Investing in Rural Healthcare: Impact of Private Equity Acquisition on Financial and Utilization Outcomes of Rural Hospitals

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Abstract

Private equity investment in the healthcare sector has risen considerably in recent decades, yet the impact of private equity ownership in rural hospital markets is largely unknown. Existing research points to a correlation between private equity acquisition and increased hospital incomes and charges. Rural hospitals, however, are structurally and operationally different from their urban counterparts, with lower occupancy rates and higher susceptibility to financial distress. This paper seeks to (1) characterize the types of rural hospitals acquired by private equity firms and (2) examine the changes in rural hospital financial, utilization, and survivability outcomes following private equity ownership. Using a 15-year panel of Medicare data, I estimate the impact of 352 private equity deal-hospitals across nine financial and utilization outcomes. Additionally, I estimate the impact of private equity on hospital closures. I find that private equity acquisition improves profitability for both urban and rural hospitals, but the magnitude is smaller for rural hospitals. My results suggest that private equity-owned hospitals increase profits by reducing operating expenses. Among rural hospitals, private equity ownership is associated with fewer discharges and lower occupancy rates, which may be a concern for long-term viability. I find a statistically significant negative correlation between private equity acquisition of rural hospitals and an increased likelihood of closure. PE-acquired hospitals have a negative spillover effect on other hospitals within the same hospital referral region, leading to a higher probability of closing.

JEL classification: G23, G33, G34, I10, I11

Keywords: Private equity, leveraged buyout, rural hospitals, healthcare

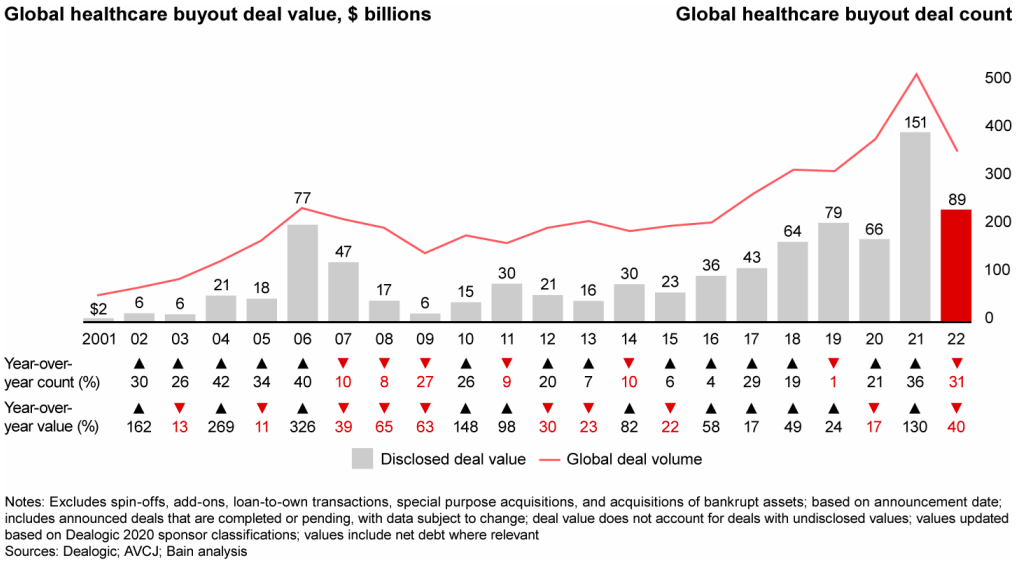
1. Introduction

In rural areas, hospitals are the cornerstone for community health and well-being. Yet, rural hospitals face disproportionate challenges in providing quality healthcare and close at a higher rate compared to their urban counterparts. Rural hospitals, which make up nearly half of all hospitals in the United States, serve a population that is generally older, sicker, and poorer compared to the national average (American Hospital Association, 2022). These hospitals have lower occupancy rates and more staffing shortages, often resulting in lower operating margins and increased difficulty of covering the fixed costs of delivering care. Furthermore, relative to urban hospitals, rural hospitals rely heavily on governmental funding such as Medicare, which reimburses less than commercial insurers for identical services. Consequently, rural hospitals are at a higher risk for financial distress and closure. Due to the marked differences between rural and urban hospitals, I analyze the differential impact of private equity ownership on rural hospitals' financial performance and overall survivability.

Private equity (PE) investors are attracted to the healthcare industry for a multitude of reasons. The healthcare sector is not only large – making up 17% of the US GDP – but also fragmented, presenting many opportunities to consolidate market power. Given the misaligned incentives between providers and payers, many facilities are inefficient and underperforming, allowing PE firms to enact change to multiply value. For hospitals with tight operating margins, particularly rural hospitals, the influx of capital flowing from private equity investors may serve as an attractive opportunity to improve the business. Furthermore, private equity provides valuable managerial expertise, which is especially beneficial for hospital executives with limited business proficiency.

Private equity involvement in healthcare markets has grown considerably since the turn of the century. Global healthcare buyout deal valuation reached a record high of $151 billion in 2021, compared to an estimated $15 billion in 2010 (Figure 1).

Figure 1. Private equity deal volume of the global healthcare market (Jain et al., 2023)



Notes: Excludes spin-offs, add-ons, loan-to-own transactions, special purpose acquisitions, and acquisitions of bankrupt assets; based on announcement date; includes announced deals that are completed or pending, with data subject to change; deal value does not account for deals with undisclosed values; values updated based on Dealogic 2020 sponsor classifications; values include net debt where relevant
Sources: Dealogic; AVCJ; Bain analysis

Within healthcare buyouts, hospital provider deals – the main focus of this study – alongside biopharma deals have consistently made up the majority of the healthcare buyout deal value (Jain et al., 2023). Though private equity investment in the hospital provider sector has rapidly accelerated in recent years, firms have been active in healthcare provider markets since the 1990s. Early private equity investments targeted nursing homes and larger hospitals, facilities that generate steady streams of income (Appelbaum and Batt, 2020). In the past two decades, investments have spanned a wider array of healthcare facilities, particularly in high-margin specialized practices such as dermatology, radiology, anesthesiology, and urology centers. Based on data from 2017, 11% of inpatient admissions were to a facility that either once was or currently is under PE ownership (Offodile II et al., 2021). Private equity influence has also accelerated healthcare consolidation, as they promote mergers and acquisitions to expand local market power.

