medicare length of stay for Hypothesis 4) of nursing home i at year t, X_{it} is a set of time-varying nursing home characteristics, θ_i is the nursing home fixed effect, λ_t are a series of year dummies, and ε_{it} is the random error term for nursing home i at year t. The main explanatory variable $Chain_{it}$ is an indicator of post chain acquisition for nursing home i at year t. To test Hypotheses 1 and 4, β_1 is the coefficient of interest, measuring the average changes in practice patterns associated with chain acquisitions. Because each nursing home has multiple observations across the study period, standard errors are clustered at the facility level and adjusted for heteroskadasticity.

When examining the effect of chain acquisitions on changes in the distribution of different types of RUG days, the dependent variables are the proportions of Medicare days billed at different RUG categories, respectively. Specifically, they include proportions of ultra high, very high, high, medium, and non-therapy RUG days. Each of them is fit using the ordinary least squares. I do not examine low RUG days in this study because this type is rare, only accounting for less than 1% of total Medicare days.

In addition, to examine the change in overall therapy-related profitability due to chain affiliation, I construct a single composite index of therapy profitability to measure the overall profit per resident day of the therapy-component for each nursing home. More specifically, using the profit information presented in Table 2.1, the overall therapy-component profit is a weighted average measure taking account of the profit per resident day and the proportion of Medicare days associated with each type of therapy RUGs. The formula is shown below:

$$Overall\ therapy\ profit\ per\ resident\ day_i = \sum_{j=1}^{5} (Average\ therapy\ profit\ per\ resident\ day_{ij} \times proportion\ of\ Medicare\ days_{ij})$$

where *j* indexes each of the five RUG categories ranging from ultra high to low RUGs for nursing home *i* in a given year.

To control for other factors that might affect the practice patterns for nursing homes, I include a set of time-varying vector of nursing home characteristics, X_{it}, containing profit status, number of beds, occupancy rate, payer mix, demographic characteristics and activities of daily living (ADL) index; a set of staffing measures including Registered Nurse (RN) hours per resident day, Licensed Practical Nurse (LPN) hours per resident day, Certified Nurse Aide

(CNA) hours per resident day, Physical Therapist hours per resident day and Occupational Therapist hours per resident day. In addition, the Herfindahl-Hirschman Index (HHI) based on the number of beds of each nursing home is included to control for market competition within each county. Suggested by Hirth et al. (2017), the HHI is adjusted for common ownership for nursing homes within a county.

To test Hypothesis 2 on the heterogeneities by profit status of acquiring chains, I use the same identification strategy stated above by separating acquisitions by for-profit chains and not-for-profit chains. In addition, both for-profit acquisitions and not-for-profit acquisitions might increase intensity of therapy services but on different margins. For example, for-profit acquisitions may have stronger effects on the movement between very high RUGs and ultra high RUGs, while the not-for-profit acquisitions may be associated more with high RUGs to very high RUGs. To account for this possibility and to explicitly test the differences between these two types of acquisitions, I also use the overall therapy profitability index described above.

More specifically, model specification (2) is used to test Hypothesis 2. $FP\ Chain_{it}$ is an indicator of post acquisition by for-profit chains for nursing home i at year t, while $NFP\ Chain_{it}$ is the indicator of post acquisition by not-for-profit chains for nursing home i at year t. The control group contains independent nursing homes remaining independent throughout the study period. Accordingly, β_2 and β_3 are the coefficients of interest, respectively. I expect the magnitude and statistical significance of β_2 is larger than those of β_3.

$$Y_{it} = \beta_2 FP\ Chain_{it} + \beta_3 NFP\ Chain_{it} + \gamma X_{it} + \theta_i + \lambda_t + \varepsilon_{it} \qquad (2)$$

Similarly, to test Hypothesis 4, I focus on acquisitions by large, medium, and small chains. Model specification (3) is used to test possible heterogeneous effects of acquisitions of independent nursing homes varied by the size of acquiring chains. $LARGE\ Chain_{it}$ is an

indicator of post acquisition by large chains for nursing home i at year t, $MEDIUM\ Chain_{it}$ is the indicator of post acquisition by medium chains for nursing home i at year t, while $SMALL\ Chain_{it}$ is the indicator of post acquisition by small chains for nursing home i at year t. As the same with models (1) and (2), the control group here are independent nursing homes remaining independent throughout the study period. Accordingly, β_4, β_5, and β_6 are the coefficients of interest, respectively. I expect the magnitude and statistical significance of β_4 is the largest among these three coefficients.

$$Y_{i,t} = \beta_4 LARGE\ Chain_{it} + \beta_5 MEDIUM\ Chain_{it} + \beta_6 SMALL\ Chain_{it} + \gamma X_{it} + \theta_i + \lambda_t + \varepsilon_{it} \qquad (3)$$

2.6.2 Identification and Endogeneity

The identification assumption of the DID models stated above is that any systematic change in the practice pattern measures is captured by facility-level and county-level controls as well as year dummies. Therefore, any time-variant unobservable characteristics which could affect the RUGs distribution should not be associated with chain acquisitions. In addition, by including the nursing home fixed effects θ_i, I control for any time-invariant nursing home characteristics such as facility culture or management style which are unobserved in the data but could be correlated with practice patterns. In other words, the identification relies on within-facility variation in chain affiliation over time.

The main issue of these generalized DID models is the endogeneity of chain acquisitions. For example, chains' decisions on acquisitions may not be random and chains could target nursing homes with their practice patterns similar to those of chains. The relevant staffing levels such as number of hours spent by therapists with the residents are highly related to the distribution of RUG Medicare days and resulting profits. Having a certain level of expectation on

the distribution of RUGs for the potential target independent nursing homes could drive the chain's acquisition decision. In addition, unobserved factors such as the relationship between owner of the independent nursing home and acquiring chain's management team may also play an important role in acquisition decision. To address the endogeneity issue, I examine the effect of acquisitions on practice patterns over time by implementing a dynamic DID model with a set of pre- and post-acquisition year terms spanning from two years before acquisitions to two years after acquisitions.

2.6.3 Dynamic model

The objective of this alternative specification is to examine (1) whether there exists any pre-acquisition trend which could mask the true effect of acquisition itself and (2) whether the effect (if any) lasts even after the post-acquisition period. I expect to see no particular pre-acquisition trend in practice patterns. A delayed effect of acquisition on practice patterns is possible because it might take time to align the acquiring chain's objective and culture with newly acquired facilities'. More specifically, I estimate the dynamic DID model as follows:

$$Y_{it} = \sum_{-2 \le j \le 2} \beta_j Acquisition_{it+j} + \gamma X_{it} + \theta_i + \lambda_t + \varepsilon_{it} \qquad (4)$$

The model specification (4) is similar to previous specifications except that the simple post-acquisition indicator $Chain_{it}$ is replaced by a set of indicators measuring each year ranging from two years before acquisition to two years after acquisition. By interacting the treatment variable with year dummies, this dynamic model allows for any possible shifts in RUG categories to occur both before and after the chain acquisitions. For example, $Acquisition_{it+1}$ becomes 1 in the first year after acquisition and 0 otherwise. Similarly, $Acquisition_{it-1}$ is coded as 1 for the year before acquisition and 0 otherwise. The excluded reference category of this dynamic model is two or more years before acquisition.

2.7 Data

2.7.1 Datasets

The empirical analysis utilizes the facility-year level data drawn from nursing homes in the United States between 2003 and 2009. More specifically, the data comes from three sources: the Online Survey Certification and Reporting (OSCAR) system, Medicare Cost Reports (MCRs) for nursing homes and the LTC Focus. Although the Medicare PPS started in July 1998, there was a three-phase transition period during which nursing homes could be reimbursed using a mixed scheme combining cost-based and PPS approaches. According to the MCRs, year 2003 is the first year when all nursing homes started to report their RUG-specific Medicare days (Worksheet S-7). In addition, CMS recalibrated and decreased the Medicare payment rates for nursing homes in FY2010. Therefore, the study period is from 2003 to 2009.

Collected and administered by CMS, OSCAR, now known as the Certification and Survey Provider Enhanced Reporting (CASPER) system, is an online data system used by the government to determine if Medicare/Medicaid certified nursing homes are compliant with federal regulations. Every 9 to 15 months, on average 12 months, each federally certified nursing home receives an on-site inspection conducted by state agencies. The nursing homes in the OSCAR represent about 96% of the total nursing homes in the United States. A typical OSCAR survey includes information such as facility structural characteristics, staffing information and detailed inspection data. In this study, chain ownership information, profit status, number of beds, occupancy rate, ADL index and several staffing measures are extracted from the OSCAR. I also construct the chain-adjusted county HHI using the number of beds of each nursing home to reflect the competition level within each county market.

The information on practice patterns comes from the MCRs for nursing homes. Each Medicare-certified nursing home is required to submit its cost report to CMS annually. The report includes detailed information on Medicare days by each RUG as well as total Medicare days for each nursing home in a year (Worksheet S-7). I use this information to construct the proportion of Medicare days billed at different types of RUGs as one of the main dependent variables of interest. More specifically, based on the RUG categories presented in Table 2.1, I create five dependent variables: % ultra high RUG days, % very high RUG days, % high RUG days, % medium RUG days, and % non-therapy RUG days. In addition, to better compare heterogeneous effects by profit status or size of chains, I also use the information from Worksheet S-7 in the MCRs and the profit information based on the OIG report (OIG, 2015) presented in Table 2.1 to construct the single index of the overall therapy-component profit for each nursing home. Furthermore, to examine the effects of a change in chain ownership on length of stay, I extract the average length of stay of Medicare beneficiaries for each nursing home from MCRs (Worksheet S-3).

Nursing home residents' demographic characteristics including age, gender, and race are extracted from the LTC focus, which is a website maintained at Brown University. It gathers aggregated data from a variety of sources such as OSCAR and nursing home residents' assessment data.

2.7.2 Chain affiliation

The chain ownership and related transaction information is drawn from the OSCAR. There is a text field named "Name of Multi-Facility Organization" in which each nursing home self-reports its chain affiliation. However, the raw information from this field is subject to reporting issues such as typos, abbreviations and other potential inconsistencies over the years. To address

these issues, I use the chain variables that were re-coded by Grabowski et al. (2016) in which the authors made extensive efforts in cleaning the chain variables to improve the accuracy of the chain information. More specifically, the re-coding process tracked nursing homes over time using a line-by-line inspection. When inconsistencies or potential errors were detected for a nursing home over time, information such as company websites, financial disclosures, government reports, or media coverages were used to resolve the issues.

With the information available for both (1) whether a nursing home is owned by a chain and (2) by which chain a nursing home is owned, I further categorize the chains by size and profit status because different types of chains may implement heterogeneous strategies for acquired nursing homes after transactions. First, using the cleaned chain ownership identifiers, I categorize nursing homes into different sizes based on the number of facilities owned by each chain. Following the categorization by Grabowski et al. (2016), small chains are defined as organizations owning 2 to 10 nursing homes, medium chains are defined as organizations owning 11 to 29 facilities, while large chains are defined as owning 30 or more facilities in a given year. Second, based on the profit status of the majority facilities within the chain, I differentiate for-profit chains from not-for-profit chains.

2.7.3 Creation of analytical file

Information from OSCAR, MCRs and LTC Focus are linked using the unique federal provider number and year information. Nursing homes in District of Columbia, Alaska, Hawaii, Puerto Rico are excluded because the OSCAR data are not complete in these areas. In addition, hospital-based nursing homes are excluded because those facilities do not have independent cost reports and their cost information is embedded in the affiliated hospitals' cost reports. Furthermore, government-owned nursing homes are excluded because they often have very

different patient mix and severity compared to typical nursing homes. Nursing homes reporting fewer than 11 residents annually are dropped because LTC Focus is required by the CMS to suppress any relevant cells where the nursing home has fewer than 11 residents who have that characteristic.

The final analytical sample includes 13,452 unique nursing homes from 2003 to 2009. Of these nursing homes, 34.5% were always independent, 44.5% were always owned by chains, while about 21% experienced ownership changes between chains and independent. The proportion of independent nursing homes being acquired by chains and that of chain-owned nursing homes being divested and becoming independent again were similar. In addition, among the nursing homes that experienced chain acquisition events, 91.7% of independent nursing homes were acquired by chains just once, 8.1% of nursing homes had two acquisitions (e.g., first became a chain-owned facility, then being divested, but later re-joined a chain), and another 0.2% facilities had three acquisitions.

2.8 Results

Figure 2.1 shows the overall trend of different types of RUG days for all nursing homes in the sample from 2003 to 2009. The proportion of Medicare days associated with ultra high RUGs increased drastically from about 8% in 2003 to 33% in 2009. In contrast, both the proportions of Medicare days associated with high RUGs and non-therapy RUGs decreased by 20 and 14 percentage points during the same period, respectively. In addition, the proportion of very high RUG days increased slightly from about 22% to 26% while the proportion of medium RUG days fluctuated over time. During the study period, the average number of total Medicare days for a nursing home grew steadily from 4057 days in 2003 to 4725 days in 2009, as shown in Figure B1. Therefore, the significant shift towards ultra high RUG days was not only reflected in the

relative percentages but also the absolute number of Medicare days. Although differing in absolute values for each RUG type, this overall trend of shifts in distribution of different types of Medicare RUG days also applies to chain-owned and independent nursing homes as well as for-profit and not-for-profit nursing homes, shown in Figures B2 – B5.

The trend could be reasonable if other factors such as resident casemix or characteristics changed significantly. For example, if more sicker residents were admitted to nursing homes over the years, an increase in treatment intensity of therapy services should be expected. Therefore, I examine the trend of ADL index and demographic characteristics for nursing home residents over time to see if they are coincident with the change in the distribution of different RUG types. Table 2.2 shows that neither ADL index nor demographic characteristics for residents fluctuated much from 2003 to 2009 although the distribution of RUG groups changed dramatically. Therefore, the large industry-wide shift in the proportion of Medicare days across RUG types was likely to be driven by strategic decisions at the organizational level and to be less relevant to change in clinical factors at the resident level.

Because this study examines if chain affiliation affects facility practice patterns, I present information on chain activities in the nursing home industry in Tables 2.3 and 2.4-2.6. As stressed in previous sections, corporate chains play an important role in the nursing home industry. In the study sample, the proportion of chain-owned nursing homes slightly dropped from 58.8% in 2003 to 56.7% 2009[1]. Similarly, for-profit nursing homes consistently accounted for more than 76% of the total nursing homes each year in the sample. About 3% of the total

[1] Note that because government-owned or hospital affiliated nursing homes are excluded, the sample over-represents the proportion of chain-owned nursing homes, compared to the national sample, which is about 52% to 54% (Grabowski et al., 2016).

nursing homes were acquired by chains each year. On the other hand, each year, about 89% of the nursing homes were not involved in any chain ownership change. Another 8% of nursing homes were either divested from chains or switched from one chain to another. On average, as shown in Table 2.4, more than 85% of these acquisitions were pursued by for-profit chains. In terms of chain sizes, Table 2.5 shows that small chains accounted for more than 50% of the acquisitions, while large chains accounted for about 20% of the total acquisitions. To consider profit status and chain sizes together, Table 2.6 shows that for-profit small chains consistently accounted for the largest share of acquisitions from 2003 to 2009. In addition, for-profit large chains played an increasingly important role in acquisitions, ranging from 16.3% of the acquisitions in 2003 to 23.6% of the acquisitions in 2009.

Next, I compare the practice patterns between independent and chain-owned nursing homes from 2003 to 2009. The results are presented in Table 2.7. Both the proportions of ultra high RUG days and very high RUG days – two most intensive treatment categories, were significantly higher among chain-owned nursing homes, compared to those among independent nursing homes. Especially, the proportion of ultra high RUG days for chain-owned nursing homes was 20.6%, which was 4.6 percentage point higher than that for independent nursing homes. In contrast, the proportions of relatively less intensive RUG groups – high, medium, and low RUGs, were all lower among chain-owned nursing homes. The comparison in practice patterns was also consistent across each year during the study period. In particular, the gap in the proportion of ultra high RUG days between these two types of nursing homes increased over the study period as well.

As previously shown in Figure 2.1, the proportion of ultra high RUG days increased significantly from 2003 to 2009. Figures 2.2 and 2.3 confirm this trend again by looking at

ownership groups separately. To describe the heterogeneity of RUG days across ownership groups, Figures 2.2 and 2.3 compare the overall distribution of RUG days across four ownership groups in 2003 and 2009, respectively. More specifically, I categorize each nursing home based on its profit status and chain affiliation. Compared to other ownership types, for-profit chain-owned nursing homes had the highest proportions of ultra high RUG days but the lowest proportions of medium or high RUG days in both 2003 and 2009. In contrast, not-for-profit independent nursing homes consistently had the lowest proportion of ultra high RUG days but the highest proportions of high and medium RUG days. Regardless of chain affiliation, compared to their not-for-profit counterparts, for-profit nursing homes had higher proportions of ultra high RUG days and non-therapy RUG days but lower proportions in high or medium RUG days.

Table 2.8 presents the summary statistics at the baseline year 2003 for nursing homes that were ever acquired by any chain and independent nursing homes remaining independent over the study period. Compared to independent nursing homes without ownership changes, independent nursing homes that were subsequently acquired by chains were more likely to be for-profit entities at the baseline. In addition, these acquired nursing homes generally had fewer beds and lower occupancy rate but slightly higher proportion of Medicare residents in 2003. In terms of staffing level, acquired nursing homes had slightly fewer RN or CNA hours per resident day while had higher LPN hours per resident day. Therapy staffing levels were about the same between two groups. Furthermore, both acquired and independent nursing homes had residents with similar ADL index. The acquired nursing homes had slightly younger and fewer female residents.

Next, I show a set of pre-acquisition trends for each variable between acquired nursing homes and independent nursing homes. The detailed graphics are shown in Figures B6 – B9. Most of the variables do not show any particular pre-acquisition trend between these two groups of nursing homes. A few exceptions are ADL index, % Medicaid residents, Physical Therapist hour per resident day, and Occupational Therapist per resident day.

In addition to the informal visual inspection of the pre-acquisition trends for the treatment and control groups, I also empirically conduct a more formal test by interacting the acquisition indicator with year dummies. Essentially, these tests use the same dynamic model as shown in Equation (4) by replacing the practice pattern variables with a variety of independent variables shown in Figures B6-B9. If the trends between acquired and independent nursing homes are the same, then coefficients of t-2 and t-1 should be insignificant, i.e. the difference in differences is not significantly different between the acquired and independent nursing homes in the pre-acquisition period. These formal empirical tests yields similar results to the visual inspections. The detailed results are reported in Table B1. In general, most of the variables show similar trends between acquired and independent nursing homes. However, there exists some caveats in a few variables such as ADL index and payer mix which suggest some differences between the two groups, although not being statistically significant.

