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RESEARCH ARTICLE

Private equity ownership and nursing home quality: an instrumental variables approach

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Abstract
Since the 2000s, private equity (PE) firms have been actively acquiring nursing homes (NH). This has sparked concerns that with stronger profit motive and aggressive use of debt financing, PE ownership may tradeoff quality for higher profits. To empirically address this policy concern, we construct a panel dataset of all for-profit NHs in Ohio from 2005 to 2010 and link it with detailed resident-level data. We compare the quality of care provided to long-stay residents at PE NHs and other for-profit (non-PE) NHs. To account for unobservable resident selection, we use differential distance to the nearest PE NH relative to the nearest non-PE NH in an instrumental variables approach with and without NH fixed effects. In contrast to concerns of the public regarding quality deterioration associated with PE ownership, we find that PE ownership does not lead to lower quality for long-stay NH residents, at least in the medium term.

Keywords Private equity · Acquisition · Nursing home · Quality · Instrumental variables · Organizational structures · Differential distance

JEL Classification G34 · I11 · L22

Introduction

Private equity (PE) firms play an active but often overlooked role in healthcare markets. They acquire, operate, and sell a variety of healthcare firms. PE firms often acquire companies that

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are undervalued, inefficiently operated, or are financially distressed. Through restructuring and financial reengineering, PE firms aim to add value, enhance productivity, and eventually sell the companies for a profit. Adding value is often achieved through replacing management and aligning managerial incentives, resulting in higher revenues and lower costs (Gompers et al. 2016). For many industries, such as retail or manufacturing, these strategies may theoretically make target companies more efficient and expedite the relocation of resources. However, in healthcare industries, enhancing efficiency, productivity, and profitability are often synonymous with reducing costs in manners that lead to lower quality and worse patient outcomes.

One health care industry where PE interest has been growing is nursing homes (NHs). PE firms have been actively acquiring NHs in the United States and between 1998 and 2008, it is estimated that just under 2000 facilities, about 18% of for-profit NHs, were involved in PE transactions (GAO 2010). In the NH industry, many residents have physical and cognitive impairments (e.g., dementia) and need around-the-clock care.[1] NH quality is often not directly observable at the time of admission except through a limited number of measures publicly reported on the Nursing Home Compare website and after admission cognitively impaired residents may have difficulty communicating quality concerns to family members. Hence, NHs with stronger profit motives may provide suboptimal quality to increase profits (Chou 2002). Although all for-profit NHs may have similar incentives not to provide socially optimal quality (Grabowski and Hirth 2003), PE firms are more likely to aggressively use debt financing, concentrate ownership interests to a few parties, and use high-powered performance-based compensation. These characteristics together with the relative short-termism among PE management all raise concerns that quality may deteriorate further and resident safety may be in jeopardy when NHs are acquired and operated by PE firms (Duhigg 2007).

The media and public often view PE ownership through a negative lens, emphasizing the profit-driven nature of PE firms could lead to lower quality in NHs (Kirchgaessner 2010; The Economist 2010). However, PE ownership could also be beneficial.[2] These benefits can theoretically come from PE firms paying a greater proportion of compensation through equity ownership that gives the management team strong incentives and control to implement change, such as instituting more standardized care practices and replacing underperforming NH administrators. In addition, PE firms may also provide much needed and low-cost capital to financially distressed NHs. If these changes directly enhance how care is provided, PE firms may improve quality while at the same time increase the operational efficiency and profitability of the NHs.

In this paper, we examine the relationship between PE ownership and quality for long-stay NH residents. Although a few studies examine what occurs to NHs after being acquired by PE firms, the literature generally does not find large declines in quality (GAO 2011; Stevenson and Grabowski 2008; Harrington et al. 2012; Pradhan et al. 2013). While the best studies utilize difference-in-differences approaches and attempt to causally identify the effect of PE ownership, they do not always account for the potential statistical biases that may occur because of which NH chains PE firms choose to acquire. Furthermore, these studies only examine facility-level outcomes and do not address statistical biases due to differential selection of residents into PE and non-PE NHs.

[1] Approximately, four in five NH residents have at least one limitation in activities of daily living and about two-thirds have moderate or severe cognitive impairment (CMS 2015).

[2] Jensen (1989) provides a detailed theoretical discussion for why PE ownership could be beneficial, arguing that PE ownership can enhance efficiency and productivity through mitigating conflicts of interest between owners and managers. Kaplan and Stromberg (2009) also provide a nice summary of the beneficial effects through financial, governance, and operational engineering.

This paper differs and contributes to the literature in a number of ways. First, we utilize causal estimation techniques that account for resident selection into NHs. We have resident assessment-level data from the Minimum Data Set (MDS) that allows us to estimate a type of instrumental variables approach, (i.e. two-stage residual inclusion (2SRI) regression) with a theoretically and empirically valid exclusion restriction. This exclusion restriction, which has been utilized by a number of studies to examine NH quality,[3] is the differential distance between each resident's zip code prior to entering the NH and the nearest for-profit NH that is owned and not owned by a PE firm. This 2SRI approach allows us to estimate the relationship between PE ownership and resident-level quality accounting for any biases that may arise from selection of residents into NHs.

Our analytic sample includes long-stay NH residents in for-profit NHs located in Ohio for the years of 2005 through 2010. Studying the state of Ohio has a few advantages. Ohio has a large number of for-profit NHs. This is important because PE firms operate as for-profit entities and mostly acquire NHs that are operated as for-profits. Moreover, we follow the approach of Stevenson and Grabowski (2008) and determine which NHs are owned by PE firms by using PE transactions of NH chains.[4] Therefore, we need a state that has many NH chains that were involved in PE transactions; a situation present in Ohio during our study period. This allows us to present results which utilize both a standard 2SRI approach and a more restrictive 2SRI plus NH-fixed effect model. In addition, by utilizing data from Ohio Medicaid Cost Reports, we have a data source that provides the tax-identification number, chain name, and owner name of each NH over time. Because the NH chain information is notoriously insufficient from any single public source (Grabowski et al. 2016), the combination of tax-identification, chain name, and owner name should increase the accuracy in identifying which NHs are owned by PE firms.

We examine a total of 17 quality measures for long-stay residents; 11 of which were reported on the Nursing Home Compare website during our study period and 6 of them were collected in MDS assessment but were not publicly reported between 2005 and 2010. Although the media and advocacy community are concerned that PE ownership would lead to lower quality, our results do not support this point of view. Comparing naïve ordinary least squares (OLS) and 2SRI results, we find that ignoring resident selection into NHs leads to a systematic underestimation of the long-stay quality of NHs owned by PE firms. Based on the results from the standard 2SRI approach, residents at PE NHs receive at least similar quality to long-stay residents at other for-profit NHs not owned by PE firms. When we use the more restrictive 2SRI plus NH-fixed effect model, the conclusions drawn are similar to the standard 2SRI approach. Taken together, PE ownership does not result in quality deterioration relative to other for-profit NHs, at least in the short and medium terms (i.e., 4 to 5 years).

Private equity and nursing homes

When firms mature and management becomes entrenched, some companies may be slow in reacting to market dynamics and may allocate capital and resources in an ineffective manner. This can create tension between management and shareholders, causing the company to become undervalued. PE firms such as the Carlyle Group or Kohlberg Kravis Roberts can

[3] For examples, please see Bowblis and McHone (2013), Bowblis et al. (2016), Grabowski et al. (2013), Huang and Bowblis (2018), and Rahman et al. (2016).