Private equity involves the investment of capital in private businesses with the aim of returning a profit. Using capital from institutional investors and debt from their target acquiree, private equity firms acquire a majority stake of a company with the intent of increasing the company's value and selling it within three to seven years. During the holding period, private equity helps restructure the acquired

company to increase efficiency, generating profits when they sell the company. The primary acquisition strategy in PE is leveraged buyout (LBO). LBO transactions utilize a large proportion of debt financing with a smaller proportion of equity to acquire the target company. The high debt-to-equity ratio allows private equity firms to have more leverage, as firms invest less of their own capital and achieve a large return on equity (Metrick and Yasuda, 2010). Since most of the debt from leveraged buyouts comes from the acquired company, private equity firms may encourage riskier financial moves with minimal firm liability. For hospitals, the debt is placed on the acquired hospital's physical assets such as the land and property as collateral for the loans, which must be later paid back using hospital revenues (Miller, 2023). Private equity generates profit in target hospitals by pushing high-revenue procedures, cutting costs, reorganizing the company, and from management fees charged to its investors.

In the healthcare provider sector, a common strategy by private equity firms includes acquiring a large "platform practice," often through leverage buyout, and subsequently acquiring smaller practices in the same specialty or region. Referred to as add-on acquisitions, this method seeks to multiply the value of existing businesses, often in a less noticeable way. Private equity firms may thereby consolidate management, enhance bargaining power with payers, and increase market power in that region (Chen et al., 2020).

The short-term profit model in private equity creates different financial incentives and business strategies compared to other for-profit healthcare systems. The accelerated timeline to exit encourages cutting costs, increasing volume, and other strategies to rapidly maximize returns. With direct managerial oversight, private equity firms frequently implement structural changes to the business model of the target company for higher revenue potential. On one hand, the influx of capital may reduce operational inefficiencies, allow access to advanced facility technologies, and improve profit margins. There are growing concerns, however, that private equity investments prioritize short-term revenues at

the expense of long-term profitability. Critics argue that financial motives intrinsic to PE ownership may lead to worse patient care outcomes, reduced quality, and higher costs (Singh et al., 2022). Critics also speculate that private equity-acquired healthcare facilities are more prone to bankruptcies, driven in part by the loans that hospitals must pay back to private equity firms from the onset of acquisition (Braun et al., 2021).

The impact of private equity ownership in rural healthcare markets is largely unknown. Existing literature has explored the relationship between private equity investment and hospital costs and quality, though none has directly investigated its effect in rural markets. It is unclear whether existing findings can be generalized to rural hospitals, as rural hospitals' business structures, reimbursement policies, and management practices differ from urban hospitals. Furthermore, rural hospitals serve underprivileged populations and face heightened financial pressures, thus private equity involvement poses unique risks in the rural sector. This study aims to (1) characterize the types of rural hospitals acquired by private equity firms and (2) examine the changes in rural hospital financial, utilization, and survivability outcomes following private equity ownership.

2. Literature Review

There has been an emerging body of literature surrounding private equity ownership in the healthcare provider sector. The existing focus of private equity involvement has been concentrated mostly in nursing homes and specialized physician practices, with some more recent investigations into acute-care hospitals. The main outcomes of interest are typically financial, utilization, quality of care, and patient health-related outcomes for the acquired entities.

2.1 Impact of Private Equity on Acute-Care Hospitals

Private equity plays a growing role in financing healthcare in the United States, especially in provider markets. Yet, research into the impact of private equity acquisitions on short-term acute-care hospitals is a relatively nascent field. A team led by Bruch et al. (2020) pioneered research in the field, examining the association between PE acquisition of a hospital with changes in hospital income, use, and quality. The longitudinal study compared hospitals under PE ownership with non-PE control hospitals using a difference-in-differences mixed-effects model, from 3 years pre-acquisition to 3 years post-acquisition, to understand short-term changes. Bruch et al. (2020) found that private equity-acquired hospitals were more likely to be for-profit, medium to large-sized, and located in the South. Regarding financial performance metrics, Bruch et al. (2020) concluded that PE acquisition was associated with increases in annual hospital income through higher hospital charges, as indicated by a higher charge-to-cost ratio and a $407 increase in total charge per inpatient day. This signifies that hospitals became more profitable post-PE intervention, likely due to declining operating expenses and higher markups. Since then, research by Bruch et al. (2020), Cerullo et al. (2022), Liu (2022), and Offodile II et al. (2021) has further expanded understanding on the influence of private equity on acute-care hospitals. Although there is heterogeneity across study types and outcome measures, evidence supports that PE ownership is correlated with higher profitability, alongside increased costs of services

from higher charges and higher negotiated rates with payers. Offodile II et al. (2021) and Cerullo et al. (2022a) found lower operating expenses and a $432 decrease in per-patient costs, respectively, further indicating that the decreased costs borne by facilities were offset by increased costs to patients. A subsequent study by Cerullo et al. (2021) linked private equity acquisition to a higher likelihood of switching to profitable services and technologies, including hemodialysis, robotic surgery, and digital mammography. Additionally, they found that hospitals acquired by PE were more likely to discontinue or lessen services with unreliable revenue streams. These techniques employed by private equity firms may, in part, explain the improvements to hospital profitability. In both studies, improved hospital efficiency was accompanied with negative or mixed impacts on quality, indicating that profitability alone cannot accurately display the effects of PE ownership. In fact, increases in profitability may come at the cost of reduced patient outcomes and clinical quality.

Across all studies evaluating healthcare quality, the outcomes vary considerably. Bruch et al. (2020) found improvements in acute myocardial infarction (AMI) and pneumonia quality scores in hospitals owned by PE compared to their non-PE counterparts. On the other hand, Cerullo et al. (2022b) found decreases to in-hospital mortality among AMI patients and no significant association between other patient-level outcomes. Their study also shows no change in 30-day readmission rates. Overall, within the hospital provider landscape, evidence points to increased profitability, increased charges, and mixed impacts on care quality.

2.2 Impact of Private Equity on Nursing Homes and Specialty Practices

Financial and Utilization Impact

Current research on the financial impact of private equity acquisition in non-hospital practices points to an increase in charges and mixed impacts to cost. Braun et al. (2021) analyzed spending and utilization trends among dermatology practices and found a 3-5% increase in price of routine medical

visits across private equity owned practices relative to non-PE affiliated ones, as well as a significant increase in patient volume. Analyzing commercial claims data across three specialties, Singh et al. (2022) found a $23 rise in the allowed amount per claim and a $71 increase in charge per claim compared to non-acquired specialty practices. La Forgia et al. (2022) reports similar findings, with a $116 increase in the allowed amount per claim among anesthesia practitioners. In a recent study on nursing homes, Gupta et al. (2024) determined that private equity ownership is associated with an increase in the log amount billed per patient stay and up to 90 days post-discharge. Thus, multiple studies across various patient care facilities found higher charges billed to patients in private equity acquired facilities.