Table 2.9 shows the estimation results of changes in RUG distributions from the main DID model controlling for facility characteristics, competition at the county level, facility fixed effects and year dummies. Columns represent separate regressions on the proportion of each type of RUG days, except for low RUGs. Compared to independent nursing homes with no ownership change, chain acquisitions of independent nursing homes were associated with about 2.92 percentage points ($p < 0.01$) increase in the proportion of ultra high RUG Medicare days.

Throughout the study period, the average proportion of ultra high RUG days was around 15.8 percent. Therefore, the coefficient of acquisition on increase in the % ultra high RUG days is not only statistically significant but also economically meaningful. In contrast, the proportions of very high RUGs, high RUGs and non-therapy RUGs are all negatively associated with chain acquisitions, with statistically significant magnitudes of -1.63, -0.94 and -0.91 percentage points. These shifts in the distribution of RUG Medicare days translate to a significant increase in the therapy-specific profit per resident day. More specifically, chain acquisition of independent nursing homes is associated with an increase of about 1 in the therapy add-on profitability index and it is statistically significant at 0.01 level.

As a robustness check, I exclude a few facility-level variables such as staffing measures or ADL index which may be endogenous to practice patterns of nursing homes in an alternative specification but the coefficient of the acquisition barely changes. The results suggest that chain acquisitions of independent nursing homes shift the distribution of the RUG categories towards the most intensive category and away from the less intensive RUG categories.

Next, I examine the role of profit status of the acquiring chains in affecting practice patterns of acquired nursing homes. As stated in Hypothesis 3, I expect to see a larger effect of acquisition if the acquiring chain is for profit. Table 2.10 shows the results. Not surprisingly, the overall effect of chain acquisitions on the proportion of ultra high RUG days is mainly through for-profit chain acquisitions. More specifically, for-profit chain acquisitions of independent nursing homes are associated with 3.6 percentage point increase in the proportion of ultra high RUG days. On the other hand, the coefficient of not-for-profit chain acquisitions on the proportion of ultra high RUG days is not statistically significant. As shown in Figure 2.1 and Table 2.9, there is an overall shift towards the highly intensive RUG days. Table 2.10 provides

some additional nuance insights into this trend. Among for-profit chain acquisitions, the shift is mainly from proportion of very high RUG days – the second highest reimbursement rate category -- to the proportion of ultra high RUG days – the highest reimbursement rate category. Among not-for-profit chain acquisitions, the shift is mainly from the proportion of high RUGs – the third highest reimbursement rate category – to the proportion of very high RUGs. In addition, after for-profit chain acquisitions, there is a 1.3 percentage points decrease in the proportion of non-therapy RUGs. Because for-profit chain acquisitions and not-for-profit chain acquisitions are associated with shifts in RUG distributions on different margins, it is difficult to compare just based on the changes in these RUG categories. Therefore, to standardize the comparison, in the last column, I present the results using the constructed therapy-component profit per resident day as an indicator for the overall profitability on providing therapy services. As shown, for-profit chain acquisitions are significantly associated with 1.2 increase in the overall therapy-component profit index per resident day. Based on the formal Wald tests, the difference between coefficients of for-profit and not-for-profit chain acquisitions is statistically significant at 0.05 level. Therefore, the results suggest that for-profit chains adopted more aggressive billing strategies by targeting the most profitable RUG category, compared to not-for-profit chains.

As indicated in Hypothesis 3, I am also interested in exploring if the chain size matters in how chain acquisitions could affect practice patterns of acquired nursing homes. In this analysis, chains are categorized into three groups – large, medium and small – based on the number of facilities owned by each chain. The control group includes independent nursing homes that remained independent. The results are shown in Table 2.11. Although accounting for about 20% of the total acquisitions, large chain acquisitions have a significantly stronger association with acquired facilities' practice patterns. The proportion of ultra high RUGs for an average

independent nursing home increased by 8.7 percentage points after being acquired by a large chain, compared to independent facilities without chain acquisitions. Similarly, acquisitions by medium chains are associated with about 3.3 percentage points increase in the proportion of ultra high RUG days. Acquisitions by small chains, although accounting for about 50% of the total acquisitions, correlate with acquired nursing homes' practice patterns by 1.3 percentage points. In terms of the therapy-component profit index, large chain acquisitions are associated with a 2.75 increase in the therapy profit index per resident day, followed by medium chain acquisitions at about 1.3, while small chain acquisitions do not seem to affect this composite measure. The formal Wald tests suggest these coefficients are statistically different from each other at the conventional level.

The results from the generalized DID model provides little additional insights on the dynamics of chain acquisitions and change in RUG category distribution. For example, if there was a pre-acquisition trend in changing RUG distribution, it could complicate the interpretation of the acquisition effects observed in the generalized DID specification. To explore these dynamics, I examine the effect of chain acquisitions over time. Table 2.12 presents the detailed results from this dynamic model with leads and lags, as indicated in model specification (4). Most of the RUG categories do not show any significant pre-acquisition trend. For example, the proportions of very high RUGs, high and non-therapy RUGs did not decrease until the acquisition year. However, in the year prior to acquisition, targeted independent nursing homes had already started to increase the proportion of ultra high RUGs by 2.47 percentage points, compared to two or more years before the acquisition. This also leads to a significant increase of 0.76 in the therapy add-on profit index in one year prior to the acquisition, compared two or more years before the acquisition. In addition, the persistent post-acquisition effects on ultra

high, very high and high RUGs suggest that acquisitions could affect the practice patterns of these previously independent nursing homes several years even after acquisitions.

To sum up findings on the relationship between chain acquisition and change in distribution of RUG categories, I find suggestive evidence that previously independent nursing homes significantly increased their proportion of ultra high RUG days while decreasing the proportions of very high and non-therapy RUG days after being acquired by corporate chains, compared to other independent facilities that did not experience chain ownership change. The effects are concentrated among for-profit chain acquisitions than not-for-profit chain acquisitions. Furthermore, together accounting for nearly 50% of the acquisitions, large and medium chains had stronger impacts on acquired facilities in changing the distribution of RUG categories than small chains did. However, keep in mind that there is one caveat that the dynamic model with leads and lags relative to the acquisition year indicates that the increase in proportion of ultra high RUG days occurred one year before acquisition.

After establishing the association between chain acquisition and practice patterns on RUG categories, I explore if chain acquisitions had any association on length of stay for Medicare beneficiaries in acquired nursing homes. From 2003 to 2009, the average Medicare length of stay in the sample was about 28 days. Figure 2.4 breaks down the number by ownership groups and years. In general, not-for-profit facilities slightly decreased length of stay, while for-profit facilities slightly increased the measure from 2003 to 2009. On average, the average length of stay among for-profit nursing homes was about 5 days longer than that in not-for-profit nursing homes. Remember that as shown in Figures 2.2 and 2.3, the proportion of ultra high RUG days increased across all of the ownership categories between 2003 and 2009. Although for-profit facilities had higher proportion of ultra high RUGs than not-for-profits, the Medicare length of

stay among for-profits continued to increase from 2003 to 2009 compared to the slightly decreasing trend observed among not-for-profits.

The results from the DID model on Medicare length of stay are presented in Table 2.13. Similar to the analysis for practice patterns, results from three specifications are presented: (1) only controlling for the year trend and facility fixed effects; (2) adding county HHI control; (3) adding facility controls and county HHI control. Because the results are robust across all three specifications, I report the results from the specification using the full control from here on. As shown, the effect of chain acquisition on average Medicare length of stay was about an increase of 0.21 days but not statistically significant ($p > 0.10$). I also break down the analysis on length of stay by profit status and size of the acquiring chains and show the results in Table 2.14. Most of the types of chain acquisitions did not significantly affect Medicare length of stay. Only not-for-profit chain acquisitions were marginally ($p < 0.10$) associated with one day decrease in the length of stay. In general, the effects of chain acquisition on Medicare length of stay are imprecise. However, the signs of the estimates suggest that for-profit and chains were positively associated with length of stay for Medicare beneficiaries in nursing homes during the study period. It is further confirmed by adding the leads and lags to the preferred specification as shown in Table B2.

2.9 Discussion and Conclusion

Nursing home chains own more than half of the nursing homes in the United States. For decades, whether chains affect various aspects of nursing homes -- such as quality of care, staffing, and financial health -- have been concerns for policymakers and researchers. It is well known that the Medicare PPS creates financial incentives for nursing homes to categorize patients into RUG codes with higher reimbursement rates so higher profits can be achieved. Both

the Medicare reimbursement scheme and chains play important roles in shaping the landscape of nursing home industry. However, to my knowledge, there are no studies that explored the relationship between chain affiliation and strategic practice patterns of nursing homes. The era of Medicare PPS for nursing homes provides an ideal setting to investigate this relationship. More specifically, this study tracks chain acquisitions of independent nursing homes from 2003 to 2009 to explore whether previously independent nursing homes would change their billing practice patterns after being acquired by nursing home chains.

My results suggest that chain acquisitions of independent nursing homes are associated with a higher proportion of residents being categorized into the most profitable RUG level. This relationship varies with types of ownership. More specifically, independent nursing homes that were acquired by large corporate chains placed a higher proportion of residents in the highest reimbursed RUG category than medium or small chains. Similarly, the increase in proportion of residents being categorized into the ultra high RUGs is larger after FP chains acquisitions, compared to NFP chains acquisitions. I also find that the chain effects on this aggressive billing patterns may last for several years after the acquisitions. Although chain acquisitions of independent nursing homes are found to be positively associated with an increase in the proportion of residents being put in the higher-paying RUGs for acquired nursing homes, these acquisitions do not seem to significantly change the length of stay.

Overall, my results are consistent with previous literature which found that healthcare providers' responses to financial incentives created by payment or regulation changes vary across organizational ownerships. For example, both Silverman and Skinner (2004) and Dafny (2005) found that for-profit hospitals were more likely to engage in upcoding behaviors. In the home health industry, for-profit incumbents (Kim and Norton, 2015) were found to respond

strategically in practice patterns following entrants in the same market. Similarly, both for-profit (Kim and Norton, 2017) and chain-owned (Kim and Huang, 2017) home health agencies were more likely to adopt strategic practice patterns than were not-for-profits or independents. Focusing on the nursing home industry, Bowblis et al. (2016) concluded that for-profit nursing homes place a significantly higher proportion of patients in the highest reimbursed RUG categories than not-for-profits.

This study contributes to the existing literature about healthcare providers' upcoding behaviors and regulatory exploitation. To my knowledge, this is the first study that estimates the effects of chain acquisitions of independent nursing homes on strategic billing practice patterns. Although large corporate chains were linked to several high-profile lawsuits regarding their questionable billing practices, no prior studies are found to systematically examine this issue using the national nursing home data. Second, I find substantial heterogeneity within types of acquiring chains. Compared to smaller and not-for-profit chains, larger and for-profit acquiring chains had stronger influence on the strategic billing practices of acquired independent nursing homes. In addition, I find that the effects of chain acquisition on strategic billing practices for acquired independent nursing homes do not only exist just one year after acquisitions. Rather, these post-acquisition effects last for several years, especially for the proportion of residents being categorized into the ultra high RUGs. Also note that one caveat of the findings is that chains were likely to target independent nursing homes even before the actual acquisitions, evident by the significant increase in the proportion of ultra high RUG days one year before acquisitions. This finding poses another research question: why these independent facilities became the targets of acquisitions? Did they desperately try to change their RUG mix to improve their financial performance so they could at least maintain their daily operations? Or, did they

improve these measures to show potential buyers that they were still worth buying? Given these limited evidences, future research could focus on why these independent facilities were acquired at the first place.

This paper has several limitations. First, the measure of the practice pattern is the proportion of different types of RUG Medicare days. Although this measure can reasonably proxy for the change in distribution across different RUG types, it does not accurately reflect the potential gaming behaviors such as manipulating the amount of therapy minutes to move residents' RUG categories up. A more accurate assessment of the upcoding behavior could be achieved by utilizing both the residents' assessment files and Medicare's claim data. Second, the perspective of clinical outcomes is lacking in this study. For example, measures such as improvement in function ability or discharge locations would be helpful in more comprehensively evaluating the welfare implications of changes in practice patterns due to chain acquisition of independent nursing homes. If an increase in the proportion of residents in the most intensive RUGs category is associated with significant improvement in functional status or an increase in the probability of residents being discharged back to their homes or communities, the observed shift toward more profitable RUG categories might not a be purely artificial upcoding practice, which could have some welfare implications. Unfortunately, the datasets used in this study do not contain such information. Third, the data on chain acquisitions comes from the OSCAR. Because the survey is not strictly enforced in a timely fashion, nursing homes often report information on ownership changes months after the actual transactions occur. As a result, the timing of chain acquisitions might not be accurate. This limitation might also contribute to the findings that target nursing homes already increased the proportion of ultra high RUG days one year before the acquisition. Unfortunately, to what extent this limitation could bias the

results is unknown given that OSCAR is the only resource available for comprehensively examining chain ownerships in the nursing home industry. In the future, the federal government should find ways to improve the accuracy of ownership information reported in the OSCAR.

In conclusion, this study identifies a strong increasing trend of proportion of post-acute residents being categorized into more profitable RUGs among all nursing homes in the United States from 2003 to 2009 – a period after the implementation of Medicare PPS. Substantial heterogeneities exist in this strategic billing practice patterns between independent and chain-owned nursing homes. Using a unique dataset that identifies the chain acquisitions of independent nursing homes during the period between 2003 and 2009, I track the changes in the practice patterns both before and after the chain acquisitions. I find that chain acquisitions of independent nursing homes were associated with 2.92 percentage points increase in the proportion of residents being categorized into the highest therapy treatment level. A more dynamic model suggests that the chain effects on this aggressive billing practice may last for several years after the acquisition. In addition, I find that the main effects are mostly due to acquisitions by large for-profit corporate chains. However, an increase in treatment intensity among chain-affiliated nursing homes does not seem to decrease the length of stay of Medicare beneficiaries in nursing homes.

In 2009, about one-quarter of the nursing homes' medical claims were found to have errors primarily due to the upcoding issue, which resulted in about $1.5 billion in inappropriate Medicare payments to nursing homes (OIG, 2015). Since the implementation of Medicare PPS, the federal government has increasingly focused on the issue of inappropriate Medicare payments to nursing homes. This study provides the empirical evidence showing that nursing home chains, especially those for-profit and large chains, were more likely to affect the billing

practice patterns of acquired independent nursing homes. The findings of this study continue to stress the importance of the federal government to closely monitor the chain related transactions in the nursing home industry. In particular, given the limited government resources, large corporate chains should be the particular monitoring targets for the purpose of financial fraud and suspicious medical upcoding behaviors.

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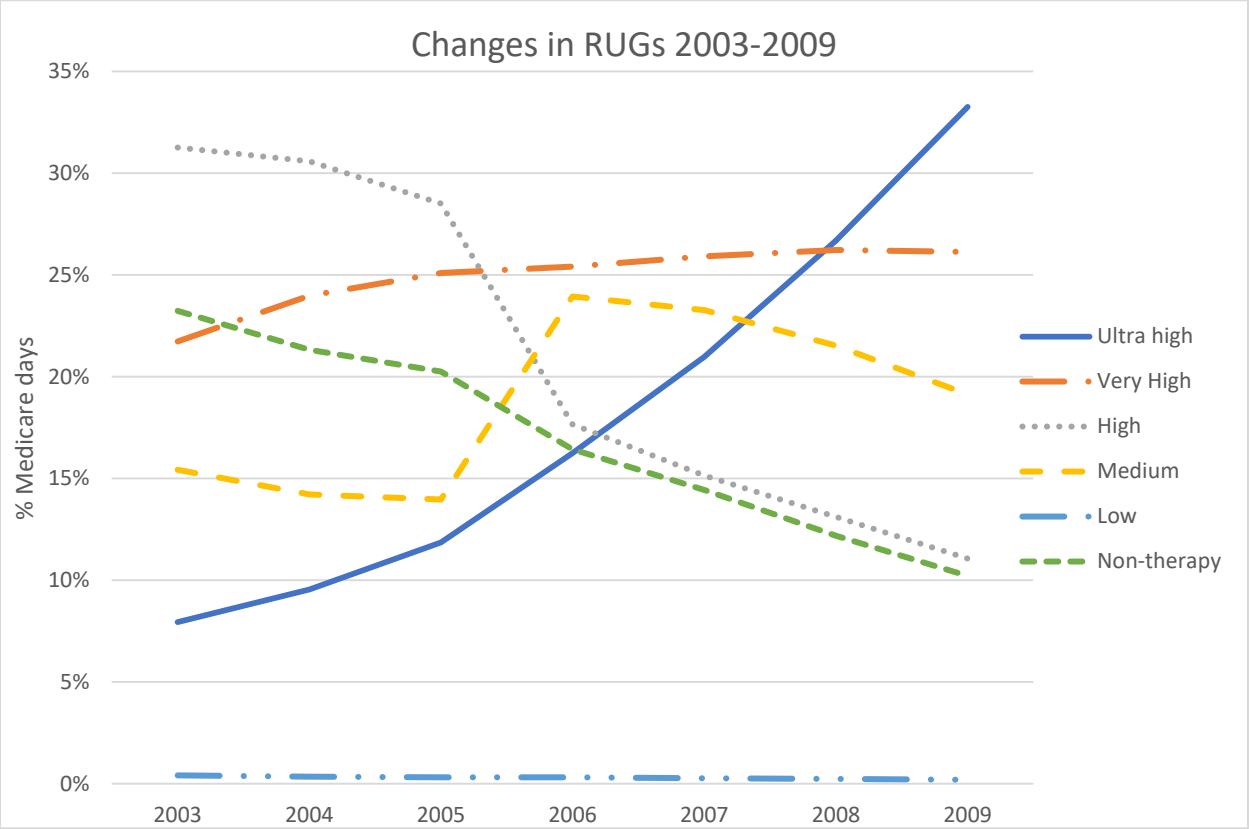
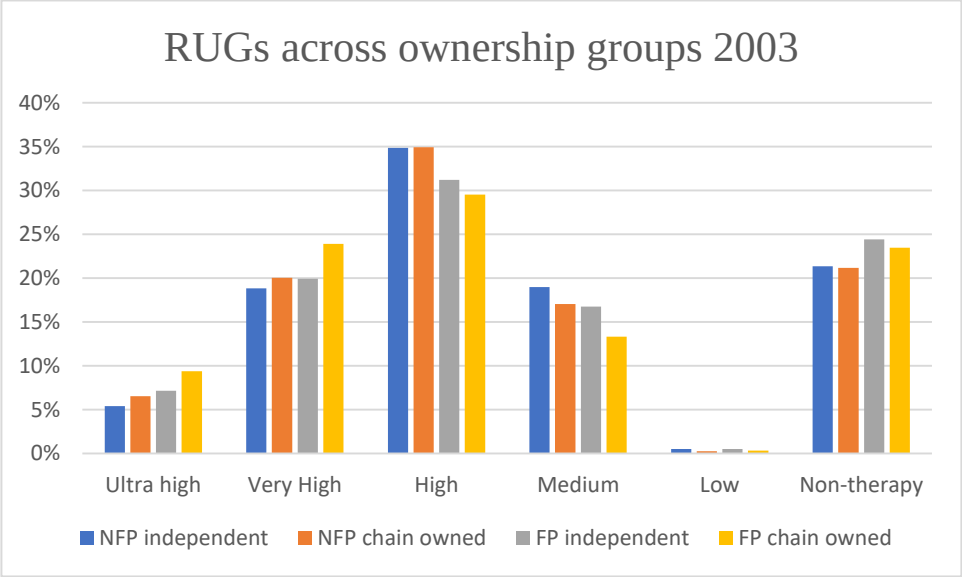
2.11 Figures

