

Does Private Equity Investment in Healthcare Benefit Patients? Evidence from Nursing Homes

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Presented by Lucas Do and Yibo Sun

Motivation

- Private Equity (PE) ownership has improved productivity in other sectors, due to its distinct incentive to quickly increase firm value.
- The healthcare sector could be different due to government regulations and subsidies, insurance, and friction in information on quality.
- PE activity in U.S. healthcare has been rising, with total investment increasing from less than \$5 billion in 2000 to more than \$100 billion in 2018.
- Focus: PE ownership of nursing homes.

Outline

- Institutional Background
- Data and descriptive statistics
- Empirical Strategy:
 - Instrumental variable estimation
 - Marginal Treatment Effects
- Results

Institutional Background – Nursing Homes

- Nursing homes provide both short-term rehabilitative stays and long-term custodial stays.
- Medicare and Medicaid account for 75% of revenues.
- About 70% of nursing homes are for-profit.
- The largest component of operating cost is nursing staff, including certified nurse assistants (60%), licensed practical nurses (20%), and registered nurses (20%).
- Difficult for patients to assess nursing home quality. Patient demand does not respond to poor quality scores.

Institutional Background – PE Control

- Leveraged buyouts: a target firm is acquired primarily with debt financing and a small portion of equity.
- Fund managers' compensation depends on increasing portfolio company value.
- Short-term time horizon of PE investments could push managers to maximize short-term profits at the expense of long-term reputation and performance.
- PE owners often sell real estate assets shortly after the buyout of a nursing home.

Institutional Background – PE Control

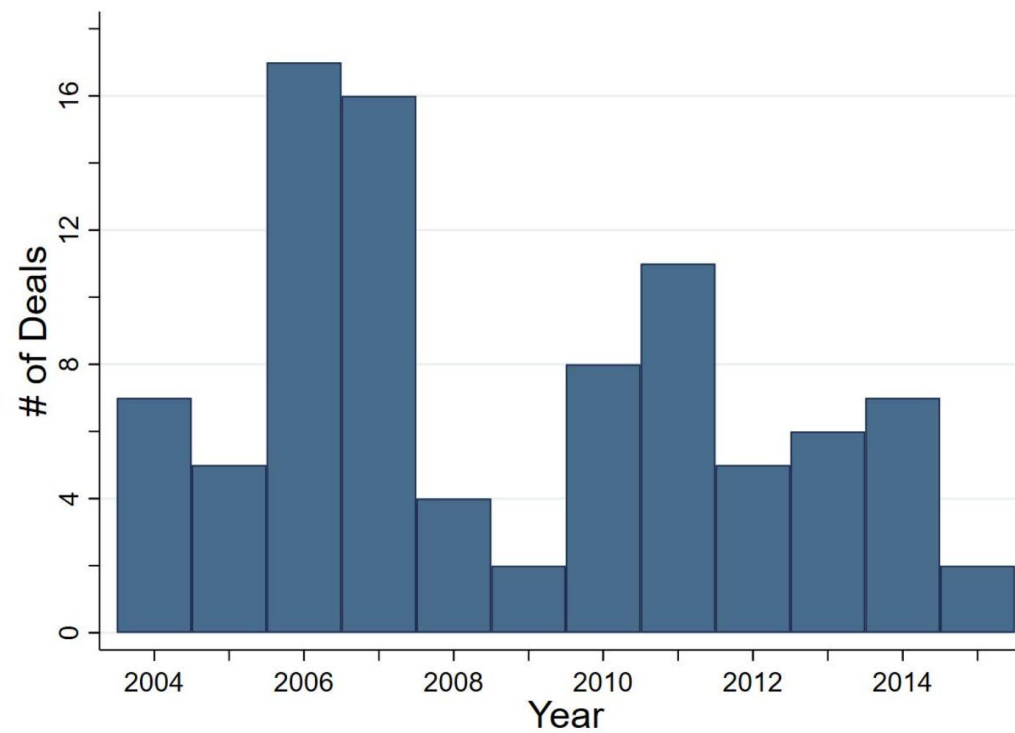
- The effects of PE ownership on patients are theoretically ambiguous.
- Better management and access to credit may improve care quality.
- On the other hand, quality may deteriorate due to cost cutting and interest and lease payments.

Data

- Facility-level annual data 2000 - 2017: 15,000 unique nursing homes in each year; patient volume, nurse availability, etc.
- Patient-level data for fee-for-service Medicare beneficiaries 2004 - 2016: demographics, mortality, claims.
- Restrict to the subsample of first nursing home stays (> 7 million patients over 12 years)
- Outcomes: mortality, amount billed to Medicare, antipsychotic medication, etc.
- a proprietary list of transactions in the “elder and disabled care” sector compiled by Pitchbook Inc. (128 deals, 1,674 facilities)