Among the limited studies assessing the impacts of private equity on facility profitability, existing studies present varied conclusions on income and spending. An early study investigating nursing homes from 2000-2007 finds that private equity-controlled facilities have higher profit margins and operating margins, hypothesized due to higher revenues from increased length of stay (Pradhan et al., 2014). Bos and Harrington (2017) conducted a case study of a large nursing home chain and found higher operating margins post-PE ownership, though no significant change in total margin. They also found considerably higher debt-to-asset ratios following the takeover, which may have long-term negative consequences. On the other hand, Gupta et al. (2024) presents data that suggest PE-owned nursing home are not more profitable than their non-affiliated counterparts, with no effect on overall revenue. In the private practice space, Braun et al. (2021) found no significant changes in dermatology spending or usage of major procedures such as biopsies and lesion destructions. Taken together, evidence suggests that private equity has positive or neutral impacts on facility profitability, though it is ambiguous how, if at all, private equity firms are generating net profits.

Quality Impact

News often portrays the narrative that profit-driven private equity firms lead to reduced quality of care and long-term financial distress. Despite the media's criticism towards PE, recent literature provides mixed evidence regarding private equity's impact on patient care quality. On one hand, numerous studies find lower registered nurse (RN) staffing levels in nursing homes pre- and post-acquisition by PE (Pradhan et al., 2014; Bos and Harrington, 2017; Gupta et al., 2024). Since higher nurse staffing levels is associated with higher quality of care, lower staffing levels may invoke concern for patient outcomes (Bostick et al., 2006). In an early study assessing the impact of private equity in nursing homes, Stevenson and Grabowski (2008) found improved resident outcomes across several health indicators – including catheter use, weight loss, urinary tract infections, and ulcers – and no significant changes to the remaining indicators. Thus, they find no evidence to suggest worsened quality of care in nursing homes post-private equity ownership. A causal estimation study controlling for resident selection and facility fixed effects likewise reports no significant declines in nursing home patient quality measures (Huang and Bowblis, 2019). Yet Harrington et al. (2011) reported an increase in the total number of deficiencies and severe deficiencies in the years following private equity acquisition. Furthermore, recent study estimating the causal effects of private equity in nursing homes concludes that PE ownership leads to increased patient mortality, as explained by declines in patient well-being metrics, lower nurse staffing, and decreased compliance with care standards (Gupta et al., 2024). These mixed findings indicate the nuanced impact of PE ownership in provider markets, which may vary depending on local competitive incentives, target provider characteristics, and the specific strategies employed by the PE owner (Gandhi et al., 2020).

My approach expands on existing research by using updated data on key financial measures and usage to assess the impact of private equity acquisition in hospital settings. There is currently a lack of

research on private equity's effect on rural hospitals, and rural healthcare markets generally. My research provides novel insight on the differential impact of private equity in rural hospitals, relative to urban hospitals, as rural healthcare providers face disparate challenges and serve a unique subset of patients. Additionally, my work uncovers the impact of private equity acquisitions on hospital closures and the potential spillover effects within local healthcare markets.

3. Theoretical Framework

3.1 Principal Agent Theory

The principal-agent theory is largely cited to explain differences in behavior between private equity firms and management. The agency relationship is defined in which the *principal actor* delegates some decision-making authority to an *agent* who is expected to act as "an extension of the self" and further the principal's interests (Braun and Guston, 2003; Jensen and Meckling, 1976). Following assumptions of monotonicity and utility maximization, we assume both actors are rational and seek to optimize their own preferences. If incentives are properly aligned, in theory no conflict arises. In misaligned incentive cases, however, the agent may prioritize his personal welfare and not act in the best interest of the principal. This potential divergence in interests gives rise to agency costs. As established by Jensen and Meckling, agency costs are any costs incurred by the principal actor to ensure the agent makes optimal decisions from the perspective of the principal actor (Jensen and Meckling, 1976). This may cost the principal actor in three main ways: monitoring expenditures, bonding expenditures, and residual loss. The firm must expend resources to monitor the agent, incentivize the agent in the form of bonds and contractual agreements, and bear any residual costs when the agent contradicts the principal's best interests. In corporate governance, agency costs are exacerbated when there is considerable information asymmetry or priority disconnect between the two parties.

The ownership structure in private equity reduces the impact of agency costs. Since PE holders take ownership in the target company, the interest of the PE general partners is more closely aligned with the interest of the investors. Regulations are also in place to align incentives and ensure agents are following their fiduciary duties. Therefore, private equity firms and management have a shared goal of value-addition for the company, maximizing returns for stakeholders (Jensen and Meckling, 1976; Karstensen, 2018; Pradhan, 2013).

3.2 Free Cash Flow Theory

Researchers also point to the free cash flow hypothesis to understand how debt influences ownership changes and organizational efficiency. Free cash flow is the cash flow in excess of that needed to pay for financial obligations. Jensen suggests that conflicts are likely to arise between managers and shareholders when the organization generates substantial free cash flow (Jensen, 1986). In line with the agency theory, corporate managers are the agents of shareholders. Payouts to shareholders reduce the resources under managers' control, thus reducing managers' power. Managers are instead incentivized to seek opportunities to grow the firm as it increases managers' power and compensation, despite these opportunities likely yielding lower returns and decreasing shareholder value. Therefore, excess free cash flow encourages "empire building" activities, thereby worsening the principal-agent problem (McGrath and Nerkar, 2023).

Jensen (1986), however, highlights the value of debt as a substitute for dividends. He argues that when managers issue debt in exchange for stock, they are effectively bonding their promise to pay out future cash flows. Debt thus reduces the agency costs of free cash flow by reducing the cash flow available to managers (Jensen, 1986). This is at play in private equity investments. PE firms use leverage to reduce free cash flow, reducing agency costs by decreasing cash flow available to management. Since the threat of defaulting on debt is far more severe than missed dividends, management focuses highly on efficiency of returns. Under Jensen's theory, leverage buyout models are the dominant corporate organization form due to their efficient governance structures. Hence, I hypothesize that short-term hospitals will be more profitable post-acquisition by a private equity firm, relative to pre-acquisition and relative to non-PE affiliated hospitals.

One consequence of extreme levels of debt from leveraged buyouts is company bankruptcy. Yet Kaplan and Stromberg (2008) analyzed over 17,000 private equity sponsored transactions between

1970-2007 and found only 6% of deals ending in bankruptcy or reorganization (Kaplan and Stromberg, 2008). This has an annual default rate that is lower than that in Moody's reports for all US corporate bond issuers from 1980-2002. In line with the reasoning provided, I hypothesize that private equity-owned rural hospitals are more likely to face closure, compared to non-private equity affiliated rural hospitals.

3.3 Private Equity and Rural Healthcare

Prior literature finds that private equity buyouts generate higher returns, as well as improved productivity and operational efficiency. Capital provided by PE ownership may alleviate credit constraints, enabling more investment (Boucly et al., 2011). Edmans (2011) shows that leverage concentrates stakeholders' stakes and incentivizes them to actively monitor the firm's cash flows, which leads to better investment decisions. In sum, the corporate governance structures intrinsic to the PE model lead to improvements in financial performance. Moreover, current literature does not point to the concern that PE investments increase post-buyout bankruptcy rate. Bernstein analyzed PE deals that occur during economic recessions and concluded that PE-backed companies experienced higher asset growth, debt flow, and market shares compared to non-PE backed ones (Bernstein et al., 2019).