Figure 2. 1 Overall trend of different types of RUGs from 2003 to 2009



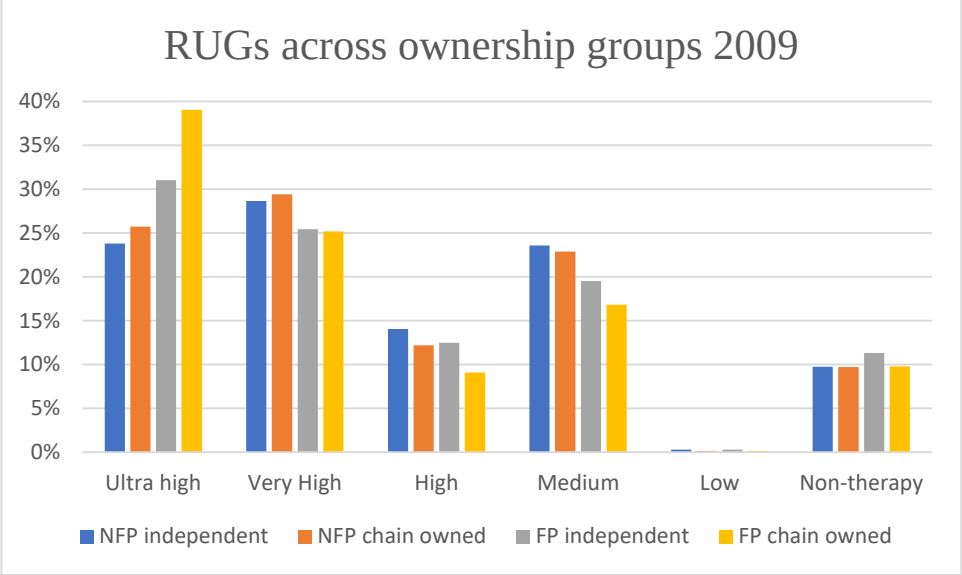
The sample includes all nursing homes in the OSCAR with matching records in the MCRs and LTC Focus from 2003 to 2009. Excluded nursing homes are: (1) facilities located in AK, HI, DC or PR; (2) hospital-based or government owned facilities; or (3) facilities with missing values in RUG Medicare days.

Figure 2. 2 Comparison in RUG distribution among different ownership groups 2003



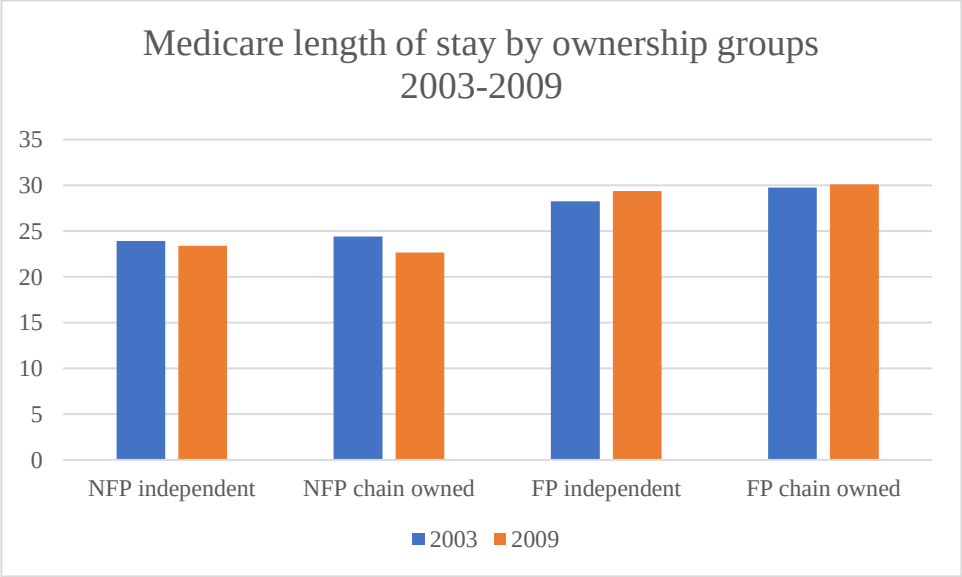
The sample includes all nursing homes in the OSCAR with matching records in the MCRs and LTC Focus from 2003 to 2009. Excluded nursing homes are: (1) facilities located in AK, HI, DC or PR; (2) hospital-based or government owned facilities; or (3) facilities with missing values in RUG Medicare days.

Figure 2. 3 Comparison in RUG distribution among different ownership groups 2009



The sample includes all nursing homes in the OSCAR with matching records in the MCRs and LTC Focus from 2003 to 2009. Excluded nursing homes are: (1) facilities located in AK, HI, DC or PR; (2) hospital-based or government owned facilities; or (3) facilities with missing values in RUG Medicare days.

Figure 2. 4 Average Medicare length of stay by ownership categories 2003-2009



The sample includes all nursing homes in the OSCAR with matching records in the MCRs and LTC Focus from 2003 to 2009. Excluded nursing homes are: (1) facilities located in AK, HI, DC or PR; (2) hospital-based or government owned facilities; or (3) facilities with missing values in RUG Medicare days.

2.12 Tables

Table 2. 1 Average payment and cost of the therapy component per patient day, by level of RUGs as of year 2012

Therapy level	Minimum therapy minutes	Average payments per day	Average expense per day	Average profit per day	Marginal profit per day
Ultra high	720	$231	$165	$66	$21
Very high	500	$156	$111	$45	$15
High	325	$104	$74	$30	$11
Medium	150	$67	$48	$19	$8
Low	45	$37	$26	$11	N/A

Source: OIG analysis of SNF cost reports, 2015.

Table 2. 2 Trend of selected residents characteristics for all nursing homes in the sample by year

	ADL index	Age	% White	% Female
2003	10.79	81.34	85.03	72.89
2004	10.78	81.19	84.69	72.49
2005	10.79	81.04	84.35	72.24
2006	10.80	80.95	83.98	71.89
2007	10.81	80.88	83.62	71.54
2008	10.82	80.72	83.90	71.23
2009	10.84	80.62	83.60	70.70
N	79890			

The sample includes all nursing homes in the OSCAR with matching records in the MCRs and LTC Focus from 2003 to 2009. Excluded nursing homes are: (1) facilities located in AK, HI, DC or PR; (2) hospital-based or government owned facilities; or (3) facilities with missing values in RUG Medicare days.

Table 2. 3 Types of ownership and prevalence of acquisitions in the nursing home industry

	% Chain-owned NHs	% for-profit NHs	% Chain acquisitions of independent NHs	Total NHs
2003	58.78	76.51	2.63	10994
2004	57.02	75.95	2.76	10997
2005	56.85	75.91	3.24	11063
2006	56.44	76.27	3.18	11157
2007	56.59	76.75	3.24	11158
2008	56.85	76.68	3.38	12246
2009	56.67	76.64	2.76	12275
N	79890			

The sample includes all nursing homes in the OSCAR with matching records in the MCRs and LTC Focus from 2003 to 2009. Excluded nursing homes are: (1) facilities located in AK, HI, DC or PR; (2) hospital-based or government owned facilities; or (3) facilities with missing values in RUG Medicare days.

Table 2. 4 Chain acquisitions of independent nursing homes 2003-2009: by profit status of the acquiring chains

Year	For-profit acquisition		Not-for-profit acquisition		Total
2003	247	85.47%	42	14.53%	289
2004	258	84.87%	46	15.13%	304
2005	314	87.71%	44	12.29%	358
2006	302	85.07%	53	14.93%	355
2007	317	87.57%	45	12.43%	362
2008	348	84.06%	66	15.94%	414
2009	293	86.43%	46	13.57%	339

The sample includes all nursing homes in the OSCAR with matching records in the MCRs and LTC Focus from 2003 to 2009. Excluded nursing homes are: (1) facilities located in AK, HI, DC or PR; (2) hospital-based or government owned facilities; or (3) facilities with missing values in RUG Medicare days.

Table 2. 5 Chain acquisitions of independent nursing homes 2003-2009: by size of the acquiring chains

Year	Small chains (2-10)		Medium chains (11-29)		Large chains (>=30)		Total
2003	187	64.71%	54	18.69%	48	16.61%	289
2004	228	75.00%	38	12.50%	38	12.50%	304
2005	244	68.16%	59	16.48%	55	15.36%	358
2006	203	57.18%	97	27.32%	55	15.49%	355
2007	186	51.38%	87	24.03%	89	24.59%	362
2008	206	49.76%	97	23.43%	111	26.81%	414
2009	184	54.28%	74	21.83%	81	23.89%	339

The sample includes all nursing homes in the OSCAR with matching records in the MCRs and LTC Focus from 2003 to 2009. Excluded nursing homes are: (1) facilities located in AK, HI, DC or PR; (2) hospital-based or government owned facilities; or (3) facilities with missing values in RUG Medicare days.

Table 2. 6 Chain acquisitions of independent nursing homes 2003-2009: by profit status and size of the acquiring chains

Year	For-profit small (2-10)		For-profit medium (11-29)		For-profit large (>=30)		Total
2003	152	52.60%	48	16.61%	47	16.26%	289
2004	187	61.51%	35	11.51%	36	11.84%	304
2005	207	57.82%	55	15.36%	52	14.53%	358
2006	156	43.94%	91	25.63%	55	15.49%	355
2007	150	41.44%	78	21.55%	89	24.59%	362
2008	156	37.68%	82	19.81%	110	26.57%	414
2009	147	43.36%	66	19.47%	80	23.60%	339

Year	Not-for-profit small (2-10)		Not-for-profit medium (11-29)		Not-for-profit large (>=30)		Total
2003	35	12.11%	6	2.08%	1	0.35%	289
2004	41	13.49%	3	0.99%	2	0.66%	304
2005	37	10.34%	4	1.12%	3	0.84%	358
2006	47	13.24%	6	1.69%	0	0.00%	355
2007	36	9.94%	9	2.49%	0	0.00%	362
2008	50	12.08%	15	3.62%	1	0.24%	414
2009	37	10.91%	8	2.36%	1	0.29%	339

The sample includes all nursing homes in the OSCAR with matching records in the MCRs and LTC Focus from 2003 to 2009. Excluded nursing homes are: (1) facilities located in AK, HI, DC or PR; (2) hospital-based or government owned facilities; or (3) facilities with missing values in RUG Medicare days.

Table 2. 7 Comparison on practice patterns between independent and chain-owned NHs 2003-2009

	Independent	Chain-owned
Proportion of ultra high RUG days	0.158	0.205***
	(0.199)	(0.207)
Proportion of very high RUG days	0.239	0.258***
	(0.165)	(0.137)
Proportion of high RUG days	0.225	0.194***
	(0.168)	(0.148)
Proportion of medium RUG days	0.205	0.176***
	(0.159)	(0.128)
Proportion of low RUG days	0.00370	0.00240***
	(0.0199)	(0.0103)
Proportion of none therapy days	0.170	0.165***
	(0.159)	(0.134)
Observations	34339	45551

The sample includes all nursing homes in the OSCAR with matching records in the MCRs and LTC Focus from 2003 to 2009. Excluded nursing homes are: (1) facilities located in AK, HI, DC or PR; (2) hospital-based or government owned facilities; or (3) facilities with missing values in RUG Medicare days. Stars indicate the statistical significance based on the t-tests between each of the categories. The reference group is independent nursing homes. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 2. 8 Summary statistics for treatment and control nursing homes in year 2003

	Acquired NHs	Independent NHs
Facility structural characteristics		
For profit	0.77***	0.62
	(0.42)	(0.48)
Bed size	115.42**	122.07
	(55.01)	(73.56)
Occupancy rate	0.86***	0.88
	(0.13)	(0.11)
ADL index	10.81	10.78
	(1.07)	(1.20)
% Medicare	11.62***	10.45
	(8.32)	(9.01)
% Medicaid	63.34	62.48
	(19.43)	(21.84)
Facility Staffing measures		
Registered Nurse hours per resident day	0.29***	0.34
	(0.25)	(0.24)
Licensed Practical Nurse hours per resident day	0.73***	0.68
	(0.30)	(0.29)
Certified Nurse Aide hours per resident day	2.17***	2.28
	(0.69)	(0.69)
Physical Therapist hours per resident day	0.05**	0.05
	(0.06)	(0.06)
Occupational Therapist hours per resident day	0.05***	0.04
	(0.05)	(0.05)
Facility demographic characteristics		
Age	81.43***	82.42
	(5.82)	(5.64)
White	85.30	86.10
	(18.99)	(20.44)
Female	73.34**	74.35
	(10.52)	(10.85)
County characteristics		
HHI	0.17	0.16
	(0.20)	(0.21)
Observations	650	3282

The sample includes all nursing homes in the OSCAR with matching records in the MCRs and LTC Focus from 2003 to 2009. Excluded nursing homes are: (1) facilities located in AK, HI, DC or PR; (2) hospital-based or government owned facilities; or (3) facilities with missing values in RUG Medicare days. Treatment nursing homes are independent nursing homes that were acquired once and were not involved in other types of chain transactions during the study period. Control nursing homes are independent nursing homes that remained independent during the study period. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 2. 9 Generalized DID estimates on % RUGs 2003-2009

	Ultra high RUGs	Very high RUGs	High RUGs	Medium RUGs	Non-therapy RUGs	Therapy profit
Acquisition	0.0292***	-0.0163***	-0.0094**	0.0052	-0.0091**	1.0112***
	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.27]
For profit	0.0219***	-0.0105*	-0.0068	-0.0076	0.0025	0.6303*
	[0.01]	[0.01]	[0.01]	[0.01]	[0.00]	[0.33]
Bed size	0.0005***	-0.0002*	-0.0000	-0.0002*	-0.0001	0.0196***
	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.01]
Occupancy rate	0.0664***	-0.0204	-0.0203	-0.0275**	0.0001	2.3431***
	[0.01]	[0.01]	[0.01]	[0.01]	[0.01]	[0.73]
ADL index	0.0007	-0.0035***	-0.0014	0.0020*	0.0021*	-0.1174
	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.07]
% Medicare	0.0009***	0.0006***	-0.0008***	-0.0004***	-0.0002**	0.0540***
	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.01]
% Medicaid	-0.0000	0.0002**	-0.0003***	0.0000	0.0001	0.0012
	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.01]
RN hours PPD	0.0222***	-0.0070	-0.0144**	-0.0039	0.0019	0.6565*
	[0.01]	[0.01]	[0.01]	[0.01]	[0.01]	[0.37]
LPN hours PPD	0.0140***	-0.0056	-0.0078*	0.0013	-0.0027	0.4681*
	[0.01]	[0.00]	[0.00]	[0.00]	[0.00]	[0.26]
CNA hours PPD	-0.0020	-0.0006	0.0016	0.0010	0.0001	-0.0921
	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.10]
PT hours PPD	0.0323**	0.0109	-0.0177**	-0.0218***	-0.0039	1.6826*
	[0.02]	[0.01]	[0.01]	[0.01]	[0.01]	[0.97]
OT hours PPD	0.0282*	0.0062	-0.0074	-0.0133*	-0.0131*	1.6578*
	[0.01]	[0.01]	[0.01]	[0.01]	[0.01]	[0.89]
Age	0.0028***	0.0000	-0.0023***	-0.0004	-0.0003	0.1106***
	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.03]
White	-0.0015***	0.0009***	0.0000	0.0006***	0.0000	-0.0485***
	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.01]
Female	0.0002	-0.0001	-0.0002	-0.0000	0.0001	0.0029
	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.01]
County HHI	0.0030	-0.0183	-0.0069	-0.0026	0.0198	-0.8262
	[0.02]	[0.01]	[0.02]	[0.01]	[0.01]	[0.80]
Observations	29940	29940	29940	29940	29940	29940

Standard errors in brackets. Constant terms, year fixed effects estimated but not reported. The sample includes all nursing homes in the OSCAR with matching records in the MCRs and LTC Focus from 2003 to 2009. Excluded nursing homes are: (1) facilities located in AK, HI, DC or PR; (2) hospital-based or government owned facilities; or (3) facilities with missing values in RUG Medicare days. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 2. 10 The role of profit status

	Ultra high RUGs	Very high RUGs	High RUGs	Medium RUGs	Non-therapy RUGs	Therapy profit
For-profit chain acquisition	0.0360***	-0.0260***	-0.0050	0.0064	-0.0125***	1.1915***
	[0.01]	[0.00]	[0.00]	[0.00]	[0.00]	[0.31]
Not-for-profit chain acquisition	0.0027	0.0191**	-0.0276***	-0.0003	0.0083	0.1800
	[0.01]	[0.01]	[0.01]	[0.01]	[0.01]	[0.46]
Observations	29940	29940	29940	29940	29940	29940

Standard errors in brackets. Constant terms, year fixed effects estimated but not reported. The sample includes all nursing homes in the OSCAR with matching records in the MCRs and LTC Focus from 2003 to 2009. Excluded nursing homes are: (1) facilities located in AK, HI, DC or PR; (2) hospital-based or government owned facilities; or (3) facilities with missing values in RUG Medicare days. * p < 0.10, ** p < 0.05, *** p < 0.01