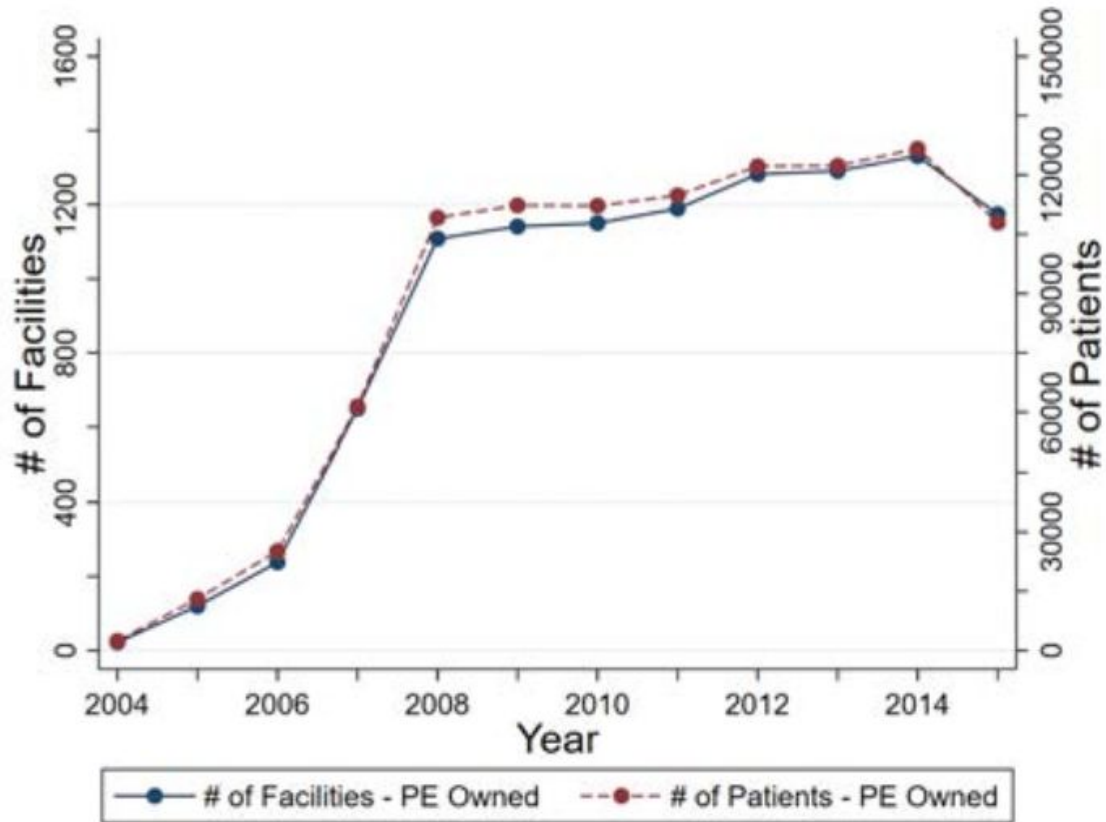
PE deals

Figure B.1: PE deals for Nursing Homes by Year

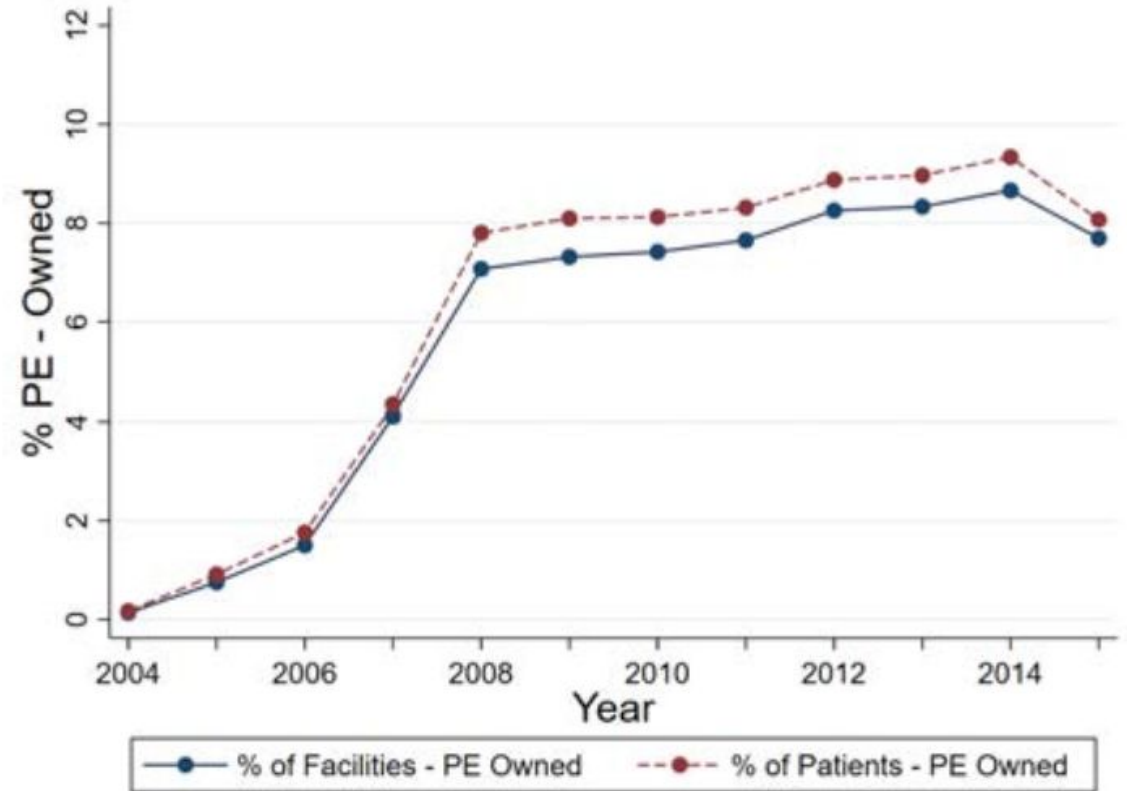


Note: This figure presents the number of unique deals for active nursing homes by PE firms for each year over the period 2004–2015.

PE Deals



Number of Facilities and Patients Acquired



Percentage of Facilities and Patients Acquired

Descriptive Statistics – Facility Attributes

	All		Not PE-owned		PE-owned	
	Mean	SD	Mean	Count	Mean	Count
A. Facility Level Attributes						
Overall Five-Star Rating	3.17	1.30	3.20	127,441	2.83	10,763
Deficiency Five-Star Rating	2.84	1.25	2.86	127,441	2.62	10,763
Staff Hours per Pat. Day	3.59	1.49	3.60	271,118	3.38	12,990
Nurse Assistant Hours per Pat. Day	2.28	0.79	2.29	271,118	2.06	12,990
Licensed Nurse Hours per Pat. Day	0.82	0.46	0.82	271,118	0.82	12,990
Registered Nurse Hours per Pat. Day	0.46	0.57	0.46	271,118	0.49	12,990
Number of Beds	104.48	56.60	104.11	271,118	112.34	12,990
Admissions	184.16	166.97	180.40	271,118	262.47	12,990
Ratio Black	0.10	0.17	0.10	271,118	0.12	12,990
Ratio Medicaid	0.60	0.24	0.60	271,114	0.60	12,990
Ratio Medicare	0.15	0.17	0.15	271,114	0.18	12,990
Ratio Private	0.25	0.19	0.25	271,114	0.22	12,990
Management Fees (2016\$)	7,076	120,673	6,001	219,231	25,833	12,564
Building Lease (2016\$)	5,860	80,223	4,825	219,262	23,919	12,564
Interest Expense (2016\$)	12,911	163,562	5,588	219,291	140,733	12,564
Cash on Hand (2016\$)	1,110,000	10,600,000	1,150,000	219,257	516,772	12,554

Descriptive Statistics – Patient Attributes

	All		Not PE-owned		PE-owned	
	Mean	SD	Mean	Count	Mean	Count
B. Medicare Patient Attributes						
Age	81.41	8.10	81.46	6,668,539	80.92	697,414
Female	0.64	0.48	0.64	6,668,539	0.62	697,414
Black	0.08	0.27	0.08	6,668,539	0.09	697,414
White	0.88	0.32	0.88	6,668,539	0.88	697,414
Married	0.34	0.47	0.34	6,668,539	0.35	697,414
Charlson Score (Previous) > 2	0.27	0.44	0.27	6,668,539	0.29	697,414
Cardio-Vascular Disease	0.18	0.39	0.18	6,668,539	0.18	697,414
Injury	0.19	0.39	0.19	6,668,539	0.19	697,414
Other	0.63	0.48	0.63	6,668,539	0.63	697,414
Dual Eligible	0.18	0.38	0.18	6,668,539	0.17	697,414
Differential Distance (Miles)	14.87	16.70	16.21	6,668,539	2.11	697,414
Mortality (Stay + 90 Days)	0.17	0.38	0.17	6,668,539	0.18	697,414
Starts Anti-Psychotics	0.06	0.23	0.06	6,668,539	0.06	697,414
Mobility Reduces	0.54	0.50	0.53	6,668,539	0.62	697,414
Develops Ulcers	0.09	0.28	0.09	6,668,539	0.09	697,414
Pain Intensity Increases	0.27	0.45	0.27	6,668,539	0.30	697,414
Amount Billed per Patient Stay (2016\$)	13,600	12,200	13,500	6,668,539	14,800	697,414
Amount Billed per Patient Stay + 90 Days (2016\$)	21,100	20,100	20,900	6,668,539	22,600	697,414

Targeting

Facilities are more likely to be targeted if they

- 1) are in more urban counties;
- 2) are in states with higher elderly population shares;
- 3) are chain-owned;
- 4) have a higher share of Medicare patients;
- 5) have a lower Five Star overall rating.