In theory, the value of PE firms' managerial insights would have positive effects on operational efficiency and facility profit margins across both urban and rural hospitals. The key differences between rural and urban healthcare markets, however, may be exacerbated under the influence of private equity. Firstly, since Medicare and Medicaid cover a substantial proportion of costs, rural patients are less cost salient, on average. Thereby, the price elasticity of demand in rural markets is lower than their urban counterparts, which may have implications regarding the utilization of care (Gupta et al., 2024). Not only do rural hospitals serve patients with more chronic conditions and higher comorbidities, but rural patients also disproportionately seek care only in dire circumstances (MACPAC, 2021; Oyeka et al.,

2018). The unique patient demographic in rural hospitals suggests that the baseline per-patient costs of care may be higher in rural hospitals relative to urban ones. Moreover, due to the isolated nature of many rural hospitals, these smaller acquisitions may have heightened local effects on competition and market share. Finally, rural hospitals are more likely to encounter patients that travel outside markets to nearby urban hospitals for elective surgery. In the long-run, bypass of rural hospitals may increase the hospital's likelihood of financial insolvency or closure. Therefore, although the theoretical framework points to improved profitability, other forces make this relationship quite ambiguous.

4. Methods

4.1 Data Sources

Private Equity Deals

Data on private equity transactions of acute-care hospitals are provided by the private market intelligence database PitchBook Inc. PitchBook Inc. provides data on U.S. private equity deals under the category "Hospitals/Inpatient Services," recording information on target hospital, date of transaction, deal type, and private equity firm investor. The "index year" of private equity acquisition is defined as the calendar year in which the deal was officially closed. I screened for deals occurring between January 2006 and December 2018, inclusive, because it allows for sufficient observations in the dataset, avoids the COVID-19 pandemic years, and encompasses the high-profile Hospital Corporation of America (HCA) leveraged buyout by Bain Capital in 2006. This time period also enables me to track financial performance and hospital closure for two years before and after the PE deal period, for complete longitudinal data on hospitals between 2004-2020. Cost reports for the year 2021 is largely missing or incomplete, though I include the data for hospitals with full-year 2021 cost data (~25% of the sample).

A prior research team led by Marcelo Cerullo at Duke University had identified and sorted private equity acquisitions classified as either primary leveraged buyout or add-on acquisitions from 2000-2018. Using the deal list compiled by Cerullo's team, I screened out non-acute care facilities and cross-referenced the remaining hospitals with those generated from Pitchbook Inc. to finalize my dataset of PE-acquired hospitals. Since I extracted financial and operational data for 2004-2020, I later adjusted my PE deal list to mark facilities that underwent PE acquisition in the years 2004-2005 and remained open through at least 2006, using Cerullo's dataset. Additionally, I referenced the hospital tracker by the Private Equity Stakeholder Project (PESP), along with industry reports and press releases, to cross-check target firms and further verify PE-acquired hospitals.

Due to the private nature of PE transactions, I am unable to gather detailed information on the PE buyers and individual buyout transactions. Aside from the name of the entity that conducts the hospital acquisition – which for healthcare facility buyouts is often a subsidiary company of a larger PE firm – I have little knowledge on the general portfolios and amount of capital allocated to the target facilities. The buyout debt structure is also undisclosed, which would have provided context on the magnitude of leverage investors have on their targets. For these reasons, I will not sort by or conduct analyses on the private equity investors. Furthermore, due to the ambiguity of the private equity holding period, I do not consider the length of private equity activity, and I record only the first deal year for hospitals that undergo multiple private equity acquisitions during the time range.

Hospital Characteristics

The hospital-level dataset used in this analysis comes from public files published by the Center for Medicare & Medicaid Services (CMS). For my analysis, I use the CMS Provider of Service (POS) files, which is a dataset with information on facility certification, termination, ownership, accreditation, service offerings, and other characteristics organized by the CMS Certification Number. This database contains information for all Medicare-certified facilities and providers and is updated each quarter. Since I am interested in hospitals in operation between 2006-2018, I downloaded the 2018 POS file of all hospitals that were ever active by end-of-year 2018. To clean my hospital list, I filtered out facilities that closed before 2006, non-hospitals, non-STACH facilities, federal hospitals, and hospitals located in unincorporated U.S. territories (see Appendix Figure 1 for full sample construction flow). My final POS dataset of short-term acute-care hospitals – hospitals with an average length-of-stay shorter than thirty days – contained 5,292 hospitals.

Although the nature of the POS file is cross-sectional, there are some variables that are of use to my research. I obtain physician, registered nurse (RN), and other employees full-time equivalent (FTE)

metrics to understand baseline utilization differences within the dataset, as seen in the summary statistics section. Critical access hospital (CAH) is a designation given to smaller, geographically isolated rural hospitals which allow them to receive total cost-based reimbursement from Medicare. CAH status is used as a control variable, alongside number of ownership changes and static bed count. Although CMS had used CBSA (Core Based Statistical Area) codes to indicate Urban-Rural status, I use an updated methodology as defined by the Federal Office of Rural Health Policy (FORHP). In 2021, FORHP began classifying Urban-Rural status using Rural-Urban Community Area (RUCA) codes, which expanded rurality to outlying metro counties without an urbanized area. I use the FORHP rural-eligible zip codes to categorize the Urban-Rural status of hospitals in the POS file. Additionally, the POS file reports hospital termination date, which is my proxy for hospital closure. The dataset unfortunately lacks the reason for termination; I recognize that termination may be due to merger, change of service provision, or bankruptcy, but for the purposes of this research, I consider all as hospital closure.

Financial and Utilization Characteristics

I use Medicare Cost Reports from CMS to obtain financial data on nongovernmental short-term acute-care hospitals. These data come from the Healthcare Provider Cost Reporting Information System (HCRIS) and displays annual cost reports that Medicare-certified institutions submit to Medicare. Medicare Cost Reports contain information on utilization characteristics (i.e. beds, discharges), hospital charges and costs, reimbursements, and other financial statement data. When sorting the data, however, I noticed that hospitals submit cost reports based on different fiscal years, with some hospitals submitting multiple cost reports for each year. Adam Sacarny, a health economics researcher from Columbia University, combatted this challenge by constructing synthetic calendar year data, using weighted sums and weighted averages for flow variables and stock variables, respectively. Adam Sacarny published his HCRIS data and methodology, both of which I carry over for my analysis.