[4] We utilize this approach because the decision to purchase or sell an entire chain is not likely subject to the performance of any individual facility. There is also better information available on transactions involving whole chains than individual facilities.

play a role in enhancing the value of these companies by obtaining majority control or by taking the public company private through leveraged buyouts (Kaplan and Stromberg 2009). Through majority ownership, PE firms exercise control and help restructure the acquired company to increase efficiency and profitability. Generally, PE firms accomplish this by using debt financing, strengthening corporate governance, and through reorganization of operations.[5]

Debt is an important tool for PE firms because interest on debt is tax deductible, greater debt loads can lead to higher returns on equity (i.e. greater financial leverage), and debt disciplines managers to slash unnecessary spending and avoid suboptimal investments (Jensen 1986). PE firms can add value through their relationships with lenders, which allows PE firms to access capital that is unavailable to the target company and borrow greater sums of money at lower interest rates, often with less restrictive debt covenants (Demiroglu and James 2008; Ivashina and Kovner 2011).

In addition, PE firms can be a catalyst for changes in corporate governance. The governance of acquired companies are often changed through concentrating ownership to a few parties, increasing managerial ownership, replacing top management, and reducing the size of governing boards (Acharya et al. 2013).[6] These changes all grant PE firms greater control to expedite organization restructuring. Finally, PE firms can create value by restructuring the operations of the company with the help of access to industry talent and experts who have successful careers in the field (Acharya et al. 2013). Through company-wide assessments, PE firms determine the best course of action to cut waste, reduce costs, and increase revenues.[7]

The NH industry is an example of one industry in which PE firms have applied these strategies. Though the NH industry has long argued that Medicaid, the largest payer for NH services, reimburses at low rates that sometimes are below costs, NHs have a steady demand for their services and stable revenues from government payers.[8] PE firms believed that some NHs were operated inefficiently and through their expertise and knowledge, PE firms could enhance efficiency and operate NHs at a lower cost than existing management. This made PE involvement in the NH highly attractive throughout the 2000s, with over 18% of for-profit NHs being involved in transactions with PE firms (GAO 2010). While enhancing efficiency in the NH industry can take many forms, such as improving scheduling, reducing staff turnover, or hiring more effective managers, this wave of PE acquisition caused many to question the consequences of PE ownership (GAO 2010).

In the case of the NH industry, operational changes can also mean cuts to staffing and services that directly impact the quality of care provided to NH residents. It can also imply using care practices that are less costly, but may harm residents in terms of the quality of care and quality of life—such as using antipsychotics as a form of chemical restraint for residents with dementia. The use of debt can have negative consequences by increasing the amount of revenue that must be devoted to interest payments and paying down debt instead

[5] For examples, see Kaplan (1989), Smith (1990), Lichtenberg and Siegel (1990), Harris et al. (2005), Bergstrom et al. (2007); and Cumming et al. (2007).

[6] Studies show that chief executives and top management teams at the PE-owned companies have larger equity stacks (Kaplan 1989), and these companies have a smaller and more efficient governance board that meets more frequently (Cornelli and Karakas 2008).

[7] PE firms are likely to relocate capital and labor to improve productivity (Davis et al. 2014). For example, PE firms may reallocate resources from inefficient to more efficient factories. It is these operational changes that create a negative image of PE firms, as these restructuring decisions cause closure of plants and stores, leading to lay-offs (Wong 2007; SEIU 2009).

[8] There are over 1.4 million people living in NHs (CDC 2016), over 35% of Americans at the age of 65 are expected to use a NH at least once in their lifetimes (Houser 2007), and Medicaid is the largest payer for NH services, spending over $51 billion per year (MedPac 2016) and providing a steady source of cash flow.

of reinvesting in quality improvement efforts. In addition, some PE firms may split the NH into two companies—one that operates and provides NH care and another one that owns the real estate where care is provided. While this can "unlock" the value of assets for the PE firm, it also leaves the NH operating company with fewer resources and flexibility to invest in quality if financial situations become tough. Overall, there are sufficient concerns that PE ownership of NHs can lead to reductions in staffing, higher turnover of staff, an increase in the use of low-quality care practices, or a greater incentive of managers to focus on profits instead of quality.

In industries where quality is directly observable, the ability of managers to lower quality is limited because providing a lower quality product will reduce demand and revenue. However, the ability to observe and act on quality can be difficult for typical NH consumers. Foremost, NH quality is an experience good, which means multiple aspects of quality are not fully known to consumers prior to their admission. While some quality measures are available on public websites (e.g. Nursing Home Compare), many other aspects of NH care, such as quality of life, are not publicly reported. Moreover, many NH residents are cognitively impaired and therefore have difficulties in communicating quality issues to family members. Furthermore, many residents face high switching costs to move to another facility, even when they observe poor NH quality. Taken together, a NH is not fully rewarded by providing high quality, and at the same time, not fully penalized by providing lower quality. This creates a situation in which NHs can take advantage of residents by promising to provide high quality when first choosing a NH but underperform on promises, reduce services, and skimp on quality once admitted (Hirth 1999).

These special institutional details faced by NH residents creates strong incentives for profit-motived owners of NHs to provide lower quality than nonprofit operators that may be less motivated by profits (Grabowski et al. 2013). Since PE firms are not long-term operators, but instead have the goal of exiting investments within a specific timeframe,[9] PE-owned NHs may have stronger profit motivates and reduce quality more when compared to other for-profit entities. In particular, PE ownership of NHs could lead to significant quality deterioration as the acquired NHs needs to devote more resources towards financing debt and meet other financial goals required by PE investors.

A number of studies have examined the impact of PE ownership on NHs. In one paper, Stevenson and Grabowski (2008) used a difference-in-differences approach and found that after controlling for secular time trends there was no significant difference in quality between for-profit NHs and PE-owned NHs. Other studies on PE ownership in the NH industry also found no consistent difference in quality and other operating outcomes (Cadign et al. 2015; GAO 2011; Harrington et al. 2012; Pradhan et al. 2013). A limitation in the existing literature is that these studies are all based on facility-level quality measures and do not account for resident selection into NHs. If PE ownership systematically alters NHs' admissions practices, the results in previous studies could be biased. Utilizing the resident assessment-level data and quality measures, we attempt to address the resident selection problem and provide a more detailed empirical assessment of the relationship between PE ownership and NH quality for the long-stay residents.

[9] For example, 42% of PE investments are sold within 5 years and 72% are sold within 10 years, either through a sale to a strategic buyer, a sale to another PE firm, or through listing the company on a public stock exchange through an initial public offering (i.e., IPO) (Kaplan and Stromberg 2009).

Data and empirical strategy

Data and study sample

To examine the effect of PE ownership on NH long-stay quality, we merge data from multiple sources. We obtain the Ohio Medicaid Cost Reports for years 2005–2010 from the Ohio Department of Job and Family Services. The Ohio Medicaid Cost Reports are facility-level datasets collected annually for every NH that receives Medicaid reimbursement in the state of Ohio, including information on the entity that owns the facility and their tax-identification number.

Next, the Ohio Medicaid Cost Reports are merged with data from the Online Survey, Certification and Reporting (OSCAR) System. The OSCAR database is the most comprehensive source of facility-level information (e.g. operational characteristics, staffing, and quality) on NHs that is collected as part of the annual recertification process including all NHs receiving Medicare and/or Medicaid reimbursement. We also utilize the zip code of each NH to identify the urban/rural setting of the facility via rural-urban commuting area (RUCA) codes available from the WWAMI Rural Health Research Center. Community characteristics measured at the county-level are obtained from the Area Health Resource File (AHRF).

Finally, these datasets are merged with resident assessment-level information from the Minimum Dataset (MDS) version 2.0. MDS is an assessment of all residents which occur on admission, discharge, and at least quarterly between admission and discharge. MDS contains information of the resident's home zip code prior to entering the NH and the clinical condition of the resident. MDS also contains information to construct measures of quality. To identify long-stay residents, we restrict the sample to quarterly and annual assessments.

By definition, there is no PE ownership of nonprofit and government NHs. Therefore, we limit our sample to only for-profit NHs. Additionally, because the state of Ohio has very few hospital-based facilities and these tend to be operated by nonprofit entities, our analysis is restricted to free-standing NHs. Since we are focusing on Ohio NHs, we also require the resident to have lived in Ohio prior to admission to the NH. The unit of analysis is at the resident assessment-level, resulting in 752,240 assessments of long-stay residents in 691 for-profit NHs, though exact sample sizes vary with the quality measure analyzed.