Table 2. 11 The role of chain size

	Ultra high RUGs	Very high RUGs	High RUGs	Medium RUGs	Non-therapy RUGs	Therapy profit
Small chain acquisitions	0.0127**	-0.0094*	-0.0066	0.0101**	-0.0071	0.4124
	[0.01]	[0.01]	[0.00]	[0.00]	[0.00]	[0.31]
Medium chain acquisitions	0.0332***	-0.0128*	-0.0127*	0.0031	-0.0112*	1.2982***
	[0.01]	[0.01]	[0.01]	[0.01]	[0.01]	[0.50]
Lager chain acquisitions	0.0866***	-0.0493***	-0.0175*	-0.0122*	-0.0082	2.7480***
	[0.01]	[0.01]	[0.01]	[0.01]	[0.01]	[0.61]
Observations	29940	29940	29940	29940	29940	29940

Large chain: 30 or more facilities; Medium chain: 11-29 facilities; Small chain: 2-10 facilities. Standard errors in brackets. Constant terms, year fixed effects estimated but not reported. The sample includes all nursing homes in the OSCAR with matching records in the MCRs and LTC Focus from 2003 to 2009. Excluded nursing homes are: (1) facilities located in AK, HI, DC or PR; (2) hospital-based or government owned facilities; or (3) facilities with missing values in RUG Medicare days. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 2. 12 Effects of chain acquisitions on % RUGs 2003-2009 (dynamic model)

	Ultra high RUGs	Very high RUGs	High RUGs	Medium RUGs	Non-therapy RUGs	Therapy profit index
t-2	0.0089	-0.0088	-0.0055	-0.0002	0.0052	0.0276
	[0.01]	[0.01]	[0.01]	[0.01]	[0.01]	[0.38]
t-1	0.0247***	-0.0099	-0.0096	-0.0076	0.0019	0.7598**
	[0.01]	[0.01]	[0.01]	[0.01]	[0.01]	[0.38]
t	0.0371***	-0.0146**	-0.0110*	-0.0007	-0.0114**	1.4561***
	[0.01]	[0.01]	[0.01]	[0.01]	[0.01]	[0.37]
t+1	0.0462***	-0.0243***	-0.0224***	0.0010	-0.0015	1.3153***
	[0.01]	[0.01]	[0.01]	[0.01]	[0.01]	[0.41]
t+2	0.0458***	-0.0328***	-0.0140**	0.0034	-0.0030	1.1982***
	[0.01]	[0.01]	[0.01]	[0.01]	[0.01]	[0.46]
2+ years post	0.0412***	-0.0382***	-0.0128*	0.0157**	-0.0070	0.9232**
	[0.01]	[0.01]	[0.01]	[0.01]	[0.01]	[0.46]
For profit	0.0221***	-0.0107*	-0.0069	-0.0076	0.0026	0.6355*
	[0.01]	[0.01]	[0.01]	[0.01]	[0.00]	[0.33]
Bed size	0.0005***	-0.0002*	-0.0000	-0.0002*	-0.0001	0.0199***
	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.01]
Occupancy rate	0.0668***	-0.0207	-0.0204	-0.0277**	0.0002	2.3596***
	[0.01]	[0.01]	[0.01]	[0.01]	[0.01]	[0.73]
ADL index	0.0007	-0.0036***	-0.0014	0.0021*	0.0021*	-0.1191
	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.07]
% Medicare	0.0009***	0.0006***	-0.0008***	-0.0004***	-0.0002**	0.0540***
	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.01]
% Medicaid	-0.0000	0.0002**	-0.0003***	0.0000	0.0001	0.0014
	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.01]
RN hours PPD	0.0225***	-0.0072	-0.0146**	-0.0039	0.0021	0.6615*
	[0.01]	[0.01]	[0.01]	[0.01]	[0.01]	[0.37]
LPN hours PPD	0.0140***	-0.0057	-0.0079*	0.0014	-0.0027	0.4672*
	[0.01]	[0.00]	[0.00]	[0.00]	[0.00]	[0.26]
CNA hours PPD	-0.0020	-0.0006	0.0016	0.0009	0.0001	-0.0910
	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.10]
PT hours PPD	0.0320**	0.0109	-0.0176**	-0.0216**	-0.0039	1.6672*
	[0.02]	[0.01]	[0.01]	[0.01]	[0.01]	[0.97]
OT hours PPD	0.0282*	0.0061	-0.0074	-0.0132*	-0.0130*	1.6558*

	[0.01]	[0.01]	[0.01]	[0.01]	[0.01]	[0.89]
Age	0.0028***	-0.0000	-0.0023***	-0.0003	-0.0003	0.1103***
	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.03]
White	-0.0015***	0.0009***	0.0000	0.0006***	0.0000	-0.0486***
	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.01]
Female	0.0002	-0.0001	-0.0002	-0.0000	0.0001	0.0031
	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.01]
County HHI	0.0021	-0.0172	-0.0063	-0.0029	0.0193	-0.8231
	[0.02]	[0.01]	[0.02]	[0.01]	[0.01]	[0.80]
Observations	29940	29940	29940	29940	29940	29940

Standard errors in brackets. Constant terms, year fixed effects estimated but not reported. The sample includes all nursing homes in the OSCAR with matching records in the MCRs and LTC Focus from 2003 to 2009. Excluded nursing homes are: (1) facilities located in AK, HI, DC or PR; (2) hospital-based or government owned facilities; or (3) facilities with missing values in RUG Medicare days. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 2. 13 Generalized DID estimates on average Medicare length of stay 2003-2009

	(1)	(2)	(3)
acquisition	0.2535	0.2534	0.2079
	[0.31]	[0.31]	[0.31]
county HHI	No	Yes	Yes
Facility controls	No	No	Yes
Observations	28021	28021	28021
R^2	0.632	0.632	0.635

Standard errors in brackets. Constant terms, year fixed effects estimated but not reported. The sample includes all nursing homes in the OSCAR with matching records in the MCRs and LTC Focus from 2003 to 2009. Excluded nursing homes are: (1) facilities located in AK, HI, DC or PR; (2) hospital-based or government owned facilities; or (3) facilities with missing values in RUG Medicare days. Column (1) includes only year dummies with no other controls; column (2) adds county controls; column (3) adds facility-level characteristics. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 2. 14 The role of profit status and chain size on the effects of chain acquisitions on Medicare length of stay 2003-2009

	For-profit acquisitions	Not-for-profit acquisitions	Large chain acquisitions	Medium chain acquisitions	Small chain acquisitions
Effects on Medicare length of stay	0.5190	-1.0030*	0.2347	0.3218	0.1375
	[0.35]	[0.60]	[0.67]	[0.56]	[0.38]
Observations	28021	28021	28021	28021	28021

Standard errors in brackets. Constant terms, year fixed effects estimated but not reported. The sample includes all nursing homes in the OSCAR with matching records in the MCRs and LTC Focus from 2003 to 2009. Excluded nursing homes are: (1) facilities located in AK, HI, DC or PR; (2) hospital-based or government owned facilities; or (3) facilities with missing values in RUG Medicare days. Facility-level characteristics and county HHI are controlled but not reported here.* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

2.13 Appendix

Figure B 1. Total Medicare days by RUG types from 2003 to 2009

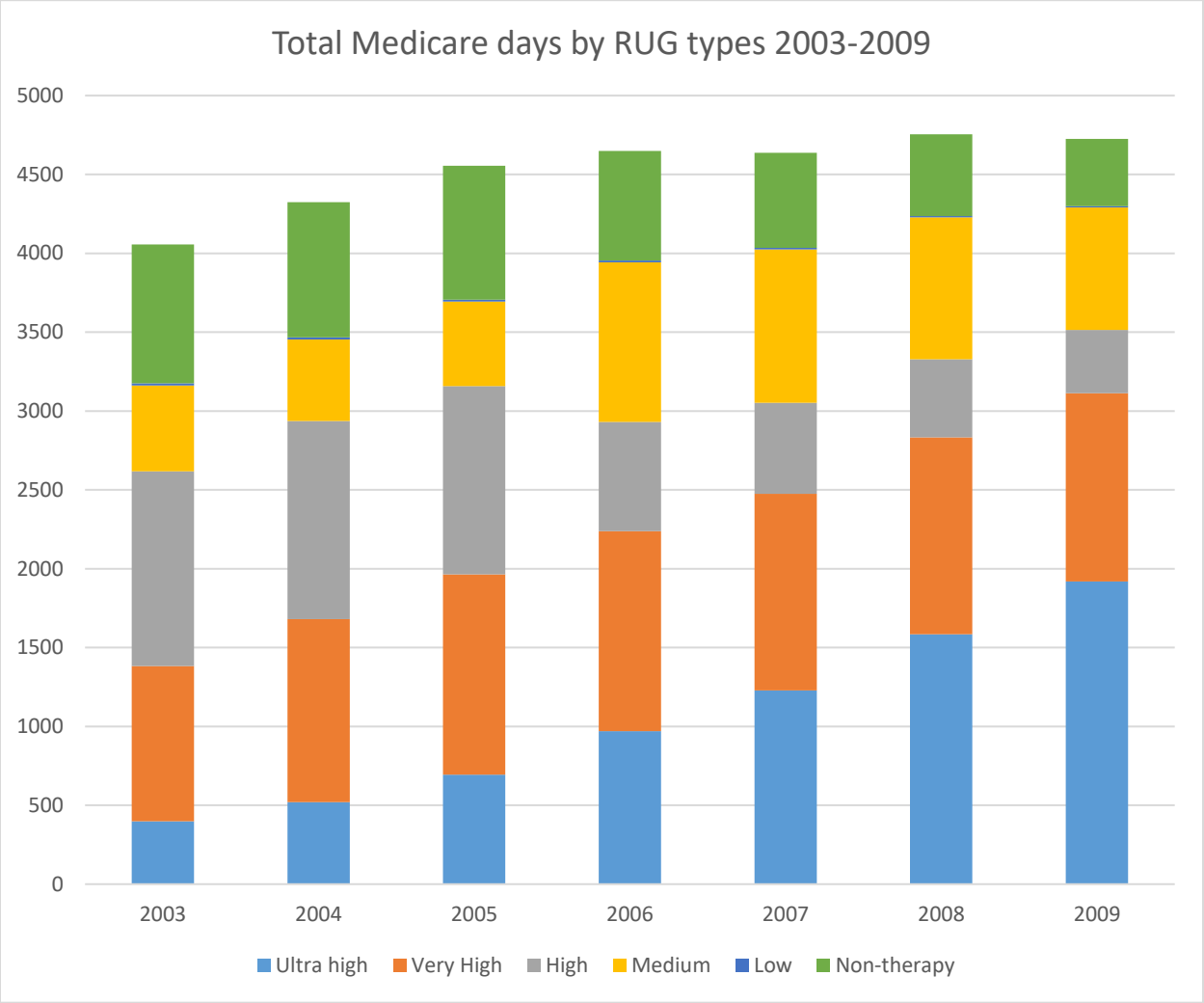


Figure B 2. Overall trend of RUG categories 2003-2009 (chain owned nursing homes only)

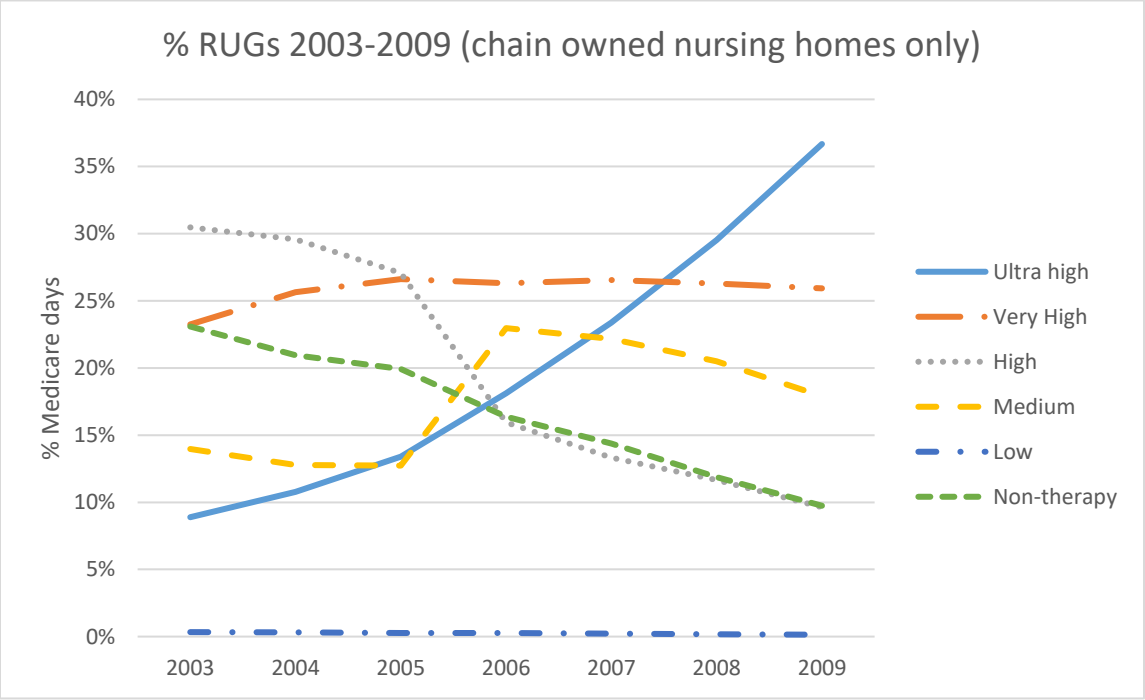


Figure B 3. Overall trend of RUG categories 2003-2009 (independent nursing homes only)

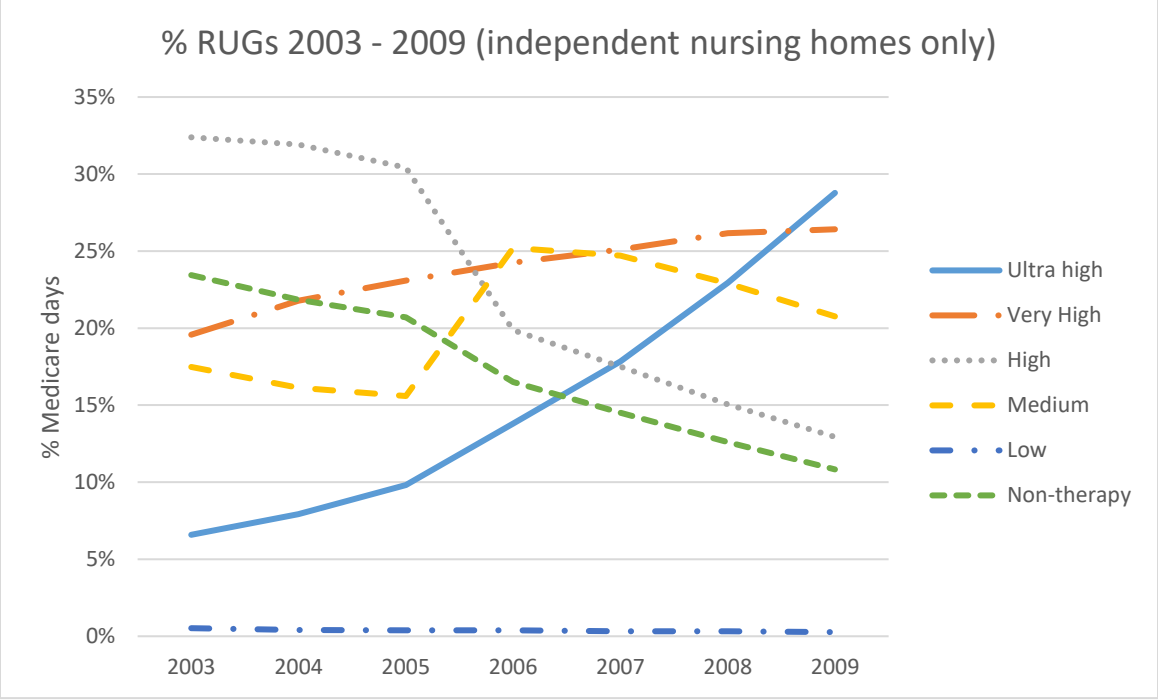


Figure B 4. Overall trend of RUG categories 2003-2009 (For-profit nursing homes only)

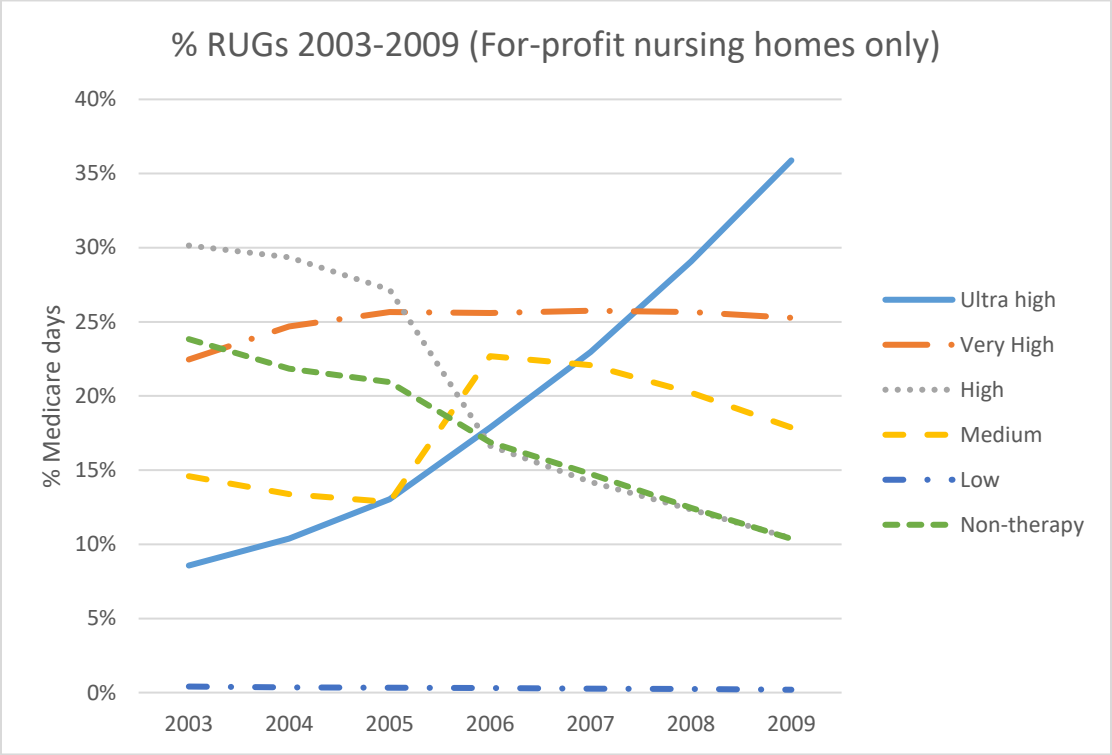


Figure B 5. Overall trend of RUG categories 2003-2009 (Not-for-profit nursing homes only)