Medicare Cost Reports are submitted manually by hospital administration, which may lead to human error and systematic inaccuracies within the data. Thus, I carefully assessed and cleaned the following relevant variables: bed count, inpatient discharges, profit margin, net patient revenue, total cost, operating expense, cost-to-charge ratio, total inpatient revenue, total outpatient revenue, total patient revenue, inpatient days of care, and number of available bed days. These metrics are used to calculate the financial and utilization outcome measures of interest. Firstly, I dropped any observations in the Cost Reports dataset that did not encompass an entire fiscal year, which standardizes the units of reporting. For the bed count variable, I compared the yearly reported bed count values with the static bed count total, as recorded in the hospital POS dataset. If the change was larger than one standard deviation, I consulted web searches to confirm the accuracy. If vastly inaccurate, I dropped the datapoint entirely. To clean the cost-to-charge ratio – the ratio of Medicare allowable hospital costs relative to the corresponding total – I followed the criteria set by the Healthcare Cost and Utilization Project (HCUP) to identify outliers. Given the considerable outliers present in the tails of the data, I performed a 1% winsorization on the cost-to-charge ratio (CCR). Similarly, I winsorize at the 1% and 99% level for inpatient discharges. For total cost and operating expense variables, I dropped the six negative observations from the dataset, seemingly erroneously reported.

To create my final dataset, I first link data from the private equity hospital acquisitions list with the CMS POS hospital dataset using the CMS Certification Number, also known as the provider number. Then, for longitudinal cost data over the period 2004-2021, I merged the previously linked POS and PE dataset with the HCRIS cost data, cross-checking with facility name to verify that all hospitals in the sample are short-term acute-care hospitals. Hospitals with no matched HCRIS cost data, as well as hospital-year observations with data covering only a fraction of a year, were dropped from the sample.

Local Market Characteristics

To define localization of healthcare service usage, the Dartmouth Atlas of Healthcare has segmented the United States into distinct healthcare markets. Using Medicare hospitalization records and migration patterns, Dartmouth Atlas defined 3,436 hospital service areas (HSA) within the United States, which tracks regions in which patients typically received care. Hospital service areas, however, only encompass local utilization patterns and do not account for the larger hospital referral network. Thus, hospital referral regions (HRR) were outlined to incorporate where patients are referred for major cardiovascular and neurosurgical procedures. The 3,436 HSAs were aggregated into 306 distinct hospital referral regions, which has become the standard for local healthcare markets. Using crosswalk files from Dartmouth Atlas and hospital addresses from the POS file, I matched sample hospitals to their respective HRR by ZIP code. To control for local market share, I calculate the percent of beds the hospital occupies within its hospital referral region.

4.2 Summary Statistics

Table 1 in the Appendix provides the descriptive statistics for all the key variables (outcome, treatment, and control) in my analysis. Table 1 below summarizes the sample of 352 hospitals ever owed by private equity between 2006-2018 and 4,940 non-PE acquired hospitals using 2018 cross-sectional data. Out of the PE-owned hospitals, around 75% of hospitals were for-profit compared to 16% in the control, which was expected given that private equity firms typically invest in hospitals with a for-profit model. For PE-acquired not-for-profit hospitals, it is likely that the hospital changed ownership type after private equity's exit. Private equity owned hospitals are predominantly urban, with 72% of PE-owned hospitals being urban compared to the non- PE-owned average of 50% at the conclusion of my study period. Compared to their non-PE counterparts, PE-acquired hospitals tend to be larger, located in urban areas, and less likely to have critical access hospital (CAH) designation. These results are

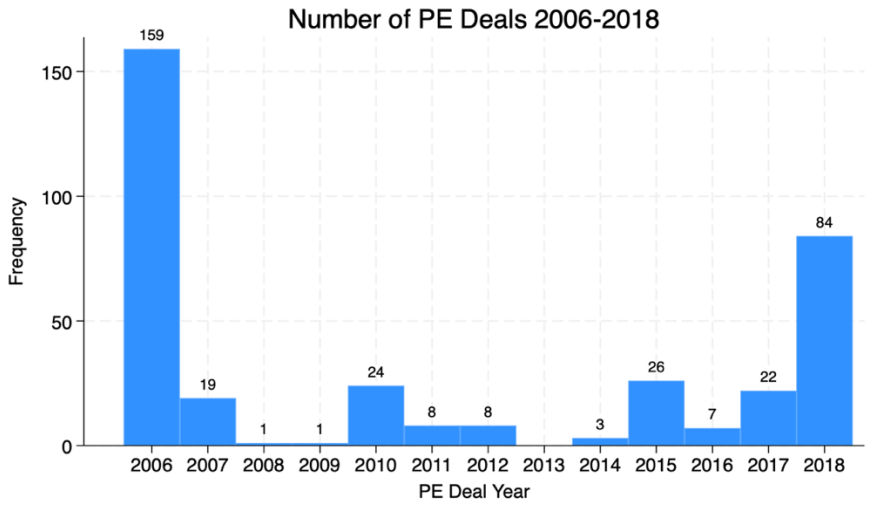
consistent with findings from Offodile II et al. (2021), supporting that private equity firms acquire hospitals with market power and strong baseline characteristics.

Table 1. Summary statistics for characteristics of PE-acquired vs. non-PE-acquired hospitals in 2018

	Hospitals, Number (%)		
	PE-Acquired	Non- PE-Acquired	Full Sample
Ownership			
Non-profit	69 (19.6%)	2,954 (60.0%)	3,023
For-profit	262 (74.4%)	787 (15.9%)	1,049
Government-run	21 (6.0%)	1,179 (23.9%)	1,200
Facility Type			
Short term	339 (96.3%)	3,540 (71.6%)	3,879
Critical access	13 (3.7%)	1,380 (27.9%)	1,393
Rural-Urban Status			
Rural	98 (27.8%)	2,471 (50.0%)	2,569
Urban	254 (72.2%)	2,469 (50.0%)	2,723
Size, by Bed Count			
<100 beds	74 (21.0%)	2,685 (54.4%)	2,760
100-400 beds	233 (66.2%)	1,693 (34.3%)	1,930
>400 beds	45 (12.8%)	562 (11.4%)	604
Closure	40 (11.4%)	618 (12.5%)	658
Observations	352	4,940	5,292

Based on the private equity hospital deal list, I identified the number of hospitals in my dataset acquired by PE firms each year (Figure 2). During my study period of interest, 2006-2018, most private equity deals occurred during 2006, as the Hospital Corporation of America (HCA) deal was the largest healthcare deal to date, accounting for 159 hospitals in 2006. Between 2008 and 2014, there were fewer relative PE-acquired hospitals, which may reflect fewer PE deals or more firms acquiring fewer large hospital systems. The number of PE-acquired hospitals in 2018 increased considerably from the prior few years, potentially indicating a recent trend towards hospital buyouts.