Defining private equity ownership

While our sample includes residents in all for-profit NHs, we follow the strategy utilized by Stevenson and Grabowski (2008) and identify NH chains that were acquired or divested in entirety by PE firms from 2000 to 2010.[10] We use chain names to identify which individual NHs are owned by PE firms. This approach has two main empirical advantages. First, because the decision of purchase and sale of the entire chain is not likely subject to the performance of any particular facility, this approach mitigates endogeneity problems that may arise due to why some individual NHs participate in PE transactions. In spirit, this identification strategy is similar to the literature which focuses on large chain mergers (Dafny et al. 2012; Hastings and Gilbert 2005). Second, we also have better information on whole-chain acquisitions and are able to separate different types of PE transactions, which is overlooked in the literature.

[10] This period of time that is both before and during the study period. We use 2000–2004 as a look-back period to identify major PE transactions of NHs prior to our study period. This enables us to identify NHs owned by PE firms but the transaction occurred before the study period (2005–2010).

We rely on two sources to identify NH chains that were involved in transactions with PE firms. First, we construct a list of these chains from the literature (Cadigan et al. 2015; Stevenson and Grabowski 2008; Pradhan et al. 2013). Second, we utilize Lexis–Nexis and conduct a search to identify NH chains that were acquired or divested by PE firms but were not mentioned in the literature. Next, we utilize the name of the entity which owned each NH and the tax-identification number of the owner to identify individual NH facilities that were operated or owned by these chains.[11] We then create a binary indicator variable, *PE*, indicating if a NH is owned by a PE firm any time during that calendar year. Because some NHs were owned and operated by PE firms during the entire study period of 2005 through 2010, whereas some NHs were acquired or divested by PE firms, our *PE* variable reflects if a nursing facility is contemporaneously owned by a PE firm in the year of the observation.

Overall, we are able to identify five regional or national chains involved in transactions with PE firms. All of these transactions occurred from February 2006 through December 2007. The NH chains involved in these transactions included *Harborside/Sun (2006)*, *HCR Manor Care (2007), Laurel Health Care (2006)*, *Tandem Health Care (2006)*, and *Trilogy Health Services (2007)*. These include some of the largest PE transactions involving NHs chains in the United States.[12] We classify these PE transactions into two categories: (1) transaction from a non-PE chain to a PE firm, or vice versa (HCR Manor, Harborside, and Laurel), (2) transaction from one PE firm to another PE firm (Tandem and Trilogy). This implies that NHs owned by Tandem and Trilogy are considered PE-owned for the entire study period. To the best of our knowledge, previous studies treat the acquisitions of Tandem and Trilogy as non-PE to PE transactions. This may lead to attenuation bias and underestimate the effect of PE ownership. We are unaware of other PE firms owning other NH chains in the state of Ohio for the entire study period.

Though we only observe the PE transactions associated with five NH chains, the number of NHs involved in these transactions is non-trivial and matches the general national trend (GAO 2010). Of the 691 for-profit NHs in the state of Ohio these five PE transactions affected 98 NHs (14.2% of the sample). Of these 98 NHs, 73 NHs involved switching from non-PE chain to PE-ownership or vice versa.

Defining nursing home long-stay quality

NHs provide care to short-stay, post-acute care patients and long-stay residents that need long-term care. Because these two populations are different in terms of how to measure their case-mixes and which aspects of quality are the most important, PE ownership could affect each population differently. Therefore, we focus on the quality of care provided to long-stay residents. Using MDS assessments, we construct a set of 17 binary resident-level quality measures that indicate whether long-stay NH residents had certain medical conditions or were treated with care practices that indicate poor quality. This implies that presence of a condition or care practice is associated with poor quality and we would expect the coefficient on PE ownership to be positive if PE firms provide worse quality.

We classify quality measures into two types: those publicly reported on the Nursing Home Compare (NHC) website and those that were not publicly reported during the study period of

[11] We also cross-check our data with a report on PE ownership in NHs from the Government Accountability Office (2010) to account for any chains that may operate various brand names.

[12] More details on these individual transactions are available in "Appendix A".

2005 through 2010.[13] Because the NHC website may be used by resident in selecting NHs, we examine publicly and non-publicly reported quality separately because PE-owned NHs may have stronger incentives to maintain or improve publicly reported quality while allowing quality in non-reported dimensions to deteriorate (Lu 2016). For publicly reported quality, these measures are defined and constructed for each individual resident based on the technical instructions used for long-stay resident quality measures reported on the NHC website for MDS version 2.0 (Abt Associates 2004). The only difference between our measures and those reported on the website is our observations use quarterly and annual assessments and we do not aggregate the measures to the facility level.[14] Instead, we run regressions at the resident assessment level. For non-publicly reported measures, we define each quality measure using the items in MDS outlined in the instructions for how NHs fill out the OSCAR data (CMS Form-672).[15]

Quality measures reported on the NHC website during the study period include indicators for whether the resident had a decline in physical functioning, used a catheter, had moderate-severe pain, was mostly bed or chairfast, had incontinence issues, was physically restrained, had a urinary tract infection, had significant weight loss, had a pressure ulcer (low vs. high-risk resident), and had a fall with a major injury. Quality measures that were not reported on the NHC during the study period include indicators for whether the resident had a contracture, a rash, or was using one of four classes of psychotropic medications: antipsychotic, antianxiety, antidepressant, or hypnotic medication.

Empirical specification

Main equation

Our empirical model describes how a comprehensive set of quality measures are different based on whether a PE firm owns a NH. In our dataset, the unit of analysis is the resident assessment for long-stay residents (i.e. quarterly and annual assessments). Treating $Q_{i,j,t}$ as a binary measure of quality for resident i NH j in year t, we estimated the following linear probability model:

$$Q_{i,j,t} = PE_{j,t}\beta + Resident_{i,j,t}\delta + NH_{j,t}\gamma + M_{m,t}\theta + \tau_t + \delta_j + \epsilon_{i,j,t} \quad (1)$$

where $PE_{j,t}$ is the variable of interest and indicates whether NH j in year t is owned by an PE firm. $Resident_{i,j,t}$ are resident-level control variables, $NH_{i,t}$ is a vector of time-varying and exogenous NH-level variables, $M_{m,t}$ represents local market and demographic characteristics measured at the county-level, τ_t is a set of year indicator variables, δ_j is a NH fixed effect, and $\epsilon_{i,j,t}$ is an error term. Because residents can be assessed multiple times, standard errors are clustered by residents.

[13] Some quality measures related to medication use are currently reported on the NHC website but were not publicly reported during the study period.

[14] Assessments must also have non-missing data for control variables. Our measures are consistent with the aggregate measures reported on the NHC website.

[15] https://www.cms.gov/Medicare/CMS-Forms/CMS-Forms/Downloads/CMS672.pdf.

Identification in Eq. (1) comes from the fact that some for-profit NHs are owned by PE firm and that a number of PE-owned facilities were either acquired from or divested to non-PE entities. The NH-fixed effect accounts for unobservable and time-invariant facility-level characteristics. However, because those non-PE/PE ownership switches occurred in 2006 and 2007, we only have 3 or 4 years in data of the post-transaction periods to study the effects of PE ownership. This relatively short time frame may not be sufficient to observe the full PE effects on quality, and therefore our NH-fixed effects specification suits better to identify the effect of PE ownership in the short and medium terms. For completeness, we estimate and present results for Eq. (1) with and without NH-fixed effects, though our preferred specifications include NH-fixed effects.

Instrumental variable and first stage

One major concern in estimating Eq. (1) is the differential selection of residents between NHs that are owned and not owned by PE firms. On the demand side, selection may occur because PE transactions were publicly reported in the news, and sophisticated consumers who are often wealthier and better educated, may avoid PE NHs. Sophisticated consumers are also more likely to have better unobserved health status, leaving PE NHs with residents that have worse unobservable health conditions. Without controlling for this selection, Eq. (1) can be biased towards finding PE NHs have worse quality than they actually provide.