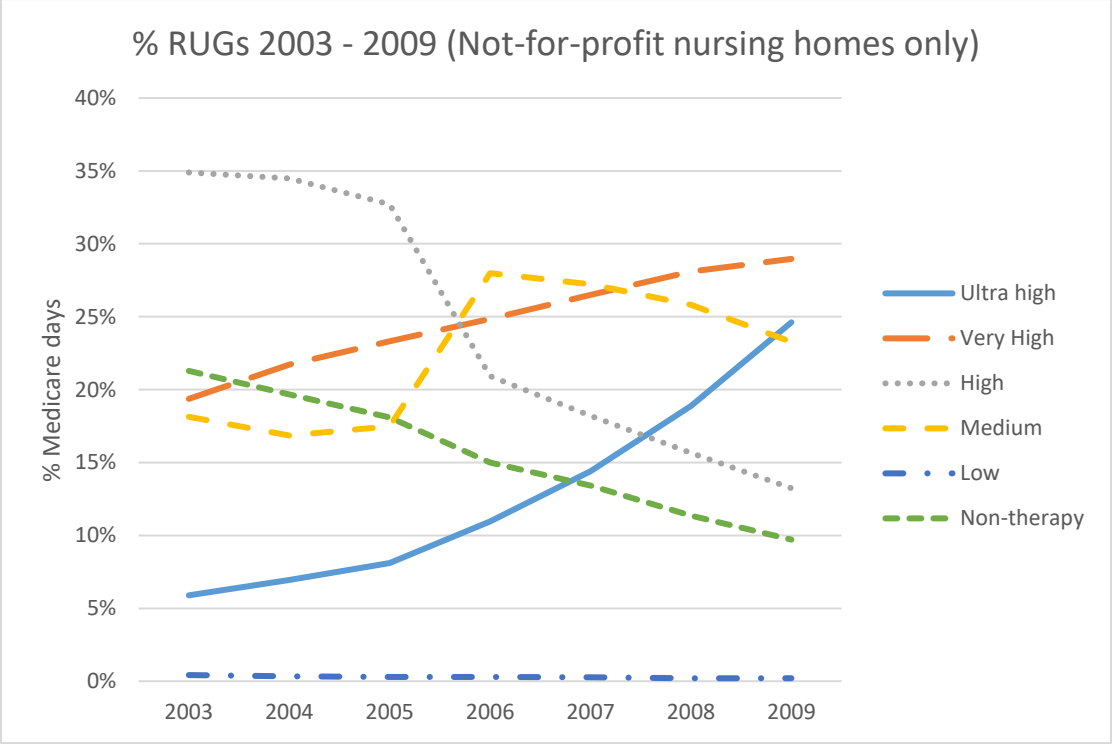
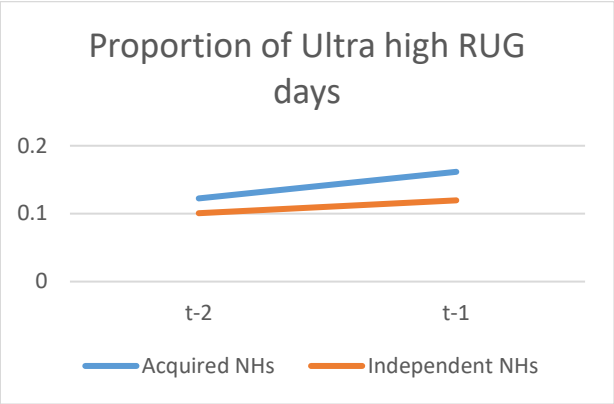
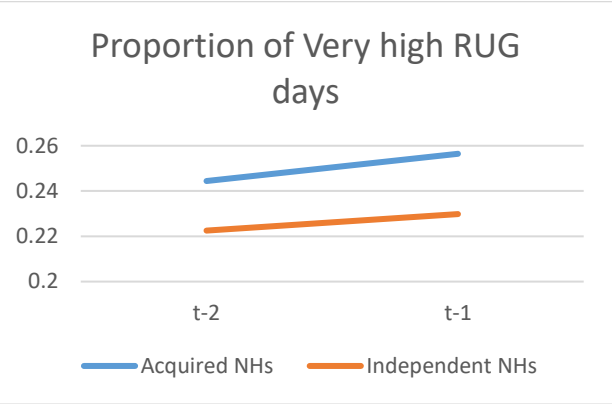
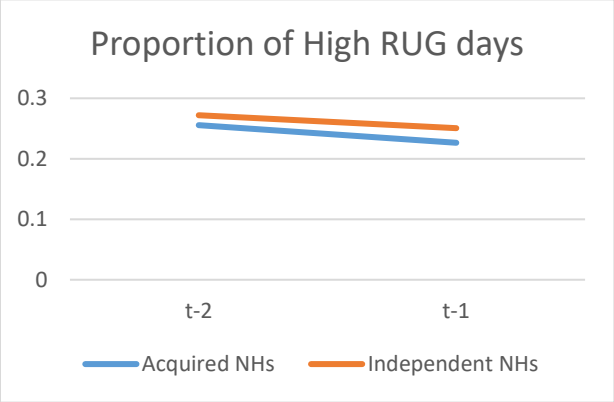
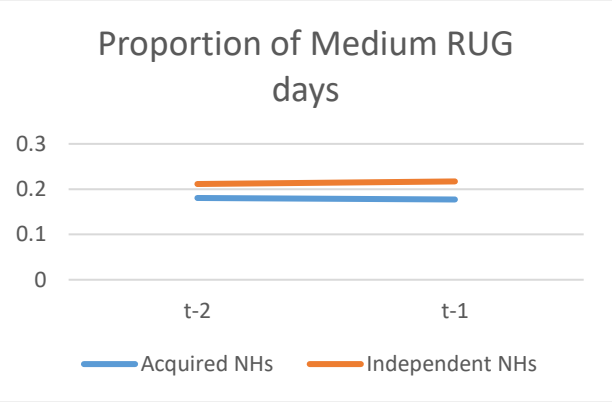


Figure B 6. Comparison of pre-acquisition trends of RUG categories between acquired nursing homes and independent nursing homes









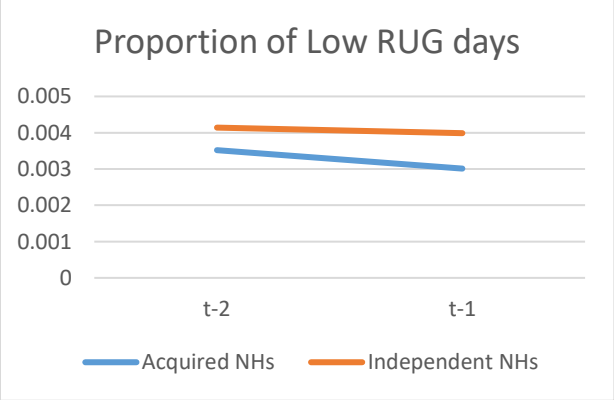


Figure B 7. Comparison of pre-acquisition trends of facility structural characteristics between acquired nursing homes and independent nursing homes

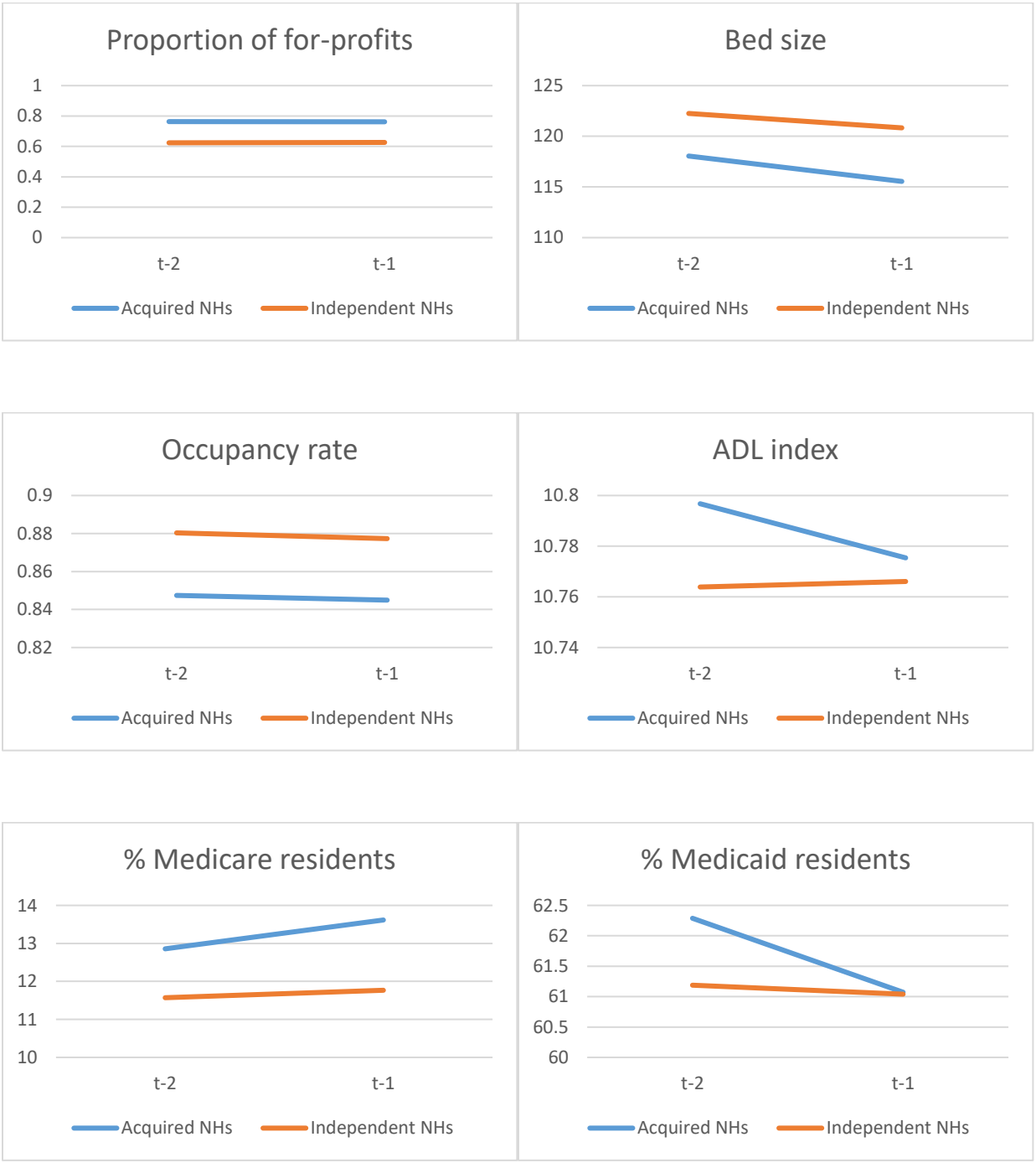
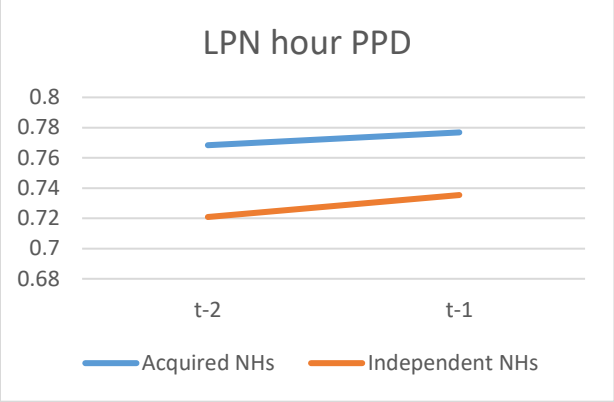
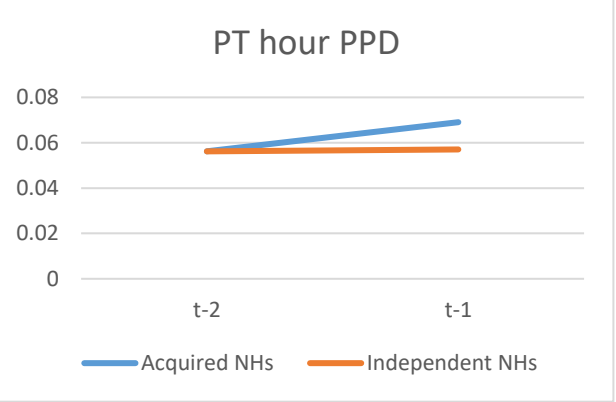


Figure B 8. Comparison of pre-acquisition trends of staffing measures between acquired nursing homes and independent nursing homes





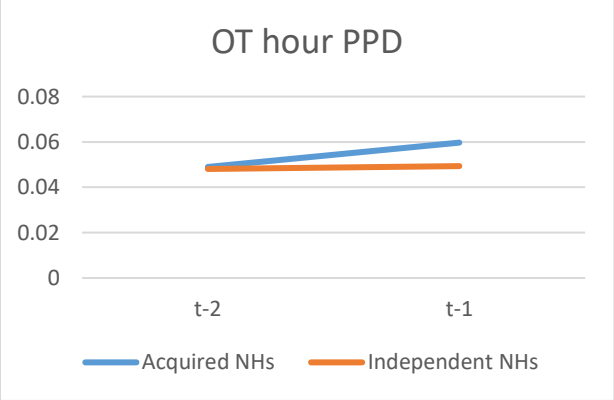


Figure B 9. Comparison of pre-acquisition trends of demographic characteristics and county HHI between acquired nursing homes and independent nursing homes

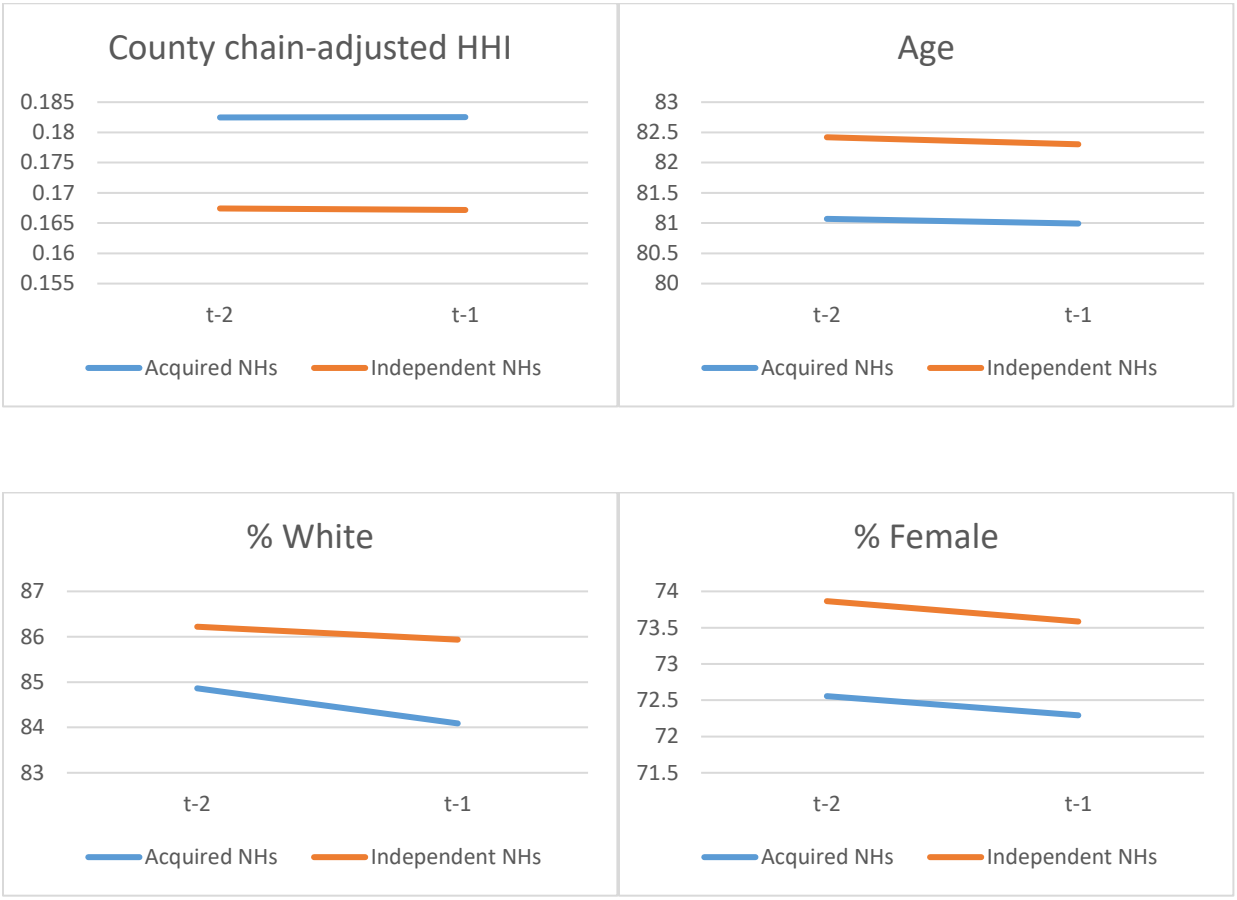


Table B 1 Wald tests for parallel trends

	t-2		t-1		t	
For profit	0.0047	[0.01]	-0.009	[0.01]	0.0159	[0.01]
Bed size	0.3005	[0.53]	-0.2207	[0.47]	-0.3564	[0.46]
Occupancy rate	-0.0037	[0.00]	-0.0048	[0.00]	-0.0125***	[0.00]
ADL Index	0.0286	[0.04]	0.0231	[0.04]	0.0976***	[0.04]
% Medicare	0.0746	[0.41]	0.6078	[0.41]	0.4569	[0.40]
% Medicaid	-0.394	[0.51]	-0.8958	[0.56]	-0.2826	[0.51]
HHI	0.0035	[0.00]	0.0046	[0.00]	0	[0.00]
RN hours per resident day	-0.0089	[0.01]	-0.0088	[0.01]	0.0017	[0.01]
LPN hours per resident day	0.0023	[0.01]	-0.0017	[0.01]	-0.0107	[0.01]
CNA hours per resident day	-0.0540**	[0.03]	-0.0373	[0.03]	-0.0613**	[0.02]
PT hours per resident day	0.0022	[0.01]	0.0129	[0.01]	0.0136	[0.01]
OT hours per resident day	-0.0025	[0.00]	0.0046	[0.00]	0.0049	[0.01]
Age	-0.1205	[0.10]	-0.1278	[0.10]	-0.1071	[0.10]
White	0.049	[0.23]	-0.2112	[0.22]	-0.1776	[0.22]
Female	-0.4266	[0.28]	-0.3575	[0.28]	-0.3755	[0.26]
Observations	29940	29940	29940	29940	29940	29940