Figure 2. Private Equity Deal-Hospitals Over Time Horizon 2006-2018



Although my study period for private equity deals spans 13 years, the bimodal distribution of deal-years has implications for my research. For instance, private equity affiliated hospitals that experience closure are likely hospitals that were acquired in the earliest years of the study period. Additionally, the acquisitions across different years may be subject to different regulatory environments, which is a limitation of my study.

Hospital addresses were geocoded and mapped to hospital referral region boundaries[1] using ArcGIS. Figure 3 shows the geographic spread of private equity activity in provider markets, by hospital referral region classified by rural-urban status. I find that private equity activity is mainly concentrated in Southeast, Mid-Atlantic, and West regions of the United States, especially in major Southern cities such as Houston and Miami. The northern US is largely untouched by private equity activity. I also find some clusters of rural hospitals acquired by private equity, as seen in areas of Kentucky and Tennessee. This supports the notion of "add-on" acquisitions in the healthcare provider sector to gain local market power. Overall, private equity has permeated much of the lower United States and major Southern cities.

[1] Hospital referral region boundary map provided by Dartmouth Atlas of Health Care

Figure 3. Geographic Distribution of Private Equity Owned Hospitals in the United States (2006-2020), Classified by Rural-Urban Status

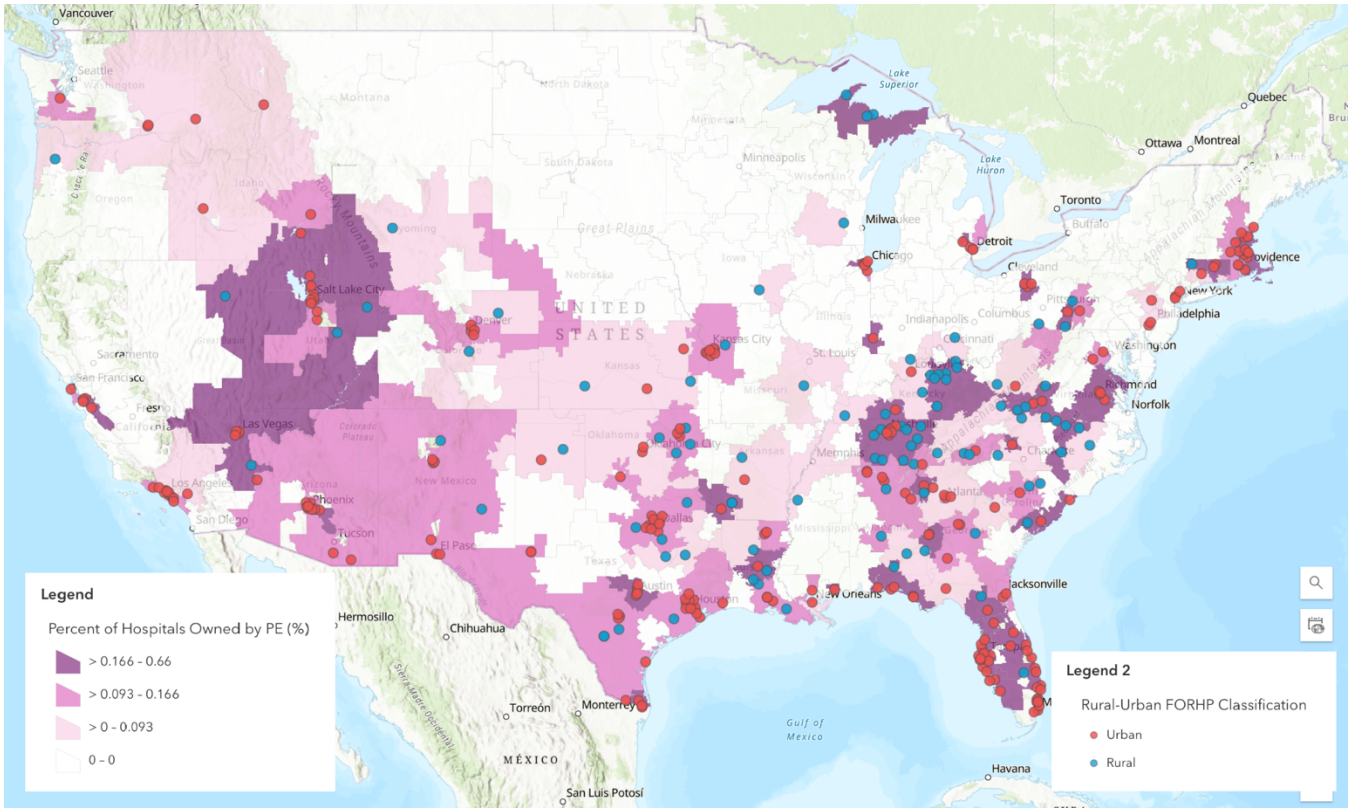


Table 2 displays hospital financial and utilization characteristics across urban and rural hospitals. Relative to urban hospitals, rural hospitals are smaller with an average bed count of 59.22 compared to 264.71 beds for urban hospitals. This is also reflected in the inpatient discharges, where rural hospitals have considerably fewer discharges, and commensurately have fewer full-time equivalent physicians and registered nurses. Due to the low volume of patients, rural hospitals also have lower occupancy rates, with a 15% difference between rural and urban for-profit hospitals. Regarding cost-to-charge ratio (CCR), for-profit hospitals have lower ratios, corresponding to higher markups, relative to their non-profit and government-owned counterparts. Rural hospitals have higher CCRs due to their reliance on public funding through Medicare, with its own hospital reimbursement policies. The gap between total income and total cost is relatively small, ranging from around $12 million in urban for-profit hospitals to around $1.6 million in rural not-for-profit hospitals.

Table 3 provides summary statistics for outcome characteristics between PE-acquired and non-PE acquired facilities. On average, private equity targets facilities that are larger, with an average bed count of 235 compared to 166, and with higher occupancy rates. This indicates that private equity is attracted to hospitals with higher demand for bed usage, likely in more urban areas. Braun et al. (2021) found that private equity firms target larger practices with more commercially insured patients, which may explain the higher profit margin among PE-owned hospitals relative to non-PE-affiliated ones. Interestingly, PE-acquired hospitals have more registered nurse full-time equivalents (FTE) compared to non-acquired facilities, yet fewer other personnel FTE. PE firms are far more likely to acquire hospitals with lower cost-to-charge ratios, indicating hospitals that charge more to insurers relative to costs. Since private equity firms seek to improve hospital profits, targeting facilities with higher markup rates is in-line with existing literature. Compared to the full sample average of 0.38, PE-acquired facilities have a CCR of 0.22, while non-PE-acquired facilities average around 0.40 CCR. Furthermore, facilities targeted by PE have higher incomes, lower total costs, and higher total patient revenues relative to their non-PE affiliated counterparts.