However, resident selection into NHs can also occur from the supply side. PE NHs may be more likely to avoid residents who have worse unobservable health status. These residents require more resources and without being offset by higher reimbursement, can lead to lower profitability. In this scenario, PE NHs are likely to have residents with better unobservable health. Conversely, NHs can exploit some reimbursement mechanisms to increase profits (Bowblis and Brunt 2014). If PE NHs are able to exploit reimbursement systems, then PE NHs may be more willing to admit residents with worse unobservable health in order to increase the utilization of ancillary services, leading to higher reimbursement and profitability. This implies on the supply side, the direction of the bias from resident selection depends on which mechanism is stronger, the incentive to admit or not admit residents with worse unobservable health conditions.

Taken together, there is sufficient rationale to be concerned that resident selection may bias the effect of PE ownership on quality, though the net direction of the bias is ambiguous. To address this selection problem, we use an instrumental variables approach, specifically, two-stage residual inclusion (2SRI) (Terza et al. 2008) that allows us to causally identify the effect of PE ownership on NH quality.[16] In 2SRI, we need at least one exclusion restriction that predicts whether a resident chooses a PE-owned NH but is uncorrelated with quality. Following the literature, we utilize the differential distance calculated in miles from the residents' home to the nearest for-profit NH owned by a PE firm and the nearest for-profit NH not owned by a PE firm in the year of the observation. This distance is calculated using the zip code of where the resident lived prior to being admitted to the NH and the zip code of the facility in the OSCAR data. Positive and larger values imply that a PE-owned NH is further away, otherwise negative and smaller values suggest PE NHs are the closest for-profit NHs.

Because the proximity to a resident's or family member's home is the most important factor in selecting NHs (Shugarman and Brown 2006; Gadbois et al. 2017), differential distance has

[16] There is an ongoing debate about whether 2SRI or two-staged least squares (2SLS) is more appropriate in various estimation contexts (Basu et al. 2018; Chapman and Brooks 2016). We compared our results using 2SRI with 2SLS and found similar results.

been found to be a theoretically valid exclusion restriction and is used by a number of papers to handle the endogeneity associated with resident selection into NHs (Bowblis and McHone 2013; Bowblis et al. 2016; Grabowski et al. 2013; Huang and Bowblis 2018; Rahman et al. 2016). We provide more discussion about the statistical validity of differential distance as an exclusion restriction in "Validity of the exclusion restriction" section. With differential distance, denoted $DD_{i,j,t}$, we estimate a first stage equation using the linear probability model as follows:

$$PE_{i,j,t} = DD_{i,j,t}\sigma + Resident_{i,j,t}\theta + NH_{j,t}\pi + M_{m,t}\theta + \tau_t + \mu_{i,j,t} \quad (2)$$

where all other variables have the same interpretation as Eq. (1). Following the 2SRI approach, we estimate Eq. (2) in order to obtain predicted residuals for each observation. These residuals are then included in Eq. (1) as a covariate.

Control variables

In all regression models, we also include control variables constructed from the MDS, OSCAR, RUCA, and AHRF. At the resident assessment level, we control for each resident's age, gender, white/non-white, cognitive status (MDS 2.0 item B4, Cognitive Skills for Daily Decision-Making), activities of daily living index score, and diagnoses of major health conditions. Facility-level controls include size (number of beds), chain affiliation, occupancy rate, staffing level, skill-mix of staffing, and the payer-mix among Medicaid, Medicare, and private payers. We also include an indicator for whether the facility has a dementia special care unit.

To control for differences in geographic settings, we differentiate between urban and rural settings by categorizing rural NHs into urban areas, micropolitan towns, small rural towns, and isolated small rural towns according to Categorization A provided by the WWAMI Rural Health Research Center.[17] To control demographic and economic differences among counties, we include population density, percentage of population are above 65 years old, per capital income, and poverty rate.

Results

Summary statistics

The summary statistics for the control variables are reported in Table 1 for the overall sample (N = 752,240), resident assessments at NHs not owned by PE firms (N = 691,630), and resident assessments at NHs owned by PE firms (N = 60,610). About 8.1% of long-stay assessments are in PE NHs. On average, most long-stay residents live further away from PE NHs, with the differential distance of 13.42 miles. The average differential distance of residents that live in non-PE NHs is 14.48 miles, and the average differential distance of the PE NH residents is 1.33 miles, suggesting residents choose NHs that are close to their home.

Among the resident-level characteristics, residents in both type of facilities are rather similar except that at PE NHs, there are fewer residents who are severely cognitively impaired (10.1 vs. 14.0%). For the facility and local market characteristics, weighted by the number of

[17] http://depts.washington.edu/uwruca/ruca-uses.php.

Table 1 Descriptive statistics: long-stay residents by private equity (PE) ownership

	All for-profit facilities		Not PE owned		PE owned	
	Mean	SD	Mean	SD	Mean	SD
Key Variables						
Differential distance of PE minus non-PE	13.423	14.206	14.483	14.240	1.325	5.606
Private equity (PE) owned	0.081	0.272				
Long-stay resident characteristics						
Age	82.931	8.213	82.896	8.224	83.327	8.078
Female	0.728	0.445	0.728	0.445	0.727	0.446
Non-white	0.131	0.337	0.131	0.337	0.127	0.333
Moderately independent cognitive status	0.218	0.413	0.216	0.412	0.243	0.429
Moderately impaired cognitive status	0.542	0.498	0.544	0.498	0.521	0.500
Severely impaired cognitive status	0.137	0.343	0.140	0.347	0.101	0.301
Activities of daily living index	12.244	4.649	12.207	4.663	12.663	4.456
Diabetes	0.344	0.475	0.343	0.475	0.350	0.477
Arteriosclerotic heart disease	0.191	0.393	0.190	0.392	0.196	0.397
Heart failure	0.277	0.448	0.277	0.447	0.287	0.453
Stroke	0.230	0.421	0.230	0.421	0.233	0.423
Hip fracture	0.027	0.163	0.028	0.164	0.023	0.150
COPD	0.235	0.424	0.235	0.424	0.237	0.425
Pneumonia	0.033	0.179	0.033	0.180	0.032	0.175
Facility characteristics						
Number of beds	116.250	45.587	116.479	45.626	113.640	45.054
Chain-owned facility	0.701	0.458	0.675	0.468	1.000	0.000
% Medicaid-paid	0.649	0.136	0.655	0.134	0.584	0.145
% Medicare-paid	0.132	0.076	0.129	0.075	0.165	0.078
Occupancy rate	0.877	0.103	0.877	0.103	0.868	0.094
Dementia special care unit	0.243	0.429	0.250	0.433	0.167	0.373
Registered nurse (HPRD)	0.300	0.160	0.295	0.157	0.347	0.183
Licensed practical nurse (HPRD)	0.890	0.288	0.896	0.289	0.829	0.264
Certified nurse aide (HPRD)	2.206	0.590	2.229	0.593	1.943	0.477
Urban-Rural						
Micropolitan	0.176	0.381	0.175	0.380	0.196	0.397
Small rural town	0.070	0.255	0.063	0.242	0.154	0.361
Isolated small rural town	0.020	0.138	0.019	0.136	0.027	0.162

Table 1 continued

	All for-profit facilities		Not PE owned		PE owned	
	Mean	SD	Mean	SD	Mean	SD
County characteristics of facility						
County population density	963.771	952.734	967.426	950.888	922.060	972.579
Number of facilities in county	33.274	32.209	33.464	32.216	31.109	32.051
% County aged 65 +	14.131	2.022	14.125	2.035	14.200	1.862
County per capita income	33,922.590	5547.132	33,933.945	5605.309	33,793.013	4832.077
County poverty rate	14.163	3.797	14.131	3.788	14.527	3.884
Sample size	752,240		691,630		60,610	

The unit of observation is a resident assessment. Differential distance is defined as distance in miles of nearest for-profit facility owned by a PE minus nearest for-profit facility not owned by a PE in the year of the observation. Larger values imply the closest PE owned facility is further away
HPRD hours per resident day

resident assessments, PE NHs are more likely to be part of a chain (100 vs. 67.5%),[18] have fewer Medicaid (58.4 vs. 65.5%) and more Medicare residents (16.5 vs. 12.9%), and are less likely to have dementia special care unit (16.7 vs. 25.0%). In terms of nursing staff, direct care staffing levels are measured in terms of hours per resident day (HPRD) for registered nurse (RN), licensed practical nurse (LPN), and certificated nurse aide (CNA) staffing. PE NHs have higher RN staffing levels (0.347 vs. 0.295 HPRD) and lower LPN and CNA staffing levels (0.829 vs. 0.896 HPRD; 1.943 vs. 2.229 HPRD). Both types of NHs are relatively similar in terms of size (number of beds) and occupancy rate. Residents in PE NHs are more likely to locate in rural settings (37.7 vs. 25.7%).[19] Both types of NHs are relatively similar in other county-level characteristics.