⇒ need to estimate the effects of PE ownership within-facility.

	Mean	(1)	(2)	(3)	(4)	(5)
Urban Indicator	0.56	0.193*** (0.037)				0.105** (0.041)
State Elder Ratio	0.24	4.340*** (1.328)				18.819*** (3.906)
1(Chain)	0.53		0.835*** (0.033)			0.367*** (0.029)
Hospital-Owned	0.07		-0.221*** (0.053)			-0.003 (0.067)
Log(Beds)	4.5		0.287*** (0.030)			0.086*** (0.032)
Admits Per Bed	2.08		0.051*** (0.007)			0.009 (0.015)
Ratio Medicaid	0.60			-0.879*** (0.117)		-0.434* (0.229)
Ratio Private	0.25			-1.441*** (0.144)		-0.422* (0.236)
Ratio Black	0.10			0.002 (0.099)		
Overall Rating	3.15				-0.075*** (0.015)	-0.066*** (0.015)
Staff Hr per Patient Day	3.55				-0.022 (0.018)	
Observations		235,670	218,592	218,592	103,831	103,831
Y-Mean (pp)		0.6	0.6	0.6	0.6	0.6

Targeting

PE targets

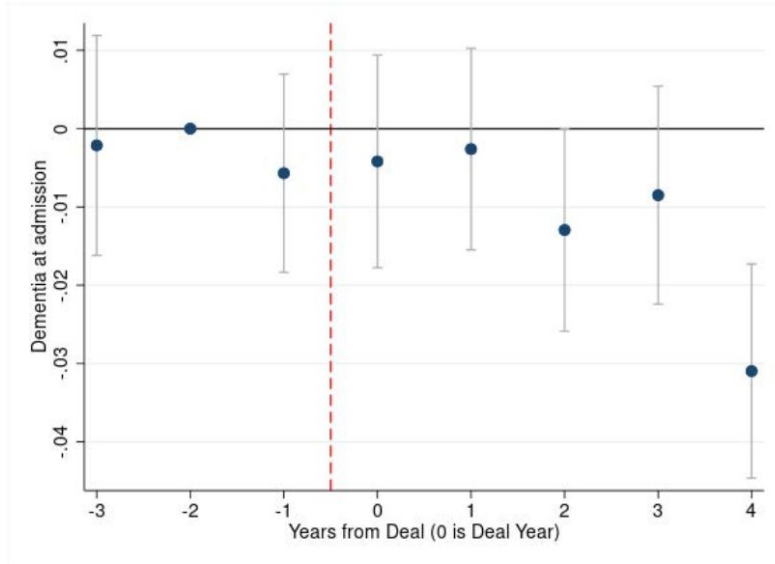
- are slightly larger, have fewer staff hours per resident and a lower Overall Five Star rating.
- bill about 10% more per stay.
- in more urban counties and in states with higher elderly population shares.
- are more likely to be chain-owned.
- have a higher share of Medicare patients.

⇒ Need to estimate the effects of PE ownership within-facility.

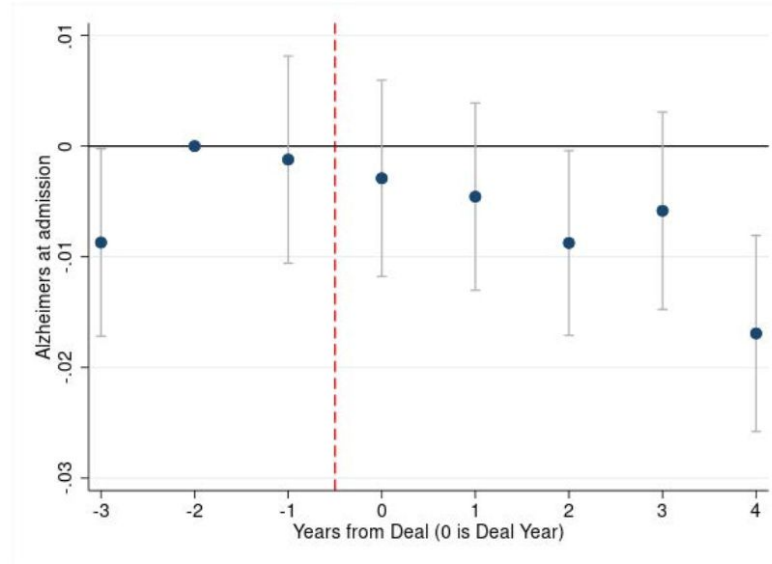
Empirical Strategy

- Concerns:
 - Targeting of facilities acquired by PE \Rightarrow include facility fixed effects
 - Differential customer selection following PE ownership \Rightarrow a differential distance instrument, exploiting patient preference for nearby healthcare providers
 - PE firms could target geographic markets with desirable trends.
- Instrument: Difference between two distances
 - from a patient's home zip code to the closest PE-owned facility zip code;
 - from the patient's residence to the nearest non-PE facility zip code.
- The instrument varies both across zip code and over time.