Standard errors in brackets. Constant terms, year fixed effects estimated but not reported. The sample includes all nursing homes in the OSCAR with matching records in the MCRs and LTC Focus from 2003 to 2009. Excluded nursing homes are: (1) facilities located in AK, HI, DC or PR; (2) hospital-based or government owned facilities; or (3) facilities with missing values in RUG Medicare days. Facility-level characteristics and county HHI are controlled but not reported here.* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table B 2 Effects of chain acquisitions on Medicare length of stay 2003-2009 (dynamic model)

	Average Medicare length of stay
t-2	-0.9268**
	[0.47]
t-1	-0.5981
	[0.47]
t	-0.2967
	[0.45]
t+1	-0.2166
	[0.49]
t+2	-0.4093
	[0.53]
More than 2 years after acquisitions	-0.1825
	[0.54]
For profit	4.0978***
	[0.42]
Bed size	0.0089
	[0.01]
Occupancy rate	4.4940***
	[0.88]
ADL index	0.0403
	[0.09]
% Medicare	0.0248***
	[0.01]
% Medicaid	0.0101
	[0.01]
RN hours PPD	-0.9788**
	[0.43]
LPN hours PPD	-0.2806
	[0.29]
CNA hours PPD	0.0619
	[0.11]
PT hours PPD	0.7017
	[0.61]
OT hours PPD	0.4786*
	[0.27]
Age	-0.0111
	[0.04]
White	-0.0344**
	[0.02]
Female	-0.0114
	[0.01]
County HHI	0.6347
	[1.15]
Observations	28021

Standard errors in brackets. Constant terms, year fixed effects estimated but not reported. The sample includes all nursing homes in the OSCAR with matching records in the MCRs and LTC Focus from 2003 to 2009. Excluded nursing homes are: (1) facilities located in AK, HI, DC or PR; (2) hospital-based or government owned facilities; or (3) facilities with missing values in RUG Medicare days. Facility-level characteristics and county HHI are controlled but not reported here.* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Chapter 3 The role of financial performance on chain acquisition of independent nursing homes

3.1 Introduction

In the United States, nursing homes are the predominant institutional providers of long-term care. The aging of the population poses a major challenge for nursing homes to meet the increasing demand for elder care. In the past two decades, a tremendous amount of chain related transactions, such as mergers and acquisitions, occurred within the nursing home industry (Grabowski et al., 2016). Quality of care has been a serious concern behind these chain-related transactions for both the federal government (Department of Health and Human Services, 2009; GAO, 2010, 2011) and health policy researchers (Banaszak-Holl et al., 2002; Stevenson and Grabowski, 2008; Harrington et al., 2012; Grabowski et al., 2016). Therefore, it is important to understand the motivation behind these chain acquisitions. Although a large body of literature focuses on the relationship between chain affiliation and nursing home performance, relatively few studies have examined factors associated with chain acquisition of independent nursing homes in the past two decades. Given the prominent role of chains in the nursing home industry, it is important to understand the antecedents of chain acquisitions. Furthermore, surprisingly, financial performance has been largely ignored in studies that examined factors contributing to chain acquisitions. Evidence suggests that ownership conversions could be driven by financial stress of the targeted facilities (Sloan et al., 2003; Pozniak et al., 2010; Bowblis, 2011). Using a nuanced longitudinal dataset that tracks chain acquisitions of independent nursing homes in the United States from 2000 to 2010, this study investigates the factors associated with chain

acquisitions of independent nursing homes, with a special focus on financial performance of targeted independent nursing homes.

Prior research related to nursing homes largely focused on ownership conversions between for-profit and not-for-profit (Grabowski and Stevenson, 2008; Bowblis, 2011), nursing home closures (Castle, 2005, 2009; Zinn et al., 2009; Bowblis, 2011), acquisitions of chain-owned nursing homes by large private investment firms (Cadigan et al., 2015), or chain acquisitions without considering financial performance of targeted nursing homes (Banaszak-Holl et al., 2002; Grabowski et al., 2016). Most of the previous studies focused on the effects of organizational ownership changes, but not the antecedents of ownership changes. Among the few studies that explored the predictors of ownership changes, Banaszak-Holl et al. (2002) did not examine financial performance and focused on chain acquisitions prior to 1997. Bowblis (2011) examined ownership conversions between for-profits and not-for-profits, which accounts for a small portion of ownership changes, compared to chain-related transactions. Cadigan et al. (2015) found that private investment acquisitions of chain-owned nursing homes had little impact on the financial performance of nursing homes. However, in that study, the authors focused on private investment and whole-chain transactions, which is conceptually different from this study's focus: chain's acquisition of independent nursing homes. To sum up, this study aims to fill the research gaps by (1) exploring the relationship between financial performance and chain acquisitions of independent nursing homes, and (2) using a more recent longitudinal data tracking nursing home chain acquisitions from 2000 to 2010. In particular, this study focuses on chain acquisitions of independent nursing homes in the United States. In addition, this study explores heterogeneities in chain acquisitions by chain size.

In the United States, nursing homes are heavily regulated by both federal and state governments. There are about 15,600 nursing homes serving roughly 1.4 million elderly on any given day (National Center for Health Statistics, 2015). Expenditures on nursing facilities across the country were about $160 billion in 2014 and projected to reach $270 billion in 2023 (Centers for Medicare and Medicaid Services, 2014). Medicare and Medicaid together pay nearly 80% of the total nursing home costs, while private insurance payments and out-of-pocket payments account for the rest (Kaiser Family Foundation, 2013). In contrast to the hospital industry, the nursing home industry is primarily dominated by for-profit facilities, which account for about two thirds of all nursing homes; while not-for-profit organizations and government together own just about 32% of total nursing home facilities (Harrington et al., 2011). Furthermore, chains own over 50% of the nursing homes in the United States (Banaszak-Holl et al., 2002; Harrington et al., 2011; Grabowski et al., 2016; Hirth et al., 2017).

Federal payment policies and states' legal environments have changed dramatically in the nursing home industry during the past two decades. Since the Balanced Budget Act of 1997, Medicare changed its payment system for nursing homes from a cost-plus approach to the Prospective Payment System. Evidence shows this change affected nursing homes' financial health (Qaseem et al., 2007): Five of the ten largest nursing home chains filed for bankruptcy by the year 2000 (Kitchener et al., 2005). Since then, private investment firms started entering the nursing home market by purchasing several large nursing home chains (Stevenson and Grabowski, 2008). In addition, nursing homes faced increasing liability costs and malpractice premiums in some states (Galloro, 2000). As a response, nursing homes have been constructing more complex ownership structures so they could minimize the risk of bearing legal punishments (Stevenson et al., 2006; Stevenson and Grabowski, 2008).

These policy and market factors might contribute to the nursing home industry fluctuation that involved a non-trivial amount of organizational ownership changes (Dalton and Howard, 2000). During the 1990s, the proportion of chain-owned nursing homes constantly increased from 39% in 1991 to 51% in 2000 (Banaszak-Holl et al., 2002; Grabowski et al., 2016). Interestingly, in the past decade, this growth of nursing home chains seemed to slow down as the proportion of chain owned facilities remained at around 50% (Grabowski et al., 2016). However, according to the data used in this study, the proportion of chain-related transactions remained at approximately 10% each year. More specifically, each year, about 3% of the total nursing homes in the United States would join a chain, with little fluctuation over the past two decades.

Earlier studies exploring the determinants of chain acquisitions largely focused on the hospital industry. McCue and Furst (1986), Phillips (1999), and Menke (1997) all found that chains tended to acquire independent hospitals that were financially distressed. Sloan et al. (2003) concluded that a low profit margin was consistently an important antecedent of ownership conversions in the hospital industry. Since year 2000, researchers started to explore chain acquisitions in the nursing home industry. Banaszak-Holl et al. (2002) studied acquisitions of nursing homes from 1991 through 1997. They found that nursing homes with lower quality performance were more likely to be acquired. By examining nursing homes in the United States from 1993 to 2004, Grabowski and Stevenson (2008) found that for-profit nursing homes tended to acquire declining nursing homes while not-for-profit facilities were more likely to buy improving nursing homes. Bowblis (2011) found that nursing homes facing greater financial difficulty were more likely to experience for-profit/not-for-profit ownership conversion or closure during the period of 1998 through 2004. Using data from 1998 to 2010, Cadigan et al. (2015) suggested that private investment did not seem to affect nursing homes' performance in

general. Similarly, Grabowski et al. (2016) found that low-quality nursing homes were more likely to be bought or sold by chains but noted that acquired facilities already had lower quality of care before the acquisitions. Outside of hospitals or nursing homes, a study focusing on the dialysis industry (Pozniak et al., 2010) found financial stress and better quality of care were predictors for chain acquisition of independent dialysis facilities. In addition to ownership changes, a few studies focused on nursing home closures. More competitive environment (Castle 2005), lower quality and higher Medicaid occupancy rates (Castle et al. 2009), poor prior financial performance (Zinn et al. 2009) were associated with increased risk of nursing home closures.

3.2 Conceptual framework

Theoretically, chain acquisition of independent facilities could generate benefits for both acquiring chains and targeted facilities. From the targeted facilities' perspective, acquisitions allow them to gain access to capital, centralized administrative and clinical support through the chain organization. Independent facilities may benefit from acquisitions through knowledge transfer, standardizing operational process, and effective management skills so quality of care may be improved. In addition, the joint production of facilities owned by the same chain could generate economies of scale that could reduce the purchase costs for equipment and supplies.

From a chain's perspective, the chain may seek to increase its market power by acquiring independent facilities (Wells and Banaszak-Holl, 2000; Banaszak-Holl et al., 2002). Increased market power leads to cheaper labor and supply expenses, and possibly higher private-pay prices. Acquiring more facilities could help a chain expand its reach to the markets served by the acquired facilities so it has a larger resident base. Hirth et al. (2017) indicated that nursing home chains may prefer to expand their presence across a larger geographic area without necessarily

increasing concentration in local markets. Similarly, Dafny et al. (2016) demonstrated that cross-market hospital mergers may result in higher prices. In addition, a chain may be able to offer additional services by acquiring facilities specializing in different service lines. For example, if the acquired facilities have specialty care units that were rarely offered by the chain before, the acquisition would benefit the chain in terms of expanding its product line. In addition to facility-level characteristics, previous research suggests that nursing home ownership change may be also driven by broader policy and market factors (Stevenson et al., 2006).

Following Sloan et al. (2003), I start the conceptual model by analyzing targeted independent nursing homes and acquiring chains' objectives when being involved in an ownership transaction. Consider an independent nursing home and a nursing home chain that is interested in acquiring. The current owner of the independent nursing home has an anticipated Net Present Value (NPV) until its final period, estimated at NPV_a. The chain offers a purchasing price based on its own evaluation, estimated at NPV_b. Then, the decision on a transaction depends upon the comparison between the independent nursing home owner's value NPV_a and the chain's value of the home NPV_b. If the independent home's current owner values the home more than the chain does, such as $NPV_a > NPV_b$, the nursing home is not sold. Otherwise, the independent nursing home will be acquired by the chain.

If the potential buyer can leverage its management skills and operate more efficiently, it could achieve cost savings in the long run. After the transaction, the chain could standardize its administration process and help the acquired nursing home improve its access to capital. Therefore, it is possible for a nursing home chain to offer a higher purchase price with the objective of achieving cost savings and improving profit margins in the long run. Based on the

conceptual framework stated above, Sloan et al. (2003) predicted and empirically confirmed that hospitals with worse financial performance were more likely to experience ownership changes.

Banaszak-Holl et al. (2002) argued that nursing home chains could have two acquisition strategies: "turn around" and "cream skimming". The "turn around" strategy indicates that targeted facilities had poorer performance before acquisitions. Under this strategy, chains would hope to use their management skills to improve acquired facilities' performance. In contrast, the "cream skimming" strategy suggests that chains would acquire high-performing targets. Under this scenario, chains would take advantage of the acquired facilities to enhance chains' reputation, to expand their market share or to reduce competition.

Empirical findings from most of the existing studies support the "turn around" strategy. Although evaluating the effects of chain acquisitions is beyond the scope of this study, I hypothesize that independent nursing homes with worse financial performance are more likely to be acquired by corporate chains. In addition, the size of acquiring chains may matter. The determinants of acquisition decisions could differ between large and small chains. For example, larger acquiring chains may have better resources in terms of centralized administration process and access to capital. Prior studies found significant differences between chains with different sizes in both antecedents of acquisitions (Pozniak et al., 2010) and effects of acquisitions (Banaszak-Holl et al., 2002). Therefore, I expect that larger chains are likely to acquire independent nursing homes with even worse financial performance, compared to smaller chains do.

Also note that, although this study focuses on facility-level financial characteristics that could affect chain acquisition decisions, macro-level policy and market factors such as state regulations and Medicaid payments, and other aspects such as facilities' performance on the

report cards could play essential roles in chain acquisitions as well. Evaluating how these factors affect acquisitions is beyond the scope of this study.

3.3 Data

3.3.1 Datasets

In this study, I track the chain acquisitions of independent nursing homes from 2000 to 2010. Financial measures and other covariates are lagged by one year to allow for possible contemporaneous effects on the probability of chain acquisitions. More specifically, the data comes from five sources: the Online Survey Certification and Reporting (OSCAR) system, the Medicare Cost Reports (MCRs) for nursing homes, LTC Focus, Area Health Resource File (AHRF), and National Conference of State Legislatures (NCSL).

Nursing homes' structural characteristics (e.g., chain affiliation), staffing measures, and quality information are extracted from the OSCAR. Collected and administered by Centers for Medicare and Medicaid Services (CMS), OSCAR[2] is an online data system used by the federal government to determine if Medicare/Medicaid certified nursing homes are compliant with federal regulations. Every 9 to 15 months, on average 12 months, each federally certified nursing home receives an on-site inspection conducted by local state agencies. Nursing homes in the OSCAR represent about 96% of the total nursing homes in the United States. A typical OSCAR survey includes information such as facility structural characteristics, staffing information and detailed health inspection data.

[2] Effective July 2012, the OSCAR system was replaced by the Certification and Survey Provider Enhanced Reporting (CASPER) system. In this study, I still use OSCAR as it was the name during the study period.

Medicare Cost Reports (MCRs) for skilled nursing facilities (CMS-2540-96 for fiscal years before 2010; CMS-2540-10 for fiscal years 2010) are used to extract financial information for nursing homes. Each year, every Medicare-certified nursing home is required to file its cost report in order to receive Medicare reimbursements. The report includes detailed financial information such as revenues and expenses at the facility level. Nursing homes with a reporting period of at least 360 days are included in the analysis. The financial measures are drawn from the Balance Sheet (Worksheet G) and Statement of Revenues and Expenses (Worksheet G3). In addition, I follow recent studies focusing on nursing homes' financial performance and private prices (Bowblis, 2015; Huang and Hirth, 2016) and drop observations with missing or negative values in financial measures where values should be positive. To address the outliers, observations at the top and bottom 1% values based on operating profit margins are dropped.

A selected set of county characteristics are extracted from LTC Focus and AHRF. Maintained at Brown University, LTC Focus is a website that provides a variety of aggregated data on state policies and county market forces related to nursing home care in the United State. AHRF is used to extract county-level unemployment rates and per capita income. NCSL is used to collect Certificate-of-Need (CON) laws in each state during the study period.

Because each nursing home is assigned a federal provider identification number which is available in both datasets, I use this number and year information to link the facility characteristics from OSCAR and financial information from MCRs. Then, I use county and state identifiers to extract variables from LTC Focus, AHRF, and NCSL. Nursing homes located in Alaska, District of Columbia, Puerto Rico and Hawaii are excluded because the OSCAR data is incomplete. In addition, government-owned facilities are dropped because they might have different organizational structures and objectives than private nursing homes. Furthermore,

hospital-based nursing homes are excluded because their financial information is embedded in the affiliated hospitals' cost reports. Due to unmatched nursing homes between OSCAR and MCRs or observations with missing, negative or outlier values in financial measures, the final analytical sample includes 14,186 unique nursing homes with non-missing values in financial measures between 2000 and 2010.

The nursing homes that are included in this study are facilities that were open either before or at the beginning of the study period. A very small number of nursing homes that closed during the study period are excluded. Because this study focuses on chain acquisitions of independent nursing homes, in the analytical sample, each nursing home started as independent. Then, the facility either remained independent throughout the study period or became chain-owned due to acquisitions. Therefore, nursing homes that were owned by chains before 2000 were excluded from the study sample.

3.3.2 Measures

3.3.2.1 Chain acquisitions

The main dependent variable is a binary chain acquisition indicator, with "1" indicating an independent nursing home was acquired by a chain and "0" indicating an independent nursing home remained independent in a calendar year. The chain affiliation information comes from two fields in the OSCAR: (1) if the facility has a multi-organizational affiliation and (2) name of the multi-institution. It is worth noting that the field of name of multi-institution is a text field. The raw information from this field is subject to reporting issues such as typos, abbreviations and other potential inconsistencies over the years. To improve the accuracy of the chain name variable, a recently published study (Grabowski et al., 2016) adopted an extensive line-by-line search approach to verify and correct the names of the affiliated chain for each nursing home

when necessary. In this study, I follow their approach to clean the chain variables and use the cleaned chain indicator and chain name information.

3.3.2.2 Chain size

Another dependent variable of interests is the size of acquiring chains. To explore the possible heterogeneity in acquisitions by chain size, I create a chain category variable indicating the size of the acquiring chains. In the sample, a chain owns 9-10 nursing homes on average. Therefore, a large chain is defined as an organization that owns 11 or more nursing homes nationally; while a small chain owns 2 to 10 nursing homes nationally in a given year. This dependent variable is coded "2" for an acquisition by large chains, "1" for acquisition by small chains, and "0" for independent nursing homes remaining independent.

3.3.2.3 Financial performance

In this study, I use three financial measures: operating profit margin, current ratio, and occupancy rate. Operating profit margin is defined as the ratio of operating profits to operating revenues. Operating revenues are defined as the total revenues related to direct patient care, excluding any contractual allowances and discounts or incomes from investment or donations. Operating expenses are costs related to direct patient care. Operating profits equal operating revenues less operating costs. Operating profit margin is an indicator of the overall profitability from operations of a nursing home. Previous studies focusing on financial performance of nursing homes consistently used this measure (Bowblis, 2011, 2015; Weech-Maldonado et al., 2012; Pradhan et al.,2013; Cadigan et al., 2015). Current ratio is defined as short-term assets divided by short-term liabilities. It is an indicator of short-term liquidity for nursing homes. Lower liquidity poses a higher risk of bankruptcy as well as a higher cost of capital (Wedig et al., 1988; Wedig et al., 1996; Sloan et al., 2003; Bowblis, 2011; Cadigan et al., 2015). In addition,

occupancy rate measures the operating efficiency of a nursing home, which is an important indicator for the financial health of a nursing home. In sum, low operating profit margins, low current ratios, or low occupancy rates indicate financial difficulty for a nursing home.