Table 2 reports the differences in the quality outcomes by PE ownership. Overall, there are no consistent differences between NHs that are owned and not owned by PE firms. Among publicly reported measures (Panel A), PE NHs do have slightly more residents with declines in physical functioning (13.4 vs. 12.1%), bowel or bladder incontinence (46.4 vs. 44.9%), and falls with a major injury (14.0 vs. 13.1%). In terms of non-publicly reported measures (Panel B), PE owned NHs have lower prevalence of contractures (48.3 vs. 52.9%) and prevalence of antipsychotic medication use (21.0% vs. 24.9%). Residents at PE NHs are also more likely to have rash (16.1 vs. 13.5%).

Validity of the exclusion restriction

In addition to the theoretical argument that differential distance is a satisfactory exclusion restriction, we empirically examine the validity of the exclusion restriction following work by Grabowski and Hirth (2003). Specifically, we divide the sample into observations above and below the median of differential distance and compare summary statistics of key covariates between these two groups. The purpose of this exercise is that if the exclusion restriction

[18] Because our identification of PE ownership relies on chain transactions, all PE NHs in our sample by design are chain-affiliated.

[19] PE NHs are more likely to locate at non-urban settings: 19.6% in micropolitan areas, 15.4% in small rural towns, and 2.7% in isolated small rural towns.

Table 2 Summary of long-stay quality measures by private equity (PE) ownership

		All For-Profit Facilities		Not PE Owned		PE Owned	
	Sample size	Mean	SD	Mean	SD	Mean	SD
Panel A: publicly reported quality measures							
Decline in physical functioning	658,955	0.122	0.328	0.121	0.326	0.134	0.341
Catheter use	733,712	0.065	0.247	0.065	0.247	0.068	0.252
Moderate-severe pain	733,197	0.090	0.286	0.090	0.286	0.090	0.286
Mostly bed or chairfast	752,021	0.036	0.186	0.036	0.187	0.033	0.179
Bowel/bladder incontinence	568,265	0.450	0.497	0.449	0.497	0.464	0.499
Physically restrained	751,460	0.056	0.230	0.057	0.231	0.051	0.219
Urinary tract infection	752,234	0.110	0.313	0.110	0.313	0.113	0.317
Weight loss	714,022	0.078	0.268	0.078	0.268	0.077	0.267
Pressure ulcers (low risk resident)	269,942	0.019	0.136	0.019	0.137	0.015	0.122
Pressure ulcers (high risk resident)	482,213	0.102	0.303	0.103	0.303	0.095	0.293
Falls with major injury	752,194	0.132	0.339	0.131	0.338	0.140	0.347
Panel B: non-publicly reported quality measures							
Contractures	752,148	0.525	0.499	0.529	0.499	0.483	0.500
Rash	752,220	0.137	0.344	0.135	0.342	0.161	0.368
Antipsychotic medication	708,707	0.246	0.430	0.249	0.432	0.210	0.407
Antianxiety medication	752,229	0.211	0.408	0.211	0.408	0.210	0.408
Antidepressant medication	752,229	0.583	0.493	0.583	0.493	0.585	0.493
Hypnotic medication	752,234	0.059	0.237	0.060	0.237	0.057	0.232

The unit of observation is a resident assessment. Sample sizes vary due to the inclusion criteria utilized for each quality measure

is valid, then a higher (lower) proportion of residents will be admitted to PE NHs when the differential distance is below (above) the median. Furthermore, there should be little difference in summary statistics of observable covariates. If these observable covariates are balanced across the two groups, unobservable characteristics are also likely to be balanced and the exclusion restriction is less likely to be correlated with unobservable characteristics, such as unobservable health status, threatening the validity of the exclusion restriction.

As Table 3 shows, observations with the differential distance below the median (comparing to above the median) are more likely to be admitted to PE owned NHs (14.9% vs. 1.2%). More importantly, there is little variation in the summary statistics for resident covariates by having differential distance above or below the median, except that facilities with differential distance below the median have a greater proportion of non-white residents (16.8 vs. 9.4%). Also, facilities with differential distance below the median are larger, more likely to be chain-affiliated, less likely to have dementia special care unit, and less likely to be rural areas. While some of these differences become smaller by restricting the sample to only chain-based NHs, we provide a more detailed discussion of these issues in robustness checks ("Robustness checks" section). Overall, Table 3 suggests that the observable covariates are relatively balanced, mitigating the concerns that the exclusion restriction is correlated with unobservable characteristics.

At the bottom of the Table 4 we report the coefficient estimates for differential distance on the probability of a resident's choice of a PE NH. For one standard deviation increase in differential distance (14.21 miles), residents are less likely to be admitted to PE NHs by 5.68 percentage points. A F-test on the exclusion restriction in the first stage results in a F-statistics of 4406. This implies differential distance strongly predicts the use of PE owned NHs and our instrument passes weak instrument tests (Staiger and Stock 1997; Stock and Yogo 2005).

In addition to standard statistical tests for weak instruments, we conduct a falsification test that is consistent to the differential distance literature (Grabowski et al. 2013; Bowblis and McHone 2013). The intuition behind the falsification test is that differential distance should be more sensitive for a resident admitted to a NH closer to their previous residence, but should have less impact if the resident chose a NH that is further away. Therefore, the effect of differential distance on the probability of using a PE-owned NH should decrease when we restrict the sample to people who use NHs further from their prior residence. Based on our sample, which only includes residents who originally lived in Ohio, 50% of residents chose a NH that is within 8.6 miles and 75% of residents lived in a NH within 20 miles of their previous home. Therefore, we cannot use the standard 50, 100, or 200 miles travel distance as the cutoffs for the falsification test. However, we find that as the sample is restricted to those who travelled further, the predictive power of differential distance becomes weaker. For example, by restricting the sample to those who travelled at least 25 miles, the effect of one standard deviation increase in differential distance (14.21 miles) reduces the likelihood of choosing PE-owned NHs by only 0.89 percentage points. Therefore, our exclusion restriction passes the falsification test. Overall, differential distance satisfies both the exclusion restriction and relevance condition, and is a valid and strong instrumental variable in predicting the choice of PE NHs.