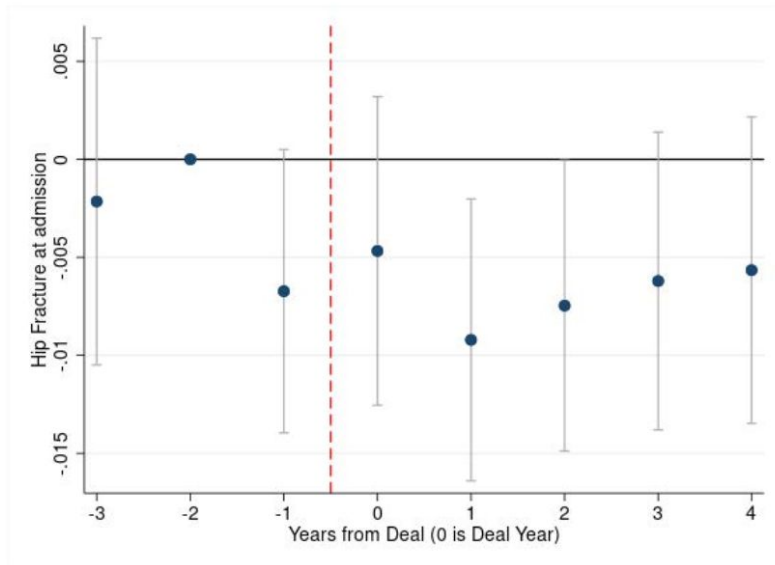
Figure B.3: Initial Patient Assessments



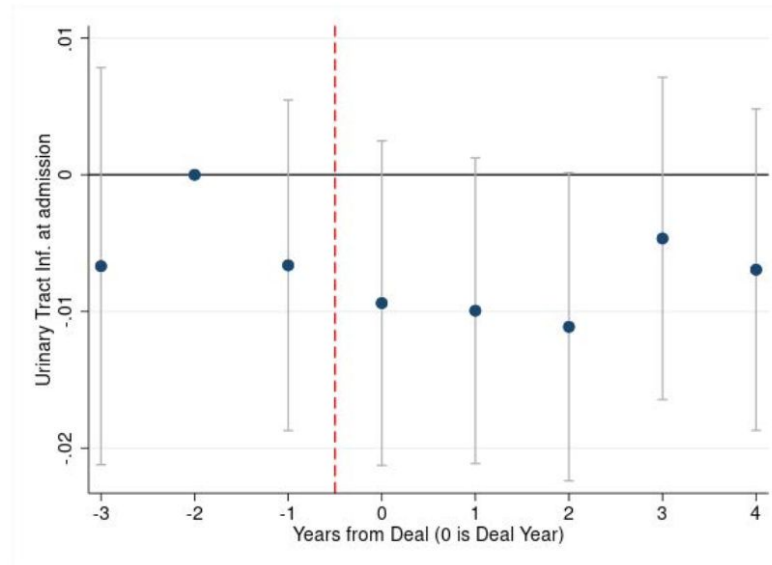
A: Dementia



B: Alzheimers



C: Hip Fracture



D: Urinary Tract Infection

Specification

$$PE_{i,j,r,t} = \alpha_j + \alpha_{r,t} + \zeta_1 D_i + \zeta_2 D_i^2 + X'_{i,z} \xi + \nu_{i,j,r,t} \quad (1)$$

$$Y_{i,j,r,t} = \alpha_j + \alpha_{r,t} + \phi PE_{i,j,r,t} + X'_{i,z} \gamma + \varepsilon_{i,j,r,t} \quad (2)$$

- D_i : differential distance;
- $X_{i,z}$: patient risk controls including age, indicators for gender, marital status, dual eligible, and 17 disease categories.
- Robustness Checks: adding time-varying socioeconomic variables at the patient's zip code-year level and omitting all controls.
- Standard errors are clustered by facility.

Identifying Assumptions

- After conditioning on covariates, unobserved characteristics correlated with the outcomes of interest are not correlated with differential distance.
- Monotonicity: a decrease in differential distance makes all patients more likely to choose a PE-owned facility.
- Tests for exclusion restriction:
 - balance of patient characteristics
 - including patient-level controls
 - including time-varying zip code-level socioeconomic controls;
 - using more granular market definitions and including market-year FEs

Balance of Patient Characteristics

- Patient characteristics are extremely similar across the two groups.

Table 3: Balance of Patient Characteristics

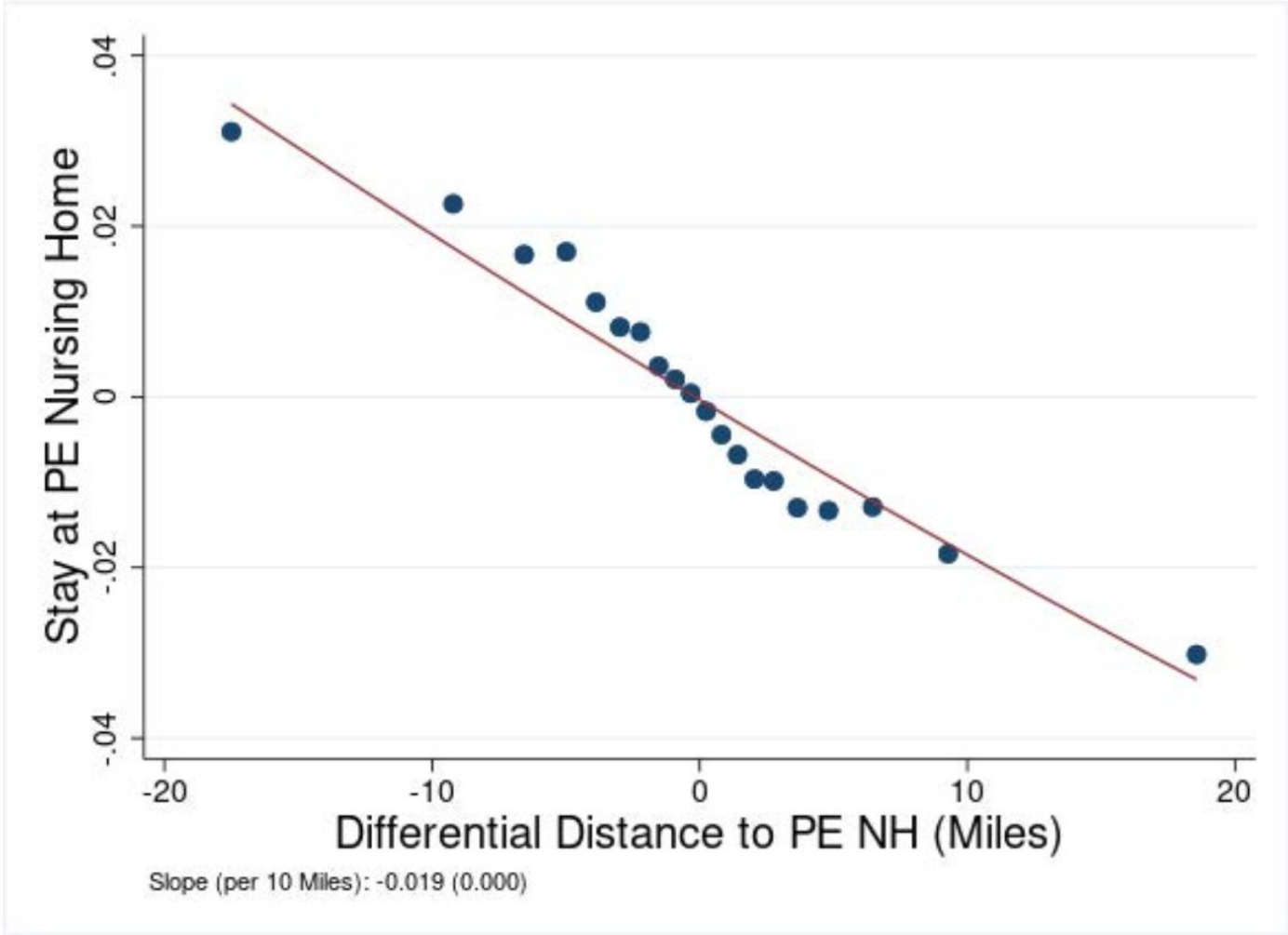
Patient Attribute	(1) DD < Median	(2) DD > Median
Differential Distance	2.70	27.04
PE-owned Nursing Home	0.17	0.02
Age	81.40	81.42
Female	0.64	0.64
Black	0.09	0.07
Married	0.35	0.34
Dual Eligible	0.16	0.19
AMI	0.08	0.08
Congestive Heart Failure	0.22	0.24
PVD	0.05	0.05
CEVD	0.13	0.14
Dementia	0.04	0.05
COPD	0.21	0.23
Rheumatoid Arthritis	0.03	0.03
Peptic Ulcer	0.02	0.02
Mild Liver Disease	0.01	0.01
Diabetes	0.21	0.22
Diabetes + Complication	0.04	0.04
Paraplegia	0.03	0.03
Renal Disease	0.14	0.13
Cancer	0.09	0.08
Severe Liver Disease	0.01	0.01
Metastatic Cancer	0.04	0.04
AIDS	0.00	0.00
Number Of Patients	3,683,135	3,682,818