Table 2. Summary statistics for financial and operational characteristics of urban vs. rural hospitals

	Urban		Rural		
	NP/Govt	For-Profit	NP/Govt	For-Profit	Full Sample
Observations	27,490	8,694	30,545	3,787	95,256
Bed Count	316.88	187.45	58.54	79.40	170.48
	(263.20)	(190.00)	(69.22)	(65.46)	(215.65)
Inpatient Discharges	12,956.28	7,437.91	1,735.81	2,294.49	6,801.69
	(9852.53)	(6912.00)	(2417.63)	(2132.82)	(8636.24)
Occupancy Rate (%)	57.61	45.51	27.67	29.87	40.88
	(18.16)	(20.69)	(17.86)	(16.58)	(23.36)
RN FTE	407.05	194.77	60.01	59.25	205.02
	(471.28)	(273.37)	(87.69)	(63.15)	(347.64)
Other Personnel FTE	886.39	301.61	156.31	114.90	440.39
	(1280.52)	(420.27)	(230.74)	(127.53)	(879.15)
Profit Margin	0.030	0.059	0.017	0.019	0.022
	(0.48)	(0.38)	(0.26)	(0.19)	(1.47)
Cost-to-charge Ratio	0.34	0.23	0.50	0.31	0.38
	(0.19)	(0.11)	(0.22)	(0.18)	(0.22)
In millions					
Total Income	321.24	141.62	43.85	41.42	179.35
	(381.37)	(157.63)	(60.24)	(38.33)	(320.51)
Total Cost	304.30	129.37	42.19	38.54	168.87
	(350.66)	(141.35)	(56.22)	(34.05)	(295.61)
Net Patient Revenue	294.60	137.57	40.53	40.14	164.58
	(341.20)	(150.84)	(54.37)	(37.68)	(284.99)
Inpatient Revenue	112.42	54.62	6.91	8.52	60.62
	(201.77)	(101.67)	(14.64)	(12.40)	(166.00)
Total Patient Revenue	922.69	631.85	96.46	142.07	557.03
	(1129.65)	(767.30)	(155.77)	(165.67)	(1034.29)

Standard errors in parentheses; observations recorded as hospital-years

Table 3. Summary statistics for financial and operational characteristics of PE-acquired vs. non-PE-acquired hospitals

	(1) PE-Acquired	(2) Non- PE-Acquired	(3) Full Sample
Observations	6,372	88,920	95,292
Bed Count	235.38 (188.88)	165.86 (216.69)	170.48 (215.65)
Inpatient Discharges	8646.93 (6880.35)	6663.76 (8737.58)	6801.59 (8636.16)
Occupancy Rate (%)	47.23 (19.35)	40.41 (23.56)	40.88 (23.36)
Registered Nurse FTE	221.58 (230.62)	203.84 (354.48)	205.02 (347.64)
Other Personnel FTE	348.12 (347.21)	446.96 (904.84)	440.39 (879.15)
Profit Margin	0.061 (0.14)	0.019 (1.52)	0.022 (1.47)
Cost-to-charge Ratio	0.22 (0.10)	0.40 (0.22)	0.38 (0.22)
In millions Total Income	164.70 (158.36)	180.46 (329.51)	179.35 (320.50)
Total Cost	148.12 (130.23)	170.42 (304.34)	168.87 (295.61)
Net Patient Revenue	161.00 (155.62)	164.84 (292.46)	164.57 (284.99)
Inpatient Hospital Revenue	62.70 (87.66)	60.47 (170.39)	60.62 (166.00)
Total Patient Revenue	809.74 (1011.48)	537.91 (1033.48)	557.02 (1034.28)

Standard errors in parentheses; observations recorded as hospital-years

Figure 4. Geographic Distribution of Hospital Closures in the United States (2006-2020), Classified by Rural-Urban Status

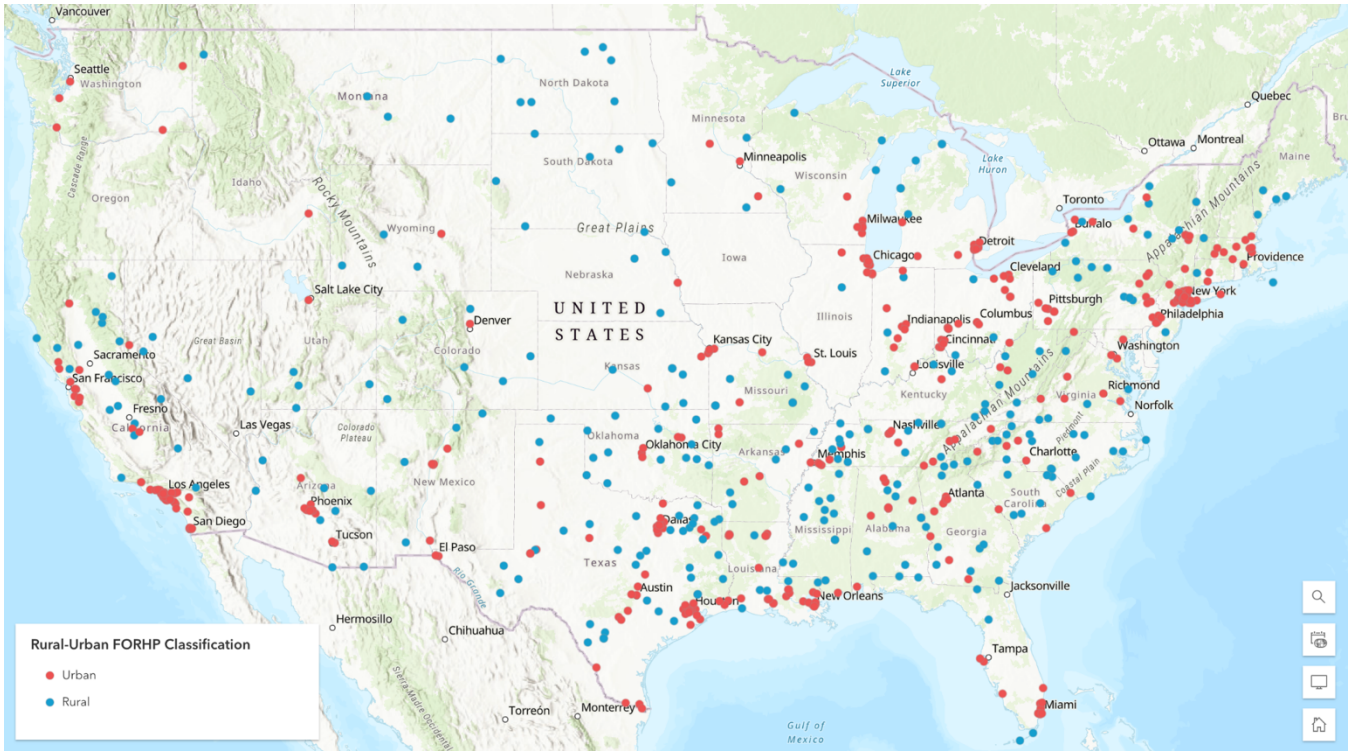


Figure 4 displays the location of the 658 hospital closures in the United States between January 2006 and December 2020. There are 287 rural hospital closures and 371 urban hospital closures over the study period. Hospital closures, unlike private equity activity, is spread relatively evenly across the contiguous United States. There appears to be a slightly higher concentration of closures in the Southeast region, affecting both urban and rural hospitals.