Table 3 Resident-level characteristics by differential distance

	Differential distance < median	Differential distance ≥ median
Private equity (PE) owned nursing homes	0.149	0.012
Long-stay resident characteristics		
Age	82.840	83.021
Female	0.724	0.732
Non-white	0.168	0.094
Moderately independent cognitive status	0.214	0.222
Moderately impaired cognitive status	0.551	0.533
Severely impaired cognitive status	0.136	0.137
Activities of daily living index	12.281	12.207
Diabetes	0.348	0.340
Arteriosclerotic heart disease	0.189	0.192
Heart failure	0.277	0.278
Stroke	0.236	0.224
Hip fracture	0.025	0.029
COPD	0.233	0.237
Pneumonia	0.033	0.034
Facility and county characteristics		
Number of beds	120.064	112.437
Chain-owned facility	0.745	0.658
% Medicaid-paid	0.643	0.655
% Medicare-paid	0.131	0.132
Occupancy rate	0.876	0.877
Dementia special care unit	0.222	0.264
Registered nurse (HPRD)	0.309	0.290
Licensed practical nurse (HPRD)	0.880	0.900
Certified nurse aide (HPRD)	2.159	2.252
Micropolitan	0.104	0.249
Small rural town	0.049	0.091
Isolated small rural town	0.010	0.029
County population density	1295.653	631.996
Number of facilities in county	43.881	22.671
% County aged 65 +	14.072	14.189
County per capita income	35,674.519	32,171.228
County poverty rate	14.753	13.573
Sample size	376,059	376,181

The unit of observation is a resident assessment. Differential distance is defined as distance in miles of nearest for-profit facility owned by a PE minus nearest for-profit facility not owned by a PE in the year of the observation. Larger values imply the closest PE owned facility is further away. The median distance is 8.5 miles

Table 4 Effect of private equity ownership on long-stay quality

Long-stay quality measure	OLS (1)	OLS w/fixed effects (2)	2SRI (3)	2SRI w/fixed effects (4)
Publicly reported quality measures				
Decline in physical functioning	0.005***	0.001	0.110***	−0.002
(N = 658,955)	(0.002)	(0.003)	(0.009)	(0.012)
Catheter use	−0.003	−0.004	−0.041***	−0.016
(N = 733,712)	(0.003)	(0.004)	(0.012)	(0.015)
Moderate-severe pain	−0.003	−0.004	−0.023*	−0.048***
(N = 733,197)	(0.002)	(0.004)	(0.013)	(0.016)
Mostly bed or chairfast	−0.004***	0.002	−0.005	−0.006
(N = 752,021)	(0.002)	(0.002)	(0.009)	(0.011)
Bowel/bladder incontinence	−0.008*	0.002	−0.067***	−0.029
(N = 568,265)	(0.005)	(0.006)	(0.023)	(0.028)
Physically restrained	0.002	0.004	0.017	0.023
(N = 751,460)	(0.002)	(0.003)	(0.012)	(0.014)
Urinary tract infection	−0.003*	0.002	−0.012	−0.018
(N = 752,234)	(0.002)	(0.003)	(0.010)	(0.013)
Weight loss	−0.003**	−0.004*	−0.026***	−0.013
(N = 714,022)	(0.002)	(0.003)	(0.008)	(0.011)
Pressure ulcers (low risk resident)	−0.003**	−0.003	−0.026***	−0.022**
(N = 269,942)	(0.001)	(0.002)	(0.007)	(0.009)
Pressure ulcers (high risk resident)	−0.008***	−0.003	−0.081***	−0.029
(N = 482,213)	(0.003)	(0.004)	(0.014)	(0.017)
Falls with major injury	0.008***	0.008**	0.004	−0.006
(N = 752,194)	(0.002)	(0.003)	(0.010)	(0.014)
Non-publicly reported quality measures				
Contractures	−0.047***	−0.041***	−0.242***	−0.173***
(N = 752,148)	(0.005)	(0.006)	(0.026)	(0.029)
Rash	0.017***	0.009**	−0.045***	−0.019
(N = 752,220)	(0.003)	(0.004)	(0.014)	(0.017)
Antipsychotic medication	−0.007	−0.001	0.046*	−0.032
(N = 708,707)	(0.005)	(0.006)	(0.024)	(0.029)
Antianxiety medication	−0.002	−0.002	0.060***	−0.083***
(N = 752,229)	(0.004)	(0.006)	(0.022)	(0.026)
Antidepressant medication	−0.009	−0.009	0.208***	−0.092***
(N = 752,229)	(0.006)	(0.007)	(0.028)	(0.033)
Hypnotic medication	−0.004*	−0.003	−0.006	0.001
(N = 752,234)	(0.002)	(0.003)	(0.011)	(0.015)

Table 4 continued

Long-stay quality measure	OLS	OLS w/fixed effects	2SRI	2SRI w/fixed effects
	(1)	(2)	(3)	(4)
First stage results				
Differential distance			−0.004***	
			(0.000)	
F-statistic on differential distance			4405.56	

Regressions include controls reported in Table 1, year fixed effects, and indicators for potentially erroneous staffing levels using a unit of observation of a resident assessment. For the catheter use and pain quality measures, additional controls are included based on CMS definitions of quality measures. Each column which reports with fixed effects include facility-fixed effects in the quality regression. Standard errors are clustered at the resident level

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

Primary findings

The effects of PE ownership on NH quality are presented in Table 4. The rows of Table 4 report the difference between PE-owned and non-PE-owned NHs for various quality measures. The first and second columns reports results for Eq. (1) using the linear probability models that are estimated by OLS, with the second column including NH fixed effects. The third and fourth columns report the effects using 2SRI, with column 4 including NH fixed effects. In all cases, positive and larger numbers would indicate that PE-owned NHs provide worse quality.

Examining the OLS results (column 1), most of the coefficient estimates are negative, suggesting better quality at PE-owned NHs. Of the 17 quality measures, 8 measures are negative and statistically significant. In contrast, only three coefficients are positive and statistically significant. When the model is estimated using 2SRI, the results (column 3) are rather consistent with most quality measures having negative signs with larger magnitudes, indicating better quality in NHs owned by PE firms. Specifically, PE-owned NHs have 4.1 percentage points fewer residents using catheters, 2.3 percentage points fewer residents with moderate-severe pain, 6.7 percentage points fewer residents with incontinence, 2.6 percentage points fewer residents with significant weight loss, and 2.6 and 8.1 percentage points fewer low- and high-risk resident with pressure ulcers. In contrast, PE-owned NHs also have 11 percentage points more residents with a decline in physical functioning and 4.6 percentage points more residents using antipsychotic medications.

In the models that control for NH fixed effects and the potential selection of residents into PE-owned NHs (column 4), 15 out of 17 measures are negative, indicating better quality at PE-owned NHs. However, only 5 results are negative and statistically significant, with PE-owned NHs having fewer residents with moderate-severe pain, pressure ulcers among low-risk residents, contracture, use of antianxiety and antidepressant medication. The lack of statistical significance in some measures may be due to the loss of statistical power, as a smaller number of observations switch from PE to non-PE or vice versa. However, the fact that most coefficient estimates are negative in direction suggests that PE firms does not provide lower quality to long-stay residents than non-PE NHs.

Robustness checks

In addition to our main results that suggest PE firms provide similar or potentially better quality than non-PE-owned NHs, we complete a number of robustness checks. These robustness checks are reported in Table 5 with Columns 1 and 8 reporting the baseline specifications from Table 4.

The first robustness check is to ensure the differential distance variable mitigates resident selection into NHs at the time of admission. Specifically, a resident that lived in a retirement community that offers independent and assisted living may have consciously considered NH quality when choosing to live in that particular retirement community (Grabowski et al. 2013; Bowblis and McHone 2013). This would invalid the exclusion restriction. To determine if this is a concern, we exclude observations where residents lived in the same zip code as the NHs they receive care (Columns 2 and 9). Restricting the sample to residents who live at NHs located in different zip codes from their previous home yields stronger and more consistent results.

Also relevant to the validity of the exclusion restriction, is the potential effect of excluding nonprofits from the study sample. While by definition PE ownership should only apply to for-profit NHs, excluding nonprofit NHs from a consumer's choice set may weaken the first stage of the 2SRI regressions. To address this concern, we repeat the analyses and include nonprofit NHs in the analytic sample. Though not reported, the results are consistent to our baseline findings. This is also consistent with prior work that studies the relationship of for-profit ownership structures and quality that found both the OLS and instrumental variable results are not sensitive to the including and excluding nonprofits in a consumer's choice set (Huang and Bowblis 2018).