First Stage

Table 2: Patient-Level Analysis: First Stage

	(1) 1(PE)	(2) 1(PE)	(3) 1(PE)	(4) 1(PE)	(5) 1(PE)
Differential Distance (In 10 Miles)	-0.0480*** (0.002)	-0.0480*** (0.002)	-0.0479*** (0.002)	-0.0454*** (0.002)	-0.0419*** (0.002)
(Differential Distance) ² (In 10 Miles)	0.0062*** (0.000)	0.0063*** (0.000)	0.0062*** (0.000)	0.0059*** (0.000)	0.0055*** (0.000)
Market Controls			Y		
Patient Controls		Y	Y	Y	Y
Facility FEs	Y	Y	Y	Y	Y
Patient FEs Level	HRR x Year	HRR x Year	HRR x Year	HSA x Year	County x Year
Observations	7,365,934	7,365,934	7,358,129	7,365,752	7,365,246
Y-Mean	0.09	0.09	0.09	0.09	0.09
F-Stat	224	224	222	220	203

Monotonicity Assumption



B: Stay at PE Nursing Home

Complier Characteristics

Distance-based compliers are more likely to be from a low-income zip code.

Table B.2: **Complier Characteristics**

	Observations	Coefficient	(Std. Errors)	Ratio
Full Sample	7,365,934	-0.0445***	(0.003)	
A. Age & Risk				
Low Risk, 65-80	2,052,655	-0.0405***	(0.002)	0.91
High Risk, 65-80	881,854	-0.0471***	(0.003)	1.06
Low Risk, 80+	3,326,940	-0.0451***	(0.003)	1.01
High Risk, 80+	1,104,387	-0.0478***	(0.003)	1.07
B. Gender				
Male	2,640,611	-0.0456***	(0.003)	1.02
Female	4,725,295	-0.0439***	(0.003)	0.99
C. Marital Status				
Unmarried	4,838,365	-0.0446***	(0.003)	1.00
Married	2,527,548	-0.0439***	(0.003)	0.99
D. Beneficiary Zip Income				
Income < Median	3,681,687	-0.0554***	(0.004)	1.24
Income > Median	3,684,035	-0.0353***	(0.003)	0.79
E. Race				
White	6,483,451	-0.0451***	(0.003)	1.01
Other	881,923	-0.0380***	(0.003)	0.85

Main Effects on Mortality and Spending

- Receiving care at a PE-owned nursing home increases the probability of death during the stay and the following 90 days by 1.7 pp, about 10% of the mean.
- ⇒ 20,150 additional deaths over the 12 years
- ⇒ 160,000 lost life-years
- ⇒ a mortality cost of \$20.7 billion (\$100,000 per life-year)

Table 4: **Patient-Level Analysis: IV Results**

A: Main Results			
	(1) Mortality (Stay + 90 Days)	(2) Log Amount Billed Per Patient Stay	(3) Log Amount Billed Per Patient Stay + 90 Days
1(PE)	0.0168** (0.007)	0.1777*** (0.028)	0.1054*** (0.024)
Observations	7,365,934	7,365,934	7,365,934
Y-Mean	0.17	9.07	9.57
F-Stat	224	224	224
B: Placebo Analysis			
	(1) Mortality (Stay + 90 Days)	(2) Log Amount Billed Per Patient Stay	(3) Log Amount Billed Per Patient Stay + 90 Days
1(PE)	0.006 (0.004)	-0.015 (0.018)	-0.016 (0.016)
Observations	7,159,535	7,159,535	7,159,535
Y-Mean	0.18	9.01	9.51
F-Stat	441	441	441

Main Effects on Mortality and Spending

- The amount billed per nursing home stay increases by 19.5%.
- The total amount billed for both the stay and the 90 days following the stay increases by about 11%.

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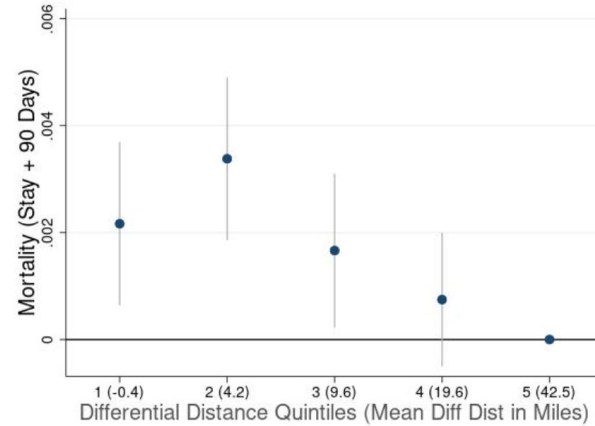
Main Effects on Mortality and Spending

- Use Medicare patient-level data from 2002–07.
- Randomly set the PE dummy to turn on in 2004 or 2005 for facilities that eventually were acquired by PE.

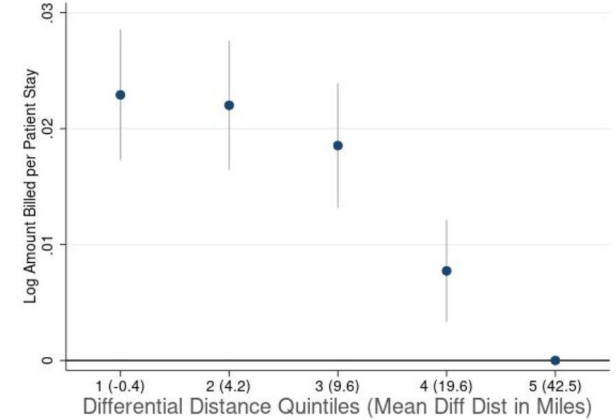
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Y-Mean	0.18	9.01	9.51
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Quintiles of Differential Distance

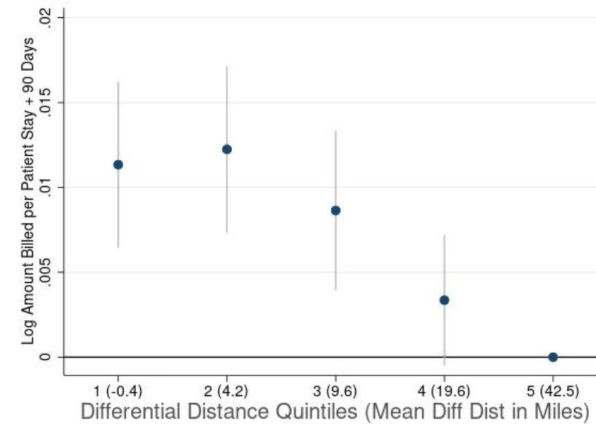


A: Mortality (Stay + 90 Days)