3.3.2.4 Covariates

I include a group of facility-level control variables from OSCAR to account for other factors which could affect the probability of chain acquisitions of independent nursing homes. More specifically, I control for profit status, number of beds, payer mix, number of health deficiencies, acuity index, presence of specialty care unit, registered nurses (RN) hours per resident day, licensed practical nurses (LPN) hours per resident day, and certified nurse aids (CNA) hours per resident day. In addition, I include a measure of each nursing home's age, defined as the number of years in operation, as an indicator for capital depreciation as well as survival prospect of the facility.

To account for macro-level factors which might affect chain acquisitions at the county and state level, I use three state policy variables: CON laws, Medicaid reimbursement rates, and Medicaid case mix reimbursement policy. At the county level, I include several characteristics including number of home health agencies per one thousand elderly, number of nurses per one thousand elderly, Herfindahl Hirschman Index based on bed size, county unemployment rate, and per capita income.

3.4 Empirical approach

The dependent variable in this study is chain acquisition of independent nursing homes and the independent variables of interest are financial measures of independent nursing homes one year before acquisition. A standard logit model is used to predict the probability that an independent nursing home is acquired by a nursing home chain in a given year during the study

period. The unit of analysis is facility-year. Chain acquisitions are tracked from 2000 to 2010. There is a one-year lag between independent variables and the acquisition indicator variable (1 = acquisition; 0 = stay independent) to allow for the potential contemporaneous effects on acquisition decisions. During the study period, each nursing home started as an independent facility at the beginning. Then, a nursing home ended either (1) when it was acquired by a chain or (2) it stayed independent throughout the study period. Therefore, nursing homes entered the model up to 11 years. Standard errors are clustered at the facility level to control for the serial correlation between observations within a facility across years. Because of the way the data is set up, the estimation here is essentially a discrete-time hazard model (Allison, 1982; Jenkins, 1995).

More specifically, the main outcome of interest is the probability of a nursing home i is acquired by a chain at time t:

$$P_{it} = Pr(T_i = t \mid T_i \geq t, \boldsymbol{x}_{it-1}) \quad (1)$$

where P_{it} is the conditional probability that a nursing home i is acquired by a chain at time t, given that the acquisition has not been occurred to the nursing home i prior to time t. Then, the logit model can be expressed as below:

$$Log\left(\frac{P_{it}}{1-P_{it}}\right) = \alpha_{t-1} + \boldsymbol{\beta}'\boldsymbol{x}_{it-1} + \varepsilon_{it-1} \quad (2)$$

where x_{it-1} are a set of time-varying facility-level predictors including the financial performance which could affect the probability of a chain's acquisition of the targeted independent nursing home. ε_{it-1} is the error term. In addition, I include a set of year dummies to control for year trends. I also account for the possible regional variation in chain acquisitions by including a set of regional dummies. The interpretation of the coefficients $\boldsymbol{\beta}'$ is the change in log odds of an independent nursing home being acquired by a chain associated with one unit change in the

predictor of interest, holding other covariates constant. To ease the interpretation, the results are presented in terms of the marginal effects (Norton and Dowd, 2018).

To test the heterogeneity in acquisitions by size of acquiring chains, a multinomial probit model is employed. The dependent variable in this model is a categorical variable that takes on the following values: 0 = remaining independent; 1 = acquired by a small chain; 2 = acquired by a large chain. The multinomial probit model is appropriate for this study because it relaxes the independence of irrelevant alternatives (IIA) assumption by using a multinomial logit model (McFadden, 1973). For example, in this study, the IIA assumption would be that the existence of acquisition by large chains has no impact on the ratio of choice between an independent nursing home remaining independent and an independent nursing home to be acquired by a small chain. However, the error terms between acquisitions by large chains and acquisitions by small chains are likely to be correlated, which would violate the IIA assumption. Instead, the multinomial probit model is more flexible, allowing the error terms to be correlated[3]. Similar to the logit model, I control for year trends and region variations in this multinomial logit model. Given the way the data is set up, this multinomial logit model is equivalent to the competing risk model in the discrete-time hazard model.

3.5 Results

Figure 3.1 illustrates the changes in proportion of chain-owned nursing homes in the sample from years 2000 to 2010. During the study period, the percent of chain-owned nursing homes decreased steadily from about 59% in 2000 to 54% in 2010. This trend is in contrast with

[3] Another option is to use a nested logit model. However, this study lacks of choice-level variables (e.g., variables specific to each type of chain acquisitions) which is required for appropriately estimating a nested logit model.

the rapid growth of chains in the nursing home industry during the 1990s (Banaszak-Holl et al., 2002) but is consistent with the findings from more recent studies (Grabowski et al., 2016; Hirth et al., 2017). Note that the study sample excludes hospital-based or government-owned nursing homes, which account for about 13% of the total nursing home-year observations. Therefore, to some extent, the sample over-represents the chain-owned facilities. The reported proportion of chain-owned nursing homes in this study is slightly higher than what was reported in recent studies (e.g., Grabowski et al., 2016) using all types of nursing homes.

Although the overall proportion of the chain-owned nursing homes remained relatively stable during the study period, especially after early 2000s, it does not necessarily indicate that chain-related transactions are few. Instead, a substantial amount of chain acquisitions and divestitures occurred during the period. More specifically, there are 14,186 unique nursing homes with non-missing financial information in the sample. Among these homes, 4440 facilities (31.3%) were always independent, 5460 facilities (38.5%) were always owned by chains, 4000 facilities (28.2%) had experienced at least one of the chain-related transactions, while 286 facilities (2%) were closed during the study period.

Table 3.1 presents the number of different types of chain related events including (1) acquisitions of independent nursing homes, (2) acquisitions of chain-owned nursing homes, (3) divestitures of chain-owned nursing homes, (4) nursing homes remaining unchanged in ownership, and (5) new nursing homes from 2000 to 2010. The percent of chain acquisitions of independent nursing homes among all nursing homes each year ranged from 2.6% to 3.5% throughout the study period, with an annual average at about 3%. Similarly, the average rates of divestiture of chain-owned nursing homes were also about 3%. On average, acquisitions of

chain-owned nursing homes accounted for about 4% of nursing homes each year. In addition, about 0.3% of the nursing homes entered the market each year.

Unlike the hospital industry, for-profit is the predominant organizational form in the nursing home industry. During the period between 2000 and 2010, a majority of the nursing homes were for-profit entities, accounting for more than 76% of the total nursing homes. Among all chain-owned nursing homes, about 83% of them were for-profit facilities.

During the study period, the number of nursing home chains gradually decreased from 815 in 2000 to 739 in 2010. Numbers of nursing homes owned by a chain varied from 2 to 541. An average nursing home chain owned about ten facilities. Using the categorization based on the number of nursing homes owned by each chain, 82.4% of the chains were small (2-10 facilities), while about 17.6% of the chains were large (11 or more facilities). This distribution remained relatively stable across years. A majority of the nursing home chains operated locally. From 2000 to 2010, about 90.4% of the nursing home chains operated in three or fewer states, while approximate 69% of the chains operated in just one state. Only slightly more than 2% of the chains operated in more than ten states.

Table 3.2 presents the overall trend of financial measures of all nursing homes in the sample from 2000 to 2010. The average operating margins for nursing homes were low, at about 0.01 across years. From 2000 to 2003, the average operating profit margins were close to zero or even negative in a few years. Since 2004, nursing homes started to improve their operating margins, ranging from 0.013 in 2004 to 0.026 in 2010. Following a similar pattern to the operating margins, current ratios, which measure the ratios of current assets to current liabilities, decreased slightly from 2.42 in 2000 to 2.2 in 2003. Then, the average current ratios gradually

increased back to 2.43 in year 2010, with little fluctuation. Average occupancy rates monotonically decreased from 86.1% in 1998 to 83.4% in 2010.

In addition to presenting the overall trend of financial measures for all nursing homes, I also compare financial performance between independent and chain-owned nursing homes, shown in the first two columns of Table 3.3. More specifically, compared to their independent counterparts, chain-owned nursing homes had significantly higher operating margins and current ratios but lower occupancy rates. In the last two columns of Table 3.3, when further separating chains based on their sizes, large chains had the highest operating margins and current ratios, compared to small chain-owned or independent nursing homes. On the other hand, occupancy rates of independent nursing homes were the highest among these three types of nursing homes, while nursing homes owned by large chains had the lowest occupancy rates.

Next, I turn to the focus of this study – chain acquisitions of independent nursing homes. Table 3.4 presents the baseline comparison of nursing homes that were (1) in the treatment group: starting as independent but ending as being acquired by chains, and (2) in the control group: remaining independent throughout the study period. In this analysis, I also exclude 286 nursing homes that closed at some point during the study period. In general, compared to independent nursing homes that remained independent during the study period, independent nursing homes that were acquired during the study period had worse financial measures at the baseline. Both types of nursing homes had negative profit margins at the baseline, reflecting the financial challenges faced by the industry after the implementation of Medicare PPS in 1998. More specifically, independent nursing homes that were later involved in chain acquisitions had an average of -0.02 in profit margins, while independent nursing homes remaining independent throughout the study period had profit margins at around -0.01. Similarly, later acquired nursing

homes had lower current ratios at the baseline than their independent counterparts did, reflecting poorer short-term liquidity and therefore higher bankruptcy risks. In addition, independent nursing homes that were later acquired by chains had lower occupancy rates by about three percentage points, which indicates lower operating efficiency levels.

This clear pattern between independent nursing homes that were acquired and those remaining independent at the baseline year is consistent across nursing homes' structural characteristics, staffing, and quality of care. More specifically, at the baseline, acquired nursing homes were more likely to be for-profit facilities, had higher proportion of Medicaid census, were slightly younger, had fewer CNA hours per resident day, and were more likely to have lower quality of care (e.g., higher number of health deficiencies, higher proportion of residents with catheter, bedsores, or physical restraint).

In short, most of these comparisons suggest that independent nursing homes that were acquired later were lower-performing facilities at the baseline. In terms of macro-level factors, later acquired independent nursing homes were located in states that had lower Medicaid rates and were less likely to have Medicaid casemix policy or CON laws in place.

Results from the discrete-time logit model are shown in Table 3.5 using different model specifications. Column (1) reports results from the model that uses financial measures as well as all other facility-level characteristics as the predictors; column (2) reports results from the model that adds county characteristics; column (3) reports results from the model that incorporates three state policy variables; column (4) reports results from the model that adds both county and state level variables. To ease the interpretation of the regression coefficients, Table 3.5 reports the marginal effects of these factors on the probability that an independent nursing home was acquired by a chain from 2000 to 2010.

Overall, marginal effects of the financial measures are fairly consistent across different model specifications. Operating profit margins, current ratios, and occupancy rates all show negative and statistically significant associations with the probability that an independent nursing home was acquired by a chain. Given the consistency of the coefficients of financial measures across different models, I focus on the discussion using the results from the full model presented in column (4). Independent nursing homes that had worse financial measures were more likely to be acquired by chains one year later. For example, a decrease of 0.01 in the operating profit margin is associated with 0.0003 ($p < 0.01$) increase in the probability that an independent nursing home was acquired by chains, holding other factors constant. To put the interpretation into more specific context, using the relative term, a decrease of 10% in the operating profit margin is associated with 0.3% increase in the probability. Similarly, a decrease in current ratio is marginally ($p < 0.10$) associated with an increase in the probability of chain acquisition. One percentage point decrease in the occupancy rate of an independent nursing home is associated with 0.0006 ($p < 0.01$) increase in the probability of chain acquisition. Using the relative term, a 10% decrease in the occupancy rate is associated with 17.7% increase in the probability of an independent nursing home is acquired by a chain. To sum up, although the magnitudes are relatively small, worse financial performance of an independent nursing home is consistently associated with an increase in the probability of that facility is being acquired by a chain.

For other facility-level controls, most of the nursing home structural characteristics have significant associations with the probability of acquisition. More specifically, for-profit status, proportion of residents relying on public payers such as Medicare and Medicaid, and presence of a specialty care unit all have positive and statistically significant associations with the probability that an independent nursing home was acquired by a chain, holding other factors constant. In

contrast, independent nursing homes that had more beds or had been in business longer were less likely to be acquired by chains, all else equal. More LPN hours per resident day and fewer RN or CNA hours per patient day are associated with an increase in the likelihood of chain acquisitions of independent nursing homes. Among all four quality indicators, only the number of health deficiencies has a positive and significant association with an independent nursing home was acquired by a chain, holding other factors constant. At the macro level, chain acquisitions of independent nursing homes were likely to occur in states with lower Medicaid reimbursement rates or states that did not have CON laws in place.

Table 3.6 presents the results of financial predictors of chain acquisitions by chain size. In this multinomial probit model, the dependent variable has three categories: independent nursing homes that were not acquired (coded as 0, the reference category), independent nursing homes that were acquired by small chains (coded as 1), and independent nursing homes that were acquired by large chains (coded as 2). Overall, different types of acquiring chains in terms of their size show some heterogeneity across measures. As hypothesized, independent nursing homes with worse profit margins are more likely to be acquired by large chains ($p < 0.05$), but not by small chains ($p > 0.10$). Lower occupancy rates are significantly associated with an increase in the probability of chain acquisitions by both small chains and large chains.

3.6 Discussion

Chain-owned nursing homes constantly account for more than half of the total nursing homes in the United States. During the past two decades, although the overall proportion of chain-owned nursing homes remained relatively steady, the nursing home industry experienced a significant amount of chain-related transactions (Grabowski et al., 2016). Mainly concerned by implications of nursing home chains on quality of care, both the U.S. government (GAO 2010,

2011) and health policy researchers (Banaszak-Holl et al., 2002; Stevenson and Grabowski, 2008; Cadigan et al., 2015; Grabowski et al., 2016; Hirth et al., 2017) raised the necessity of closely monitoring these chain transactions. Building on existing research that focused on factors associated with nursing home chains (Banaszak-Holl et al., 2002, Cadigan et al., 2015; Grabowski et al., 2016), this study evaluates the relationship between financial performance of targeted independent nursing homes and chain acquisitions. More specifically, this study contributes to existing research on nursing home chains by (1) focusing on chain acquisitions of *independent* nursing homes, (2) incorporating *financial measures* into modeling acquisition decisions, (3) exploring *heterogeneities* between small and large chain acquisitions, and (4) using a unique dataset that contains more *accurate* chain ownership information.

Overall, I find that chains are more likely to acquire independent nursing homes with worse financial performance. For example, lower profit margins, lower current ratios, and lower occupancy rates are all significantly associated with higher probabilities of independent nursing homes were acquired by chains, holding other factors constant. The association between these financial indicators of independent nursing homes and the decisions on chain acquisitions is consistent across different model specifications by adding macro-level factors such as county characteristics and state policy variables. In addition, when exploring the heterogeneity by chain size, I find that lower profit margins are significantly associated with large chain acquisitions but not small chain acquisitions. Lower occupancy rates are associated with both small and large chain acquisitions.

In general, the main findings from this study are consistent with previous literatures on predictors for ownership changes (Banaszak-Holl et al., 2002; Sloan et al., 2003; Bowblis, 2011). Lower profitability (profit margins), lower short-term liquidity (current ratios) and lower

operating efficiency (occupancy rates) are all important predictors for chain acquisitions of independent nursing homes. The nursing home industry has had thin profit margins since the Medicare PPS. This study shows that financially lower performing nursing homes are likely to be the targets for chain acquisitions. The constant organizational changes have implications on operational stabilities, service provision, staffing, and quality of care (Banaszak-Holl et al., 2002; Stevenson and Grabowski, 2008; Harrington et al., 2012; Grabowski et al., 2016). Therefore, the findings from this study raise the importance of government oversight and regulations (GAO, 2010; GAO, 2011).

In addition, both small and large acquiring chains target independent nursing homes with worse financial performance. However, compared to small nursing home chains, large chains are more likely to target independent nursing homes that have lower profit margins. Typically, larger chains have better resources in terms of centralized administration process and access to capital. Therefore, when considering acquiring independent financially lower performing nursing homes, larger chains may have more room to reduce costs after acquisitions so they can afford to take these homes with worse financial performance.

It is also worth noting that this study focuses on the antecedents of chain acquisitions of independent nursing homes. Previous literature on nursing homes (Banaszak-Holl et al., 2002) and dialysis facilities (Pozniak et al., 2010) observed both "turn around" and "cream skimming". Whether or not (and to which direction) chains can affect acquired nursing homes' performance is beyond the scope of this study. However, future studies should focus on this aspect, especially given that a majority of the current studies focusing on nursing homes are cross-sectional studies which lack the abilities of drawing causal inference. Furthermore, the risk and benefit of chain

acquisitions should continue to be evaluated because chains play an important role in the nursing home industry.

This study has several limitations. First, although the accuracy of the chain variables (chain affiliation and chain names) is improved by the careful re-coding process, reporting errors are not likely to be eliminated completely due to the subjective nature of the text field in the OSCAR. In addition, ownership structure of nursing homes has become increasingly complex in the past two decades (Stevenson et al., 2006; Stevenson and Grabowski, 2008; GAO, 2010). It is not uncommon for a nursing home to have multiple owners to separate property management from their standard daily operations. In this study, the chain ownership mainly reflects the care management aspects of nursing homes. This limitation is due to the fact that most nursing homes only report the one name for the multi-facility organization in the OSCAR. Second, the overall negative association between financial measures and the probability that chain acquisitions of independent nursing homes does not necessarily reflect a causal relationship. Although the main findings hold across different model specifications including adding a set of county characteristics and state policy variables, other unobserved factors may still mediate the relationship between financial performance and acquisition decisions. For example, the emergence of local competition from assisted living facilities or home health agencies ((Grabowski et al., 2012; Bowblis, 2014) could affect the financial performance of nursing homes and chains acquisition decisions at the same time, which could complicate the observed relationship between them. Unfortunately, this study does not have more detailed information on these alternative long-term care models. Third, this study focuses on facility-level financial performance associated with acquisition decisions. In the future, if data allows, incorporating chain-level characteristics could be more informative to reflect a more balanced perspective from

both targets and buyers in acquisition decisions. Fourth, due to the data limitation, I examine the chain acquisitions of independent nursing homes from 2000 to 2010 in this study. It does not necessarily reflect the most recent trend in the past decade. The traditional nursing home industry has been declining during the past few decades. In recent years, in the long-term care industry, more and more chain organizations own two or more product lines such as nursing homes, assisted living facilities, home health agencies, and adult day-care centers. The revenue share from traditional nursing homes operation has declined over time. Therefore, using a more recent data to examine the issue could better reflect this changing landscape.