Another set of robustness checks determines whether our results are sensitive to the selection of the comparison group. In one robustness check, we exclude independently operated NHs from the sample because our identification of PE ownership relies on whole-chain PE transactions (Column 3 and 10). Another robustness check focuses on the fact that there are a smaller number of residents in rural areas and differences by rurality could be driving some of the results. In this case, we restrict the sample to only urban NHs (Column 4 and 11). In both set of robustness checks, our main findings still hold both qualitatively and quantitatively.

Next, we focus on staffing variables. Because direct care nursing staff is one of the most important inputs in providing high quality care to long-stay NH residents, we are concerned that differences in staffing levels by PE ownership found in our summary statistics could be confounding the results. Thus, we run a specification that excludes staffing control variables (Column 5 and 12). We find nearly identical results, suggesting that nursing staff differences is unlikely contributing to the difference in quality.

We are also careful about different types of PE transactions and the divestiture of individual NHs. We compare those NHs always owned by PE firms to NHs that were never owned by PE firms during the study period (e.g. 2005–2010).[20] This comparison enables us to study the effect of PE ownership for a longer horizon, which is important because it could take time for corporate restructuring to have sizable effects on quality (Column 6). For this subsample, PE ownership lasts more than 6 years. Additionally, PE firms may divest individual NHs or chains if these facilities underperform or are not aligned with PE firms' strategic plan. If these NHs have worse quality on average, failing to account for these divestitures could lead to a finding that PE firms provide better quality. Thus, we run model specifications which modifies the definition of PE ownership from being contemporaneously owned by a

[20] The NHs that were always part of a PE firm were part of PE to PE transactions (i.e. Tandem and Trilogy).

Table 5 Specification checks of effect of private equity on long-stay quality

Long-stay quality measure	Regressions using 2SRI							Regressions using 2SRI w/fixed effects				
	Baseline	Different zip code	Chains only	Urban facilities	Exclude staffing	Always/never PE	Ever owned by PE	Baseline	Different zip code	Chains only	Urban facilities	Exclude staffing
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Publicly reported quality measures												
Decline in physical functioning	0.110***	0.180***	0.070***	0.232***	0.113***	0.290***	0.095***	−0.002	−0.019	0.001	0.018	−0.002
Catheter use	−0.041***	−0.077***	−0.022**	−0.047**	−0.037***	−0.130***	−0.035***	−0.016	−0.025	−0.016	−0.010	−0.016
Moderate-severe pain	−0.023*	−0.024	−0.034***	−0.023	−0.024**	−0.055*	−0.020*	−0.048***	−0.062**	−0.055***	−0.067**	−0.046***
Mostly bed or chairfast	−0.005	−0.009	0.007	−0.043**	−0.007	0.003	−0.004	−0.006	0.002	−0.009	−0.004	−0.005
Bowel/bladder incontinence	−0.067***	−0.094**	−0.088***	−0.213***	−0.060***	−0.075	−0.058***	−0.029	−0.004	−0.035	−0.085*	−0.026
Physically restrained	0.017	−0.001	0.025***	0.022	0.020*	0.038	0.015	0.023	0.005	0.029**	0.036	0.022
Urinary tract infection	−0.012	−0.017	−0.013	−0.006	−0.018**	−0.037	−0.011	−0.018	−0.024	−0.023**	−0.035	−0.016
Weight loss	−0.026***	−0.011	−0.022***	−0.012	−0.026***	−0.046**	−0.022***	−0.013	0.008	−0.019**	−0.007	−0.012
Pressure ulcers (low risk resident)	−0.026***	−0.049***	−0.022***	−0.046***	−0.029***	−0.066***	−0.023***	−0.022**	−0.050***	−0.017**	−0.041**	−0.021**
Pressure ulcers (high risk resident)	−0.081***	−0.097***	−0.074***	−0.120***	−0.081***	−0.223***	−0.070***	−0.029	−0.044	−0.023	−0.040	−0.026
Falls with major injury	0.004	0.013	0.024***	0.038**	0.007	0.010	0.004	−0.006	−0.025	−0.005	−0.016	−0.006

Table 5 continued

Long-stay quality measure	Regressions using 2SRI							Regressions using 2SRI w/fixed effects				
	Baseline	Different zip code	Chains only	Urban facilities	Exclude staffing	Always/never PE	Ever owned by PE	Baseline	Different zip code	Chains only	Urban facilities	Exclude staffing
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Non-publicly reported quality measures												
Contractures	−0.242***	−0.367***	−0.244***	−0.462***	−0.245***	−0.420***	−0.209***	−0.173***	−0.229***	−0.148***	−0.288***	−0.164***
Rash	−0.045***	−0.092***	−0.021*	−0.144***	−0.049***	−0.170***	−0.039***	−0.019	−0.058*	−0.023	−0.059*	−0.017
Antipsychotic medication	0.046*	0.048	0.004	0.127***	0.044*	0.125**	0.040*	−0.032	−0.105*	−0.020	−0.029	−0.029
Antianxiety medication	0.060***	0.131***	0.045**	0.202***	0.059***	0.188***	0.052***	−0.083***	−0.153***	−0.100***	−0.155***	−0.078***
Antidepressant medication	0.208***	0.370***	0.097***	0.360***	0.200***	0.536***	0.180***	−0.092***	−0.128**	−0.099***	−0.161***	−0.087***
Hypnotic medication	−0.006	0.023	0.007	0.025	−0.015	−0.012	−0.005	0.001	0.030	−0.009	0.020	0.000

Regressions are estimated using 2SRI or 2SRI with facility-fixed effects which include controls reported in Table 1, year fixed effects, and indicators for potentially erroneous staffing levels using a unit of obseration of a resident assessment. For the catheter use and pain quality measures, additional controls are included based on CMS definitions of quality measures. Baseline regression results come from Table 3

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

PE firm to ever owned by a PE firm between 2005 and 2010 (Column 7). These last two robustness checks are only available for the 2SRI approach that does not include NH fixed effects because the PE variable has no variation over time. Both robustness checks provide results consistent with the main findings.

As a final robustness check, we are concerned that some NH residents may have received care at NHs before and after PE transactions. Because these residents received care prior to the transaction, any assessments of these residents immediately after PE transactions may reflect the quality of care provided prior to PE transactions. Thus, we exclude all assessments of residents that occur within a window around PE transactions. These windows include 30, 90, and 180-day before and after the close date of the PE transaction. While not shown, we found that results are consistent with the baseline specification.

In summary, all robustness checks have similar signs and statistically significances. More importantly, results from the robustness checks are quantitatively and qualitatively similar to the baseline result and reinforce that our main findings are not subject to a particular model specification.

Alternative hypothesis: did PE firms cherry-pick NHs?

Overall, our results suggest that PE ownership does not lead to deterioration in quality when compared to for-profit NHs that are not owned by PE firms. Yet, an alternative hypothesis is that PE firms cherry-pick NHs chains that had superior quality prior to their acquisitions. If this is the case, PE firms do not really enhance quality, but instead just select the outperformers that have better quality than other for-profit NHs. Similarly, if PE NHs had mediocre quality prior to being acquired, mean revision can lead to better quality. Because all non-PE to PE transactions in our study occurred between 2006 and 2007, we use 2005 as a pre-transaction year. We then examine, among for-profit NHs in 2005 that were not contemporaneously owned by a PE firm, whether there are systematic differences in quality for NHs that were eventually acquired by a PE firm in the study period. Because there is no change of PE ownership in the pre-acquisition period and NH-fixed effects are not feasible, we only run OLS and standard 2SRI regressions. The results of these regressions are reported in Table 6.