B: Log Amount Billed per Patient Stay

$$Y_i = \alpha_{m,t} + \alpha_j + \sum_{s=2}^5 1(Q_{DD} = s) + \gamma_1 X_i + \epsilon_i$$



C: Log Amount Billed per Patient Stay + 90 Days

Heterogeneity Analysis

- Explores treatment effect heterogeneity along **observed** and **unobserved** dimensions using a **Marginal Treatment Effect (MTE)** framework.
- Key findings:
 1. IV mortality effect driven by patients who are observedly low risk and older.
 2. Larger effects among patients who are white, female, from above-median income zip codes, or previously hospitalized due to cardiovascular disease.
 3. Evidence of *reverse selection on gains*: larger effects for patients with least unobserved resistance to going to a PE facility

- PE-owned nursing homes seem to take better care of **younger, more complex patients** (3 p.p. /20% of mean).
- Consistent with authors' finding that PE ownership is associated with an increase in availability of RNs (and a decline in CNAs and LPNs).
 - RNs are responsible for more medicalized aspects of care; front line nurses support daily living activities.

Table 5: **Heterogeneity in Patient Mortality**

	(1) Observations	(2) Mean	(3) Coefficient	(4) (Std. Errors)
A: Patient Level				
1. Age & Risk				
Low Risk, 65-80	2,052,655	0.08	0.0186*	(0.011)
High Risk, 65-80	881,854	0.24	-0.0346*	(0.021)
Low Risk, 80+	3,326,940	0.16	0.0319***	(0.011)
High Risk, 80+	1,104,387	0.29	0.023	(0.020)
2. Gender				
Male	2,640,611	0.21	0.0105	(0.012)
Female	4,725,295	0.14	0.0210**	(0.008)
3. Beneficiary Zip Income				
Income < Median	3,681,687	0.18	0.0122	(0.010)
Income > Median	3,684,035	0.16	0.0262**	(0.011)
4. Race				
White	6,483,451	0.17	0.0206***	(0.008)
Other	881,923	0.16	-0.0219	(0.023)
5. Reason for hospitalization				
Cardio-Vascular	1,340,956	0.20	0.0298*	(0.016)
Injury	1,409,910	0.11	0.0236*	(0.014)
Other	4,615,012	0.18	0.0096	(0.009)

Unobserved Heterogeneity and MTEs

- MTE is a useful framework for studying health equity
 - Enables recovering treatment effects for different subpopulations (not just compliers e.g. LATE)
- Combines (1) a potential outcome model and (2) a latent selection model of patients' facility choice.

$$Y_{k,i} = X_i' \beta_k + F_j + R_{r,t} + U_{k,i}, \quad k = 0, 1$$

$$PE_i = Z_i' \delta - V_i,$$

$$PE_i = 1 \text{ if } PE_i \geq 0, \quad PE_i = 0 \text{ otherwise,}$$

- X are observed patient attributes; Z is vector of instruments; V is unobserved resistance to going to PE-owned facility.

Unobserved Heterogeneity and MTEs

$$\begin{aligned} MTE(X = x, U_D = u) &= \mathbb{E}[Y_1 - Y_0 | X = x, U_D = u] \\ &= \underbrace{x(\beta_1 - \beta_0)}_{\text{observed}} + \underbrace{\mathbb{E}[U_1 - U_0 | U_D = u]}_{\text{unobserved}} \end{aligned}$$

- Treatment effect for individuals with characteristics x at the u -th quintile of the resistance distribution.
 - Indifferent about treatment if their propensity score $P(Z) = \Pr[PE = 1 | Z]$ equals u .
 - Separated into observed and unobserved components.
- Implies the following regression function for observed outcome Y :

$$\mathbb{E}[Y | X, F, R, P(Z) = p] = X'\beta_0 + F + R + X'(\beta_1 - \beta_0)p + K(p),$$

- $K(p)$ = expected unobserved treatment gain for the treated with propensity score p .
- **Result:** 1st derivative of the regression function wrt p recovers $MTE(X=x, U=p)$

Estimating MTEs

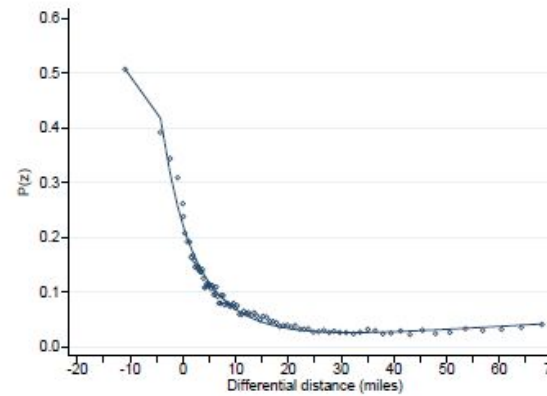
1. Estimate propensity score using selection model: $\mathbf{p} = \mathbf{Z}^* \boldsymbol{\delta}$.
2. Estimate regression function:

$$Y = X' \beta_0 + F + R + X' (\beta_1 - \beta_0) \hat{p} + \sum_{s=2}^S \rho_s K(\hat{p}) + \epsilon.$$

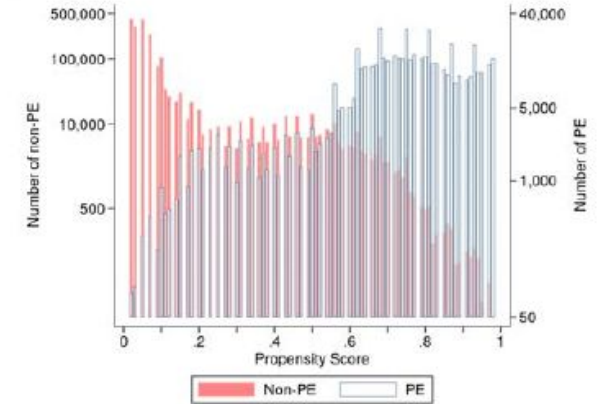
3. Differentiate the estimated equation wrt p to get MTE curve.
 - 3.1. Use a squared polynomial for $K(p)$ \rightarrow MTE is linear in unobserved resistance.

Figure 4: Marginal Treatment Effects

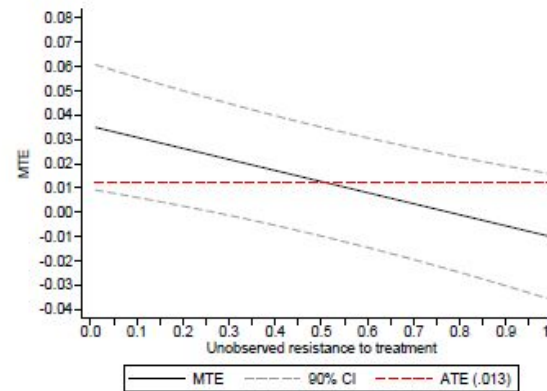
- **Negative MTE slope** → **reverse selection on gains**: those with the least resistance to choosing a PE facility experience worst mortality effects.
- Aggregate MTEs to produce other treatment effect parameters and examine counterfactuals:
 - **ATE**: 1.3 pp
 - **ATT**: 3.1 pp
 - **ATUT**: 1.0 pp
 - Only ATT statistically significant.
 - LATE (IV) was 1.7 pp.