In recent decades, states' fiscal constraints create additional challenges for nursing homes. Financial health of nursing homes has important implications on access to care, service provisions, and quality of care. Nursing homes with worse financial performance are likely to face limitations in improving quality of care and therefore creating risks for vulnerable elderly residents. In this study, I find that this type of nursing home is more likely to be acquired by chains. In general, policy makers and researchers have linked chain affiliation with poor quality of care and low staffing levels among nursing homes (Stevenson and Grabowski, 2008; GAO, 2011; Harrington et al., 2012; Grabowski et al., 2016). Since a majority of nursing homes' revenues come from federal programs such as Medicaid and Medicare, it is important for policy makers to monitor these chain acquisitions and to use predictors suggested by the existing literature to anticipate these chain related events. Public reporting has become an important policy tool in the nursing home industry to help consumers make more informed choices and to encourage providers to improve quality of care. Given the technical difficulty in accessing information such as financial data by general consumers, policy makers should consider incorporating these important financial measures into the Nursing Home Compare – the current

public reporting website for nursing homes in the United States. Such actions could be employed to better predict the probability that an independent nursing home is acquired by chains. In addition, suggested by Grabowski et al. (2016), lower quality nursing homes are more likely to be bought or sold by nursing home chains. Regulators could establish an early warning system that includes these financial measures as well as other important factors to identify lower-performing nursing homes in advance and to conduct necessary interventions to prevent these facilities from being the "hot potatoes" that are constantly involved in chain related transactions, which eventually could jeopardize the quality of care for frail elderly living in those facilities.

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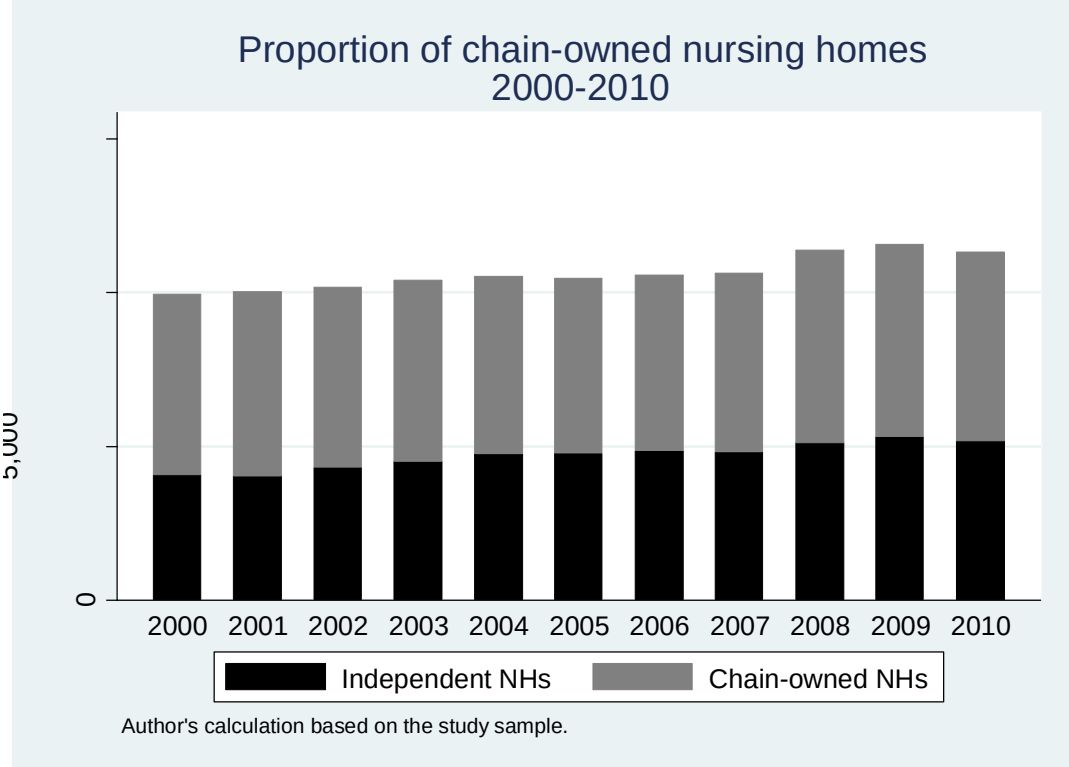
3.8 Figures

Figure 3. 1 Trend of proportion of chain-owned nursing homes from 2000 to 2010



The sample includes all nursing homes in the OSCAR with matching records in the MCRs, LTC Focus, AHRF, and NCSL from 2000 to 2010. Excluded nursing homes are: (1) facilities located in AK, HI, DC or PR; (2) hospital-based or government owned facilities; (3) facilities with missing, negative or outlier values in financial measures.

3.9 Tables

Table 3. 1 Number of chain related events among nursing homes by year

Year	Acquisition of independent NHs		Acquisition of chain-owned NHs		Divestiture of chain-owned NHs		NHs without ownership change		New NHs		Total NHs in the sample
2000	238	2.4%	338	3.4%	214	2.2%	9097	91.6%	49	0.5%	9,936
2001	287	2.9%	517	5.2%	281	2.8%	8902	88.8%	38	0.4%	10,025
2002	329	3.2%	682	6.7%	462	4.5%	8661	85.1%	39	0.4%	10,173
2003	274	2.6%	440	4.2%	360	3.5%	9299	89.4%	32	0.3%	10,405
2004	291	2.8%	454	4.3%	357	3.4%	9392	89.2%	41	0.4%	10,535
2005	334	3.2%	361	3.5%	315	3.0%	9407	90.0%	41	0.4%	10,458
2006	338	3.2%	460	4.4%	333	3.2%	9398	88.9%	37	0.4%	10,566
2007	337	3.2%	526	4.9%	321	3.0%	9400	88.4%	44	0.4%	10,628
2008	397	3.5%	530	4.7%	341	3.0%	10083	88.6%	30	0.3%	11,381
2009	320	2.8%	371	3.2%	314	2.7%	10534	91.1%	23	0.2%	11,562
2010	322	2.8%	290	2.6%	299	2.6%	10357	91.5%	46	0.4%	11,314

The sample includes all nursing homes in the OSCAR with matching records in the MCRs, LTC Focus, AHRF, and NCSL from 2000 to 2010. Excluded nursing homes are: (1) facilities located in AK, HI, DC or PR; (2) hospital-based or government owned facilities; (3) facilities with missing, negative or outlier values in financial measures.

Table 3. 2 Trend of financial measures for all nursing homes by year

	Operating profit margin	Current ratio	Occupancy rate
2000	-0.003	2.412	86.14
2001	0.000	2.368	85.91
2002	0.002	2.217	85.85
2003	-0.002	2.197	85.87
2004	0.013	2.349	85.57
2005	0.011	2.151	85.43
2006	0.012	2.357	85.35
2007	0.013	2.451	84.78
2008	0.018	2.352	84.50
2009	0.025	2.409	83.78
2010	0.026	2.432	83.41
N	116983		

The sample includes all nursing homes in the OSCAR with matching records in the MCRs, LTC Focus, AHRF, and NCSL from 2000 to 2010. Excluded nursing homes are: (1) facilities located in AK, HI, DC or PR; (2) hospital-based or government owned facilities; (3) facilities with missing, negative or outlier values in financial measures.

Table 3. 3 Comparison of financial measures for nursing homes by chain affiliation and chain size

	Independent	Chain-owned		
		All chain-owned	Small chains	Large chains
Profit margins	0.00456	0.0161***	0.00534	0.0215***
	(0.116)	(0.114)	(0.114)	(0.114)
Current ratios	2.297	2.370***	2.227**	2.443***
	(3.650)	(4.505)	(4.417)	(4.547)
Occupancy rates	85.85	84.51***	84.94***	84.29***
	(13.75)	(13.75)	(13.67)	(13.78)
Observations	51,748	65,235	21,897	43,338

The sample includes all nursing homes in the OSCAR with matching records in the MCRs from 2000 to 2010. Excluded nursing homes are: (1) facilities located in AK, HI, DC or PR; (2) hospital-based or government owned facilities; (3) facilities with missing values in financial measures. Small chains own two to ten nursing homes. Large chains own 11 or more nursing homes. Stars indicate the statistical significance based on the t-tests between each of the categories. The reference group is independent nursing homes. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 3. 4 Summary statistics at the baseline year by acquisition

	Independent NHs that were acquired by chains (treatment group)	Independent NHs remaining independent (control group)
Financial performance		
Profit margin	-0.020**	-0.011
	(0.148)	(0.140)
Current ratio	2.036***	2.474
	(4.042)	(4.165)
Occupancy rate	83.092***	86.066
	(15.706)	(15.089)
Structural characteristics		
For profit	0.789***	0.608
	(0.408)	(0.488)
% Residents on Medicare	9.591	9.880
	(11.195)	(13.996)
% Residents on Medicaid	64.379***	60.850
	(23.090)	(25.528)
Number of beds	113.927	112.287
	(54.949)	(73.239)
Presence of any specialty care unit	0.242	0.225
	(0.428)	(0.418)
Acuity Index	11.658	11.612
	(1.322)	(1.483)
Number of years in operation	11.966***	12.354
	(9.916)	(10.672)
Staffing measures		
RN hour per resident day	0.357	0.419
	(0.501)	(0.665)
LPN hour per resident day	0.750	0.761
	(0.717)	(0.888)
CNA hour per resident day	2.169***	2.387
	(1.377)	(1.888)
Quality of care		
Number of health deficiencies	6.931***	5.793
	(6.250)	(5.653)
% Residents with catheter	6.180***	5.652
	(4.817)	(5.106)
% Residents with bedsores	7.399***	6.756
	(5.346)	(5.189)
% Residents with physical restraint	11.259***	9.636
	(12.222)	(11.369)

County characteristics		
Number of home health agencies per 1000 elderly within a county	0.236	0.232
	(0.224)	(0.226)
Number of nurses per 1000 elderly within a county	41.615	40.935
	(31.726)	(29.259)
Herfindahl-Hirschmann Index	0.181**	0.167
	(0.220)	(0.208)
County unemployment rate	4.503*	4.626
	(1.993)	(2.103)
County per capita income ($)	28561.636	30058.325
	(8067.601)	(9244.876)
State policies		
State Medicaid rate ($)	132.155***	141.370
	(25.868)	(30.202)
State Medicaid casemix policy	0.598***	0.676
	(0.490)	(0.468)
State CON laws	0.688***	0.724
	(0.463)	(0.447)
Observations	*1,457*	*4,268*

The sample includes independent nursing homes at their respective baseline years. Column (1) contains independent nursing homes that were acquired later during the study period (treatment group). Column (2) contains independent nursing homes that remained independent throughout the study period (control group). Excluded nursing homes are: (1) facilities located in AK, HI, DC or PR; (2) hospital-based or government owned facilities; (3) facilities with missing values in financial measures or independent variables; (4) facilities that started as chain-owned at the beginning of the study period. Stars indicate the statistical significance based on the t-tests between treatment and control. The reference group is the control group that includes independent nursing homes remaining independent throughout the study period.* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 3. 5 Marginal effects of logit results

	(1)	(2)	(3)	(4)
Financial performance				
Operating profit margin	-0.0284***	-0.0285***	-0.0281***	-0.0278***
	(0.0102)	(0.0103)	(0.0103)	(0.0104)
Current ratio	-0.0008*	-0.0008*	-0.0008*	-0.0008*
	(0.0004)	(0.0004)	(0.0004)	(0.0004)
Occupancy rate	-0.0006***	-0.0006***	-0.0006***	-0.0006***
	(0.0001)	(0.0001)	(0.0001)	(0.0001)
Structural characteristics				
For profit	0.0203***	0.0203***	0.0210***	0.0209***
	(0.0029)	(0.0029)	(0.0029)	(0.0029)
% Residents on Medicare	0.0003***	0.0004***	0.0004***	0.0004***
	(0.0001)	(0.0001)	(0.0001)	(0.0001)
% Residents on Medicaid	0.0001**	0.0001**	0.0001**	0.0002***
	(0.0001)	(0.0001)	(0.0001)	(0.0001)
Number of beds (in 10 beds)	-0.0005**	-0.0004**	-0.0004**	-0.0004**
	(0.0002)	(0.0002)	(0.0002)	(0.0002)
Presence of any specialty care unit	0.0072***	0.0069***	0.0073***	0.0070***
	(0.0026)	(0.0026)	(0.0026)	(0.0026)
Acuity Index	0.0017**	0.0017**	0.0015*	0.0016*
	(0.0008)	(0.0008)	(0.0008)	(0.0008)
Number of years in operation	-0.0003***	-0.0003***	-0.0003***	-0.0003***
	(0.0001)	(0.0001)	(0.0001)	(0.0001)
Staffing measures				
RN hour per resident day	-0.0130***	-0.0129***	-0.0135***	-0.0134***
	(0.0046)	(0.0045)	(0.0045)	(0.0045)
LPN hour per resident day	0.0046**	0.0044**	0.0044**	0.0041*
	(0.0022)	(0.0022)	(0.0022)	(0.0022)
CNA hour per resident day	-0.0056***	-0.0054***	-0.0049***	-0.0047***
	(0.0018)	(0.0018)	(0.0017)	(0.0017)
Quality of care				

Number of health deficiencies	0.0008***	0.0009***	0.0008***	0.0009***
	(0.0002)	(0.0002)	(0.0002)	(0.0002)
% Residents with catheter	0.0003*	0.0003	0.0003	0.0003
	(0.0002)	(0.0002)	(0.0002)	(0.0002)
% Residents with bedsores	0.0002	0.0002	0.0002	0.0001
	(0.0002)	(0.0002)	(0.0002)	(0.0002)
% Residents with physical restraint	-0.00002	-0.0000	-0.0000	0.0000
	(0.0001)	(0.0001)	(0.0001)	(0.0001)
County characteristics				
Number of home health agencies per 1000 elderly		0.0021		0.0007
		(0.0049)		(0.0049)
Number of nurses per 1000 elderly		0.0001**		0.0001*
		(0.0000)		(0.0000)
Herfindahl-Hirschmann Index		0.0019		0.0004
		(0.0057)		(0.0057)
County unemployment rate		-0.0015**		-0.0013**
		(0.0007)		(0.0007)
County per capita income ($1000)		-0.0001		-0.0001
		(0.0002)		(0.0002)
State policies				
State Medicaid rate			-0.0002***	-0.0002***
			(0.0001)	(0.0001)
State Medicaid casemix policy			0.0027	0.0023
			(0.0027)	(0.0028)
State CON laws			-0.0114***	-0.0111***
			(0.0031)	(0.0032)
Observations	36866			

Standard errors in parentheses. The sample includes nursing homes that either stared as independent and remained independent throughout the study period (control group) or facilities that started as independent but were acquired by chains at some point during the study period (treatment group). Excluded nursing homes are: (1) facilities located in AK, HI, DC or PR;

(2) hospital-based or government owned facilities; (3) facilities with missing values in financial measures or independent variables; (4) facilities that started as chain-owned at the beginning of the study period. Year dummies and region dummies are estimated but not reported. Standard errors are clustered at the facility level. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 3. 6 Marginal effects of multinomial probit results

	Small chain acquisitions	Large chain acquisitions
Financial performance		
Operating profit margin	-0.0119	-0.0122**
	(0.0087)	(0.0057)
Current ratio	-0.0003	-0.0004
	(0.0003)	(0.0003)
Occupancy rate	-0.0004***	-0.0002***
	(0.0001)	(0.0000)
Structural characteristics		
For profit	0.0104***	0.0095***
	(0.0022)	(0.0017)
% Residents on Medicare	0.0001*	0.0002***
	(0.0001)	(0.0001)
% Residents on Medicaid	0.0001	0.0001**
	(0.0000)	(0.0000)
Number of beds (in 10 beds)	-0.0002*	-0.0001
	(0.0002)	(0.0001)
Presence of any specialty care unit	0.0040*	0.0029**
	(0.0022)	(0.0014)
Acuity Index	0.0007	0.0009*
	(0.0007)	(0.0005)
Number of years in operation	-0.0002*	-0.0002**
	(0.0001)	(0.0001)
Staffing measures		
RN hour per resident day	-0.0072**	-0.0052**
	(0.0036)	(0.0024)
LPN hour per resident day	0.0020	0.0026**
	(0.0021)	(0.0012)
CNA hour per resident day	-0.0021*	-0.0029***
	(0.0012)	(0.0011)
Quality of care		
Number of health deficiencies	0.0006***	0.0003***
	(0.0002)	(0.0001)
% Residents with catheter	0.0001	0.0002**
	(0.0002)	(0.0001)
% Residents with bedsores	0.0001	0.0000
	(0.0002)	(0.0001)
% Residents with physical restraint	0.0001	-0.0001
	(0.0001)	(0.0001)

County characteristics		
Number of home health agencies per 1000 elderly	0.0009	0.0001
	(0.0042)	(0.0026)
Number of nurses per 1000 elderly	0.0001**	0.0000
	(0.0000)	(0.0000)
Herfindahl-Hirschmann Index	0.0013	-0.0005
	(0.0049)	(0.0031)
County unemployment rate	-0.0010*	-0.0003
	(0.0006)	(0.0003)
County per capita income (in $1000)	-0.00004	-0.00003
	(0.0001)	(0.00009)
State policies		
State Medicaid rate	-0.0001***	-0.00004
	(0.0000)	(0.00003)
State Medicaid casemix policy	0.0012	0.0009
	(0.0023)	(0.0015)
State CON laws	-0.0070***	-0.0048***
	(0.0025)	(0.0018)
Observations	36866	36866

Standard errors in parentheses. The sample includes nursing homes that either stared as independent and remained independent throughout the study period or facilities that started as independent but were acquired by chains at some point during the study period. Small chains own 2 to 9 nursing homes. Large chains own 10 or more nursing homes. Reference category is independent nursing homes remaining independent throughout the study period. Excluded nursing homes are: (1) facilities located in AK, HI, DC or PR; (2) hospital-based or government owned facilities; (3) facilities with missing values in financial measures or independent variables; (4) facilities that started as chain-owned at the beginning of the study period. Year dummies and region dummies are estimated but not reported. Standard errors are clustered at the facility level. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$