4.3 Empirical Specification

Financial & Utilization Performance Models

To estimate the effect of private equity acquisition on financial and utilization outcomes of rural hospitals relative to their urban counterparts, I apply a difference-in-differences framework to a panel regression model, as influenced by Cerullo et al. (2021) and Bruch et al. (2020):

$$Y_{it} = \beta_0 + \beta_1 CurrentPE_{it} + \beta_2 (Rural*CurrentPE)_{it} + \beta_3 BedCnt_{it} + \mu_i + \delta_j + \varepsilon_{it,} \quad (1)$$

where Y_{it} represents the financial and utilization outcome variable for facility i at time t, where $t=1,\ldots,17$ over the years 2004-2020. The nine outcome variables of interest are detailed in Table 5. $CurrentPE_{it}$ reflects two binary indicator variables (PE_j x $Post_i$), where $CurrentPE_{it}$ =1 if facility i is under PE ownership in year t, and $CurrentPE_{it}$ = 0 if facility is not owned by private equity or year t is pre-PE affiliation. Due to variability in hospital acquisition timeframe, $CurrentPE_{it}$ = 0 for the index year and = 1 for the first complete year under PE ownership. The parameter β_1 is the difference-in-difference estimator quantifying the effect of private equity acquisition. $Rural_{it}$ is a binary indicator corresponding to rural-urban status as defined by FORHP. $Rural_i$*$CurrentPE_{it}$ corresponds to the interacted relationship between PE ownership of facility i and rural-urban status of facility i, in which the covariate is active for all rural hospitals under PE control. The key coefficient of interest is β_2, which estimates the additional effect of being a rural hospital acquired by PE for outcome Y_{it}. The model includes hospital fixed effects (μ_i) and year fixed effects (δ_j) to account for time-invariant hospital-specific unobservable characteristics, thus mitigating omitted variable bias. The hospital-level fixed effects rely on within-facility variation over time, removing any unobserved cross-sectional heterogeneity. I control for $BedCnt_{it,}$, which displays the number of beds offered by facility i at time t. Since $BedCnt_{it}$ is a proxy for hospital size, I convert $BedCnt_{it}$ into a discrete variable segmented by quartiles. All other relevant explanatory variables are hospital-dependent and thereby accounted for in the hospital fixed effects. Standard errors are clustered at the hospital level.

Additionally, I consider a second specification to analyze key differences between rural and urban hospitals. Specification (2) employs a panel regression model without hospital fixed effects to better illustrate differences between rural and urban hospitals that would be subsumed by hospital fixed effects, since the rural status of hospitals does not change during my sample period. Specification (2) studies the same outcome variables as specification (1),

$$Y_{it} = \beta_0 + \beta_1 EverPE_{it} + \beta_2 CurrentPE_{it} + \beta_3 Rural_{it} + \beta_4 (Rural*EverPE)_{it} + \beta_5 (Rural*CurrentPE)_{it} + \beta_5 \boldsymbol{H}_{it} + \delta_j + \varepsilon_{it} \quad (2)$$

where $EverPE_{it}$ is a binary indicator of whether the hospital is ever owned by private equity between 2004-2020, serving as a baseline for understanding the primary explanatory variables. $Rural_{it}$ and $CurrentPE_{it}$ variables carry the same interpretation as in specification (1). The interaction terms represent the added impact of rural status with private equity ownership.

Table 4. Description of Hospital-level Controls ($\boldsymbol{H_{it}}$)

Covariate	**Type**	**Description**
$BedCnt_{it}$	Categorical, by quartiles	Number of inpatient beds at the facility
$CriticalAccess_i$	Categorical	Yes/no
$OwnershipType_{it}$	Categorical	For-profit Non-profit Government-run
$CHOWCnt_i$	Continuous	Number of times hospital has experienced a change of ownership between 2006-2018
$MarketShare_i$	Continuous	Percentage of beds in HRR in 2018

I include *Rural*EverPE* to set the baseline of outcomes pre-PE acquisition, such that *Rural*CurrentPE* corresponds to the changes post-PE acquisition. The key coefficients of interest are β_3 and β_5, which estimate the differential impact of rural hospital status in addition to private equity rural hospital status. Since the Hausman test on specification (2) yielded p-values significant at the 5% level, I reject the random effects model and thereby focus on fixed effects. Although (2) does not include hospital fixed effects, time-related fixed effects (δ_t) and hospital-level attributes ($\boldsymbol{H_{it}}$) are incorporated to control for

relevant heterogeneity. The vector $\boldsymbol{H}_{it}$ consists of five hospital-level control variables, as described in Table 4. Similarly, standard errors are clustered at the hospital level to account for serial correlation.

To understand the relationship between PE-owned rural hospitals and hospital performance, I consider nine outcome variables that estimate different financial and operational characteristics: profit margin, net patient revenue, net patient revenue per discharge, operating expenses, total cost per patient, cost-to-charge ratio, outpatient to total patient revenue, occupancy rate and inpatient discharge (Table 5). These outcome variables were selected because they address a range of key performance indicators that quantify the success of the hospital, covering profitability, hospital-borne costs, markups on patient services, and utilization rate.

Table 5. Definition of Outcome Variables

Variable	Definition	Description
Profit margin	Net income / Total Revenue	Measures the difference between total revenue and costs as a proportion of total revenue, including non-operating income. A positive value indicates facility is making a profit.
Operating expenses		Measures the cost of operating a hospital, including staff salaries, medical supplies, equipment, interest on buildings
Net Patient Revenue	Total revenue – (Allowances + Discounts)	Measures the aggregate revenue generated from patient services collected from payers. A negative value indicates its patient discounts are greater than its total revenue.
Cost-to-charge Ratio (CCR)	Total expenses / Total charges	Measures the ratio of Medicare allowable costs to the hospital's total gross charges. A CCR closer to 0 indicates a higher markup of costs.
Net patient revenue, per patient discharge	Net patient revenue / Discharges	Normalizes revenue on a per-patient basis
Cost per patient discharge	(Operating expenses + other expenses) / Discharges	Normalizes total cost on a per-patient basis

Outpatient to total patient revenue	Outpatient revenue / (Inpatient revenue + Outpatient revenue)	