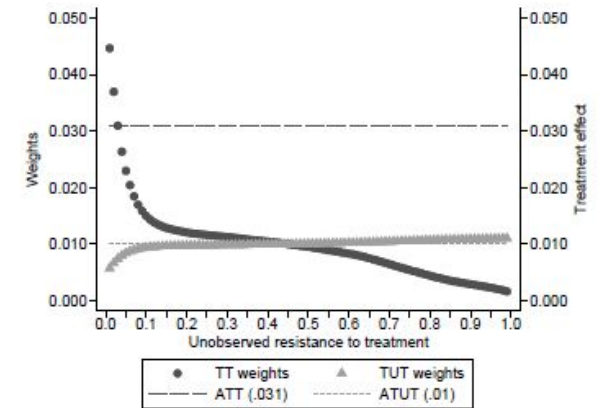
A: First stage



B: Common Support



C: MTE curve



D: ATT and ATUT

Note: This figure presents results pertaining to Marginal Treatment Effects (MTE) analysis using the Medicare patient-level data. Panel A presents the ‘first stage’ fit of predicted probability of treatment or propensity score, w.r.t the instrument. Panel B presents the overlap in distributions of PE and non-PE groups by propensity score. This plot uses a log scale due to the large number of non-PE patients with low propensity. Appendix figure B.6A presents the corresponding plot using a linear scale. Panel C presents the MTE curve with 90% confidence intervals obtained using block bootstrap and the Average Treatment Effect (ATE) estimate. Panel D presents the weights for the Average Treatment on the Treated (ATT) and Average Treatment on the Untreated (ATUT) and the corresponding estimates. Section 5.2.2 presents details of the MTE estimation.

Patient Well-being and Mechanism Tests

- Measure effect on 4 clinical outcomes used by CMS to compute Five-Star ratings.
- Using IV model, going to a PE-owned nursing home:
 1. Increases the chance of starting antipsychotics by 3 pp (50% of mean)
 2. Worsens mobility by 4.3 pp (8% of mean)
 3. Increases pain intensity by 2.7 pp (10%).
 4. No effect on developing ulcers
- These results are not driven by economies of scale and corporatization resulting from PE buyouts, nor by profit/non-profit quality differences.

Facility-level Analysis: Operation Changes

- Explore operation changes that might explain the adverse patient welfare effects
- Difference-in-difference model with fixed effects, facility-level controls P and county-level controls M :

$$Y_{j,t} = \alpha_j + \alpha_t + \beta PE_{j,t} + P'_{j,t} \gamma_1 + M'_{j,t} \gamma_2 + \varepsilon_{j,t}$$

- Consider 3 operational channels concerning facility quality and financial strategies particular to the PE industry:
 - Compliance with standards
 - Staff availability
 - Finances and operations
- Event study plots reject pre-trends.

After PE buyouts:

- No effect on revenue or costs
- **Quality ratings decline**, which reflect the facility’s reduced compliance with care protocols.
- **Staff hours decline** (except for higher-skill RNs, which account for a small fraction of all staff hours).
 - Facilities that experienced larger declines in staff also experienced greater declines in ratings.
- **Operating costs shift** away from staffing towards that are profit drivers for the PE fund (management fee, building lease, interest expense).

Table 8: Mechanisms and Operational Changes

A: Five Star Rating				
	(1) Deficiency Rating	(2) Overall Rating		
1(PE) (No Control)	-0.075** (0.037)	-0.079** (0.036)		
1(PE) (With Control)	-0.077** (0.037)	-0.082** (0.036)		
Observations Y-Mean	138,051 2.9	138,051 3.2		
B: Staff Per Patient Day				
	(1) All Staff	(2) Nurse Assistant	(3) Licensed Nurse	(4) Registered Nurse
1(PE) (No Control)	-0.050*** (0.017)	-0.068*** (0.010)	-0.019*** (0.006)	0.037*** (0.005)
1(PE) (With Control)	-0.048*** (0.016)	-0.066*** (0.010)	-0.019*** (0.006)	0.037*** (0.005)
Observations Y-Mean	283,767 3.6	283,767 2.3	283,767 0.8	283,767 0.5
C: Log Financials				
	(1) Management Fee	(2) Building Lease	(3) Interest Expense	(4) Cash on Hand
1(PE) (No Control)	0.074** (0.032)	0.564*** (0.061)	1.181*** (0.096)	-0.322*** (0.042)
1(PE) (With Control)	0.074** (0.032)	0.560*** (0.061)	1.175*** (0.096)	-0.318*** (0.042)
Observations Y-Mean	231,556 0.2	231,584 0.4	231,613 0.3	231,569 11.2