Overall, based on OLS results, we do not find consistent quality differences in the pre-acquisition period. Only 5 of 17 measures (three negative and two positive) are statistically significant and the remaining measures have mixed directions of the effect. When 2SRI is utilized, the coefficient estimates for those eventually acquired by a PE firm are negative for 13 of 17 quality measures and statistically significant at conventional levels for 6 measures. Of the four quality measures that are positive, three are statistically significant, with three of these measures being the use of various psychoactive medications. Synthesizing all the results, NH chains owned by PE firms had better or at least similar publicly reported quality as other for-profit NHs, and after acquisition, PE ownership does not lead to deterioration of quality.

Limitations

Our robustness checks find consistent results across a number of various specifications though we acknowledge a few limitations. Foremost, our statistical method addresses resident selection and finds that PE NHs have similar or potentially better long-stay quality than other for-profit NHs. While we find this result for clinical quality measures that can be calculated

Table 6 Quality differences for NHs acquired by PE firms in pre-acquisition period (2005)

Long-stay quality measure	OLS	2SRI
Publicly reported quality measures		
Decline in physical functioning	−0.001	0.31***
(N = 79,754)	(0.005)	(0.065)
Catheter use	−0.003	−0.136*
(N = 88,206)	(0.005)	(0.076)
Moderate-severe pain	0.025***	−0.124
(N = 88,171)	(0.007)	(0.089)
Mostly bed or chairfast	−0.004	−0.019
(N = 90.179)	(0.003)	(0.055)
Bowel/bladder incontinence	−0.039***	−0.239
(N = 67,426)	(0.009)	(0.138)
Physically restrained	−0.003	−0.103
(N = 90,200)	(0.004)	(0.074)
Urinary tract infection	−0.010**	−0.037
(N = 90,201)	(0.005)	(0.068)
Weight loss	0.005	−0.142**
(N = 86,934)	(0.004)	(0.061)
Pressure ulcers (low risk resident)	0.007	−0.107**
(N = 37,259)	(0.004)	(0.051)
Pressure ulcers (high risk resident)	−0.003	−0.381***
(N = 52,925)	(0.007)	(0.105)
Falls with major injury	0.007	−0.073
(N = 90,197)	(0.005)	(0.072)
Non-publicly reported quality measures		
Contractures	−0.046***	−0.697***
(N = 90,200)	(0.010)	(0.142)
Rash	0.000	−0.244***
(N = 90,200)	(0.006)	(0.087)
Antipsychotic medication	0.030***	0.211
(N = 85,675)	(0.009)	(0.137)
Antianxiety medication	0.011	0.622***
(N = 90,199)	(0.008)	(0.120)
Antidepressant medication	0.008	0.646***
(N = 90,200)	(0.011)	(0.153)
Hypnotic medication	0.005	−0.070
(N = 90,200)	(0.005)	(0.069)

Regressions are restricted to non-PE owned for-profit NHs in 2005. The reported effects are for the NH was ever owned by a PE firm during the study period. Regressions include controls reported in Table 1, year fixed effects, and indicators for potentially erroneous staffing levels using an observation of a resident assessment. For the catheter use and pain quality measures, additional controls are included based on CMS definitions of quality measures. Standard errors are clustered at the resident level. Sample sizes vary with quality measure because of how CMS defines the inclusion criteria for each quality measure

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

from the MDS, NH quality is multidimensional and these results may not hold for other measures of quality, such as resident and family satisfaction. Furthermore, our statistical method does not allow us to test the mechanisms that lead to any quality difference, therefore further research is needed to understand what drives these differences.

Our analysis is also limited by being restricted to the state of Ohio. Although we identify regional and national chains that were acquired by PE firms, it is still possible that PE firms own different types of NHs in other states. We use two PE-to-PE chain transactions to study the longer-term effect of PE ownership, but the majority of our statistical identification relies on non-PE-to-PE chain transactions and only have three to four years post-acquisition. Therefore, we are not able to assess the complete long-term PE effects, especially after their divestiture. It is estimated that about 23% of large public-to-private PE transactions across all industries in the 1980s went bankruptcy at some point (Andrade and Kaplan 1998) and this has come to fruition in the NH industry. In March of 2018, HCR ManorCare, one of the largest PE acquisition of NHs, filed for bankruptcy with $7.1 billion of debt on its balance sheet (Rucinski 2018). This recent bankruptcy highlights the need for longer-term evaluations and better understanding how PE-owned NHs weather the business and regulatory adversaries.

Conclusion

Prior studies have argued that for-profit NHs have the ability and incentive to take advantage of residents by skimping on quality in order to increase profits (Chou 2002). Given this incentive, the wave of high-profile PE acquisitions in 2000s have raised concerns from research and advocacy communities that NH residents may be exploited by PE firms. These acquisitions are often financed through large amounts of debt and PE firms expect to sell the target companies within a few years. Comparing to traditional for-profit NHs, PE ownership creates stronger incentives and pressures to skimp on quality for higher short-term profit. In addition, PE firms often acquire majority stakes of target companies and institute a smaller governing board. The concentrated ownership to fewer shareholders and smaller governing board create substantial control power to swiftly restructure the acquired companies. Combining stronger profit motives and more powerful corporate control, when incentives are not aligned with residents' interests, PE ownership theoretically can significantly lower NH quality and hurt vulnerable residents.

However, through rigorous statistical analysis, we find such concern is not consistent with the empirical evidence, at least in the short and medium timeframe. While we find suggestive evidence that PE firms acquire NH chains that had better quality, after adjusting for resident selection using 2SRI, we find that quality among long-stay residents in PE NHs is generally similar, and in some cases may be better than other for-profit NHs. These results together provide evidence that PE ownership does not deteriorate NH quality. Our findings are consistent even when we impose additional facility or market restrictions in the robustness analysis. Despite a growing and significant role in healthcare markets, our knowledge of PE ownership in healthcare firms is still very limited and many questions remain unanswered. For example, this paper focuses on long-stay residents who need chronic care. It is not clear if these results directly apply to post-acute care patients who focus on regaining functioning and returning home. Furthermore, if PE firms do not lower quality to enhance profitability, do they instead target premium consumers at the high-end markets? Or, do PE firms more aggressively engage in upcoding to increase reimbursements? In the era of tight-

ening public funding, further examination of PE ownership on pricing and billing practice can help to more comprehensively evaluate the consequences of PE ownership in the healthcare sector.

Appendix A: information of PE acquisitions

HCR Manor Care

Through a $6.3 billion buyout ($5.5 billion borrowed), the private-equity firm, Carlyle group, acquired Manor Care in 2007 (The Deal 2007), and the transaction was completed in December 2007. At the time of transaction, Manor Care was a publicly traded company that employed more than 60,000 workers.

Harborside/Sun

In 1998, Harborside was purchased by a private-equity firm, Investcorp. Harborside was later sold to Sun, a public traded nursing home chain in 2006 for $625 million, which included $350 million in cash and $275 million in debt (The Deal 2006).

Laurel Health Care

In February 2006, Formation Capital Health Care bought Ohio-based Laurel Health Care for "nearly $200 million," as reported in July 2006 in The Senior Care Investor newsletter. Laurel Health Care had 26 facilities and 2736 beds. Four months later, Formation sold Laurel Health Care along with five other senior housing groups, totaling 186 facilities and 21,000 beds, to GE Healthcare Financial Services for $1.4 billion, according to a GE news release (GRBJ 2007).

Tandem Health Care

Behrman Capital, a private equity firm, sold Tandem Health Care to other private equity firms (JER Partners and Formation Capital) in July 2006. The deal was valued at $620 million.

http://www.behrmancap.com/behrman-capital-sells-tandem-health-care-to-jer-partners-and-formation-capital-in-620-million-transaction/.

Trilogy Health Services

A Swiss private-equity firm, Lydian Capital, paid $350 millions to purchase Trilogy Health Services in 2007 from a Chicago-based private-equity frim, Frontenac. At the time of the transaction, Trilogy employed more than 5100 workers at 44 long-term care facilities in Ohio, Kentucky, Michigan, and Indiana (Irish Independent 2007). In 2015, Lydian sold Trilogy to Griffin American Healthcare for $1.12 billion (Sunday Business Post 2015).

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