Figure 5: Aggregate Quality and Staffing Outcomes

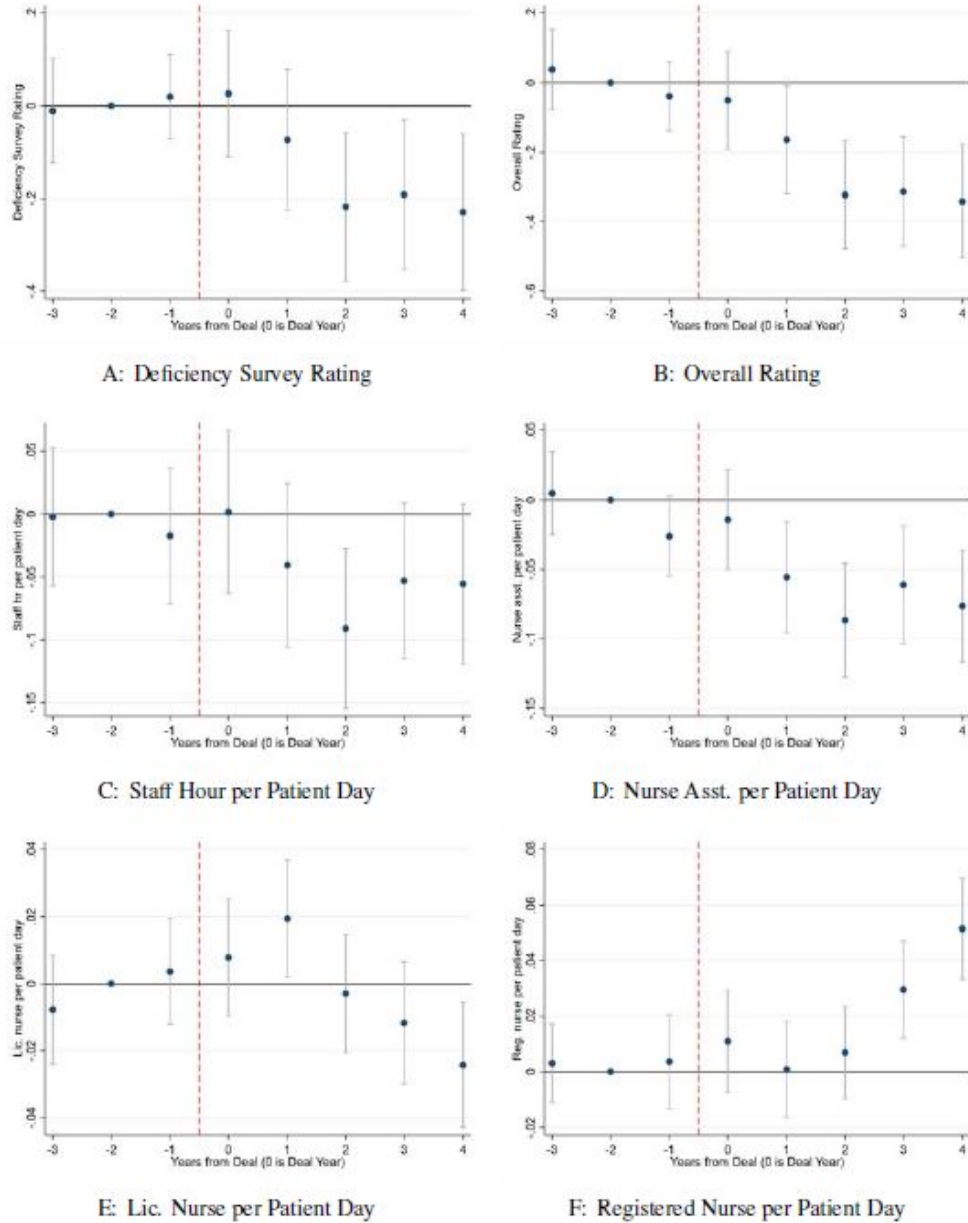
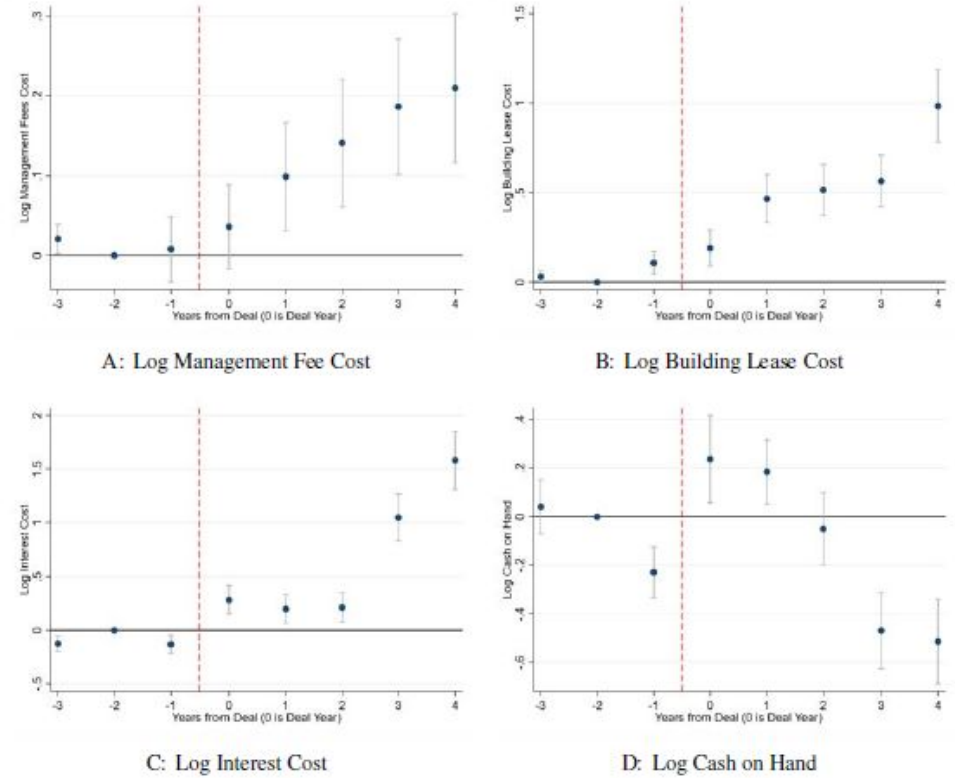


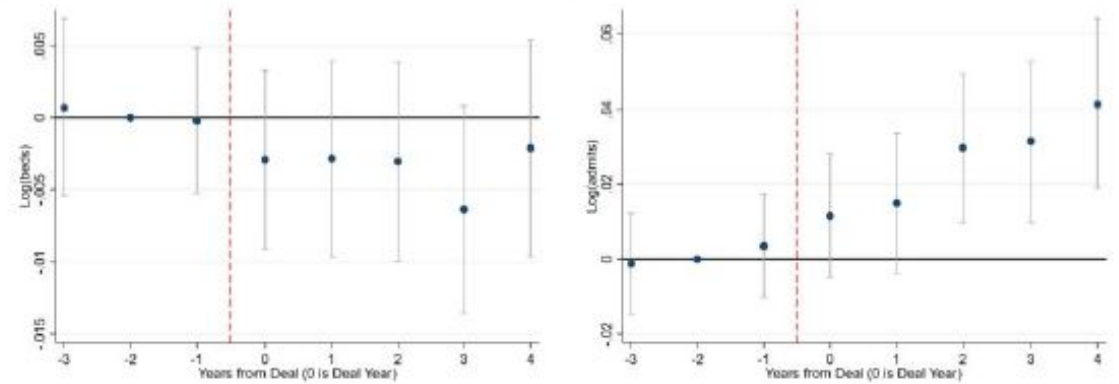
Figure 6: Facility Finances



Changes in Patient Capacity and Volume

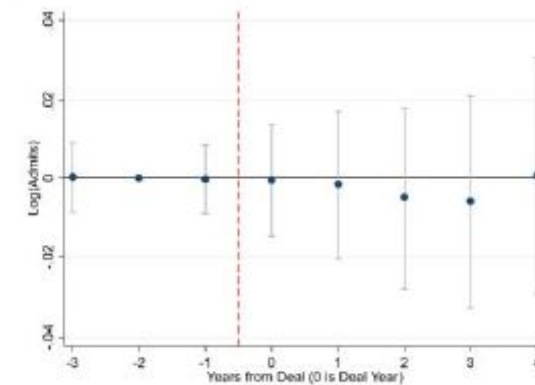
- **No change in number of beds** - might reflect regulatory constraints
- **Increase in admissions**, but not at the market level → consistent with **business stealing** rather than market expansion

Figure B.8: Patient Volume



A: Log Beds - Facility

B: Log Admissions - Facility



C: Log Admissions - Market (HRR)

Discussion

- Robust analysis of how PE ownership reduces productivity of nursing homes.
- Did not address:
 - Heterogeneity across Medicare-only vs. dual eligible patients?
 - Did patient mix change after PE?
 - What makes nursing homes in particular attractive to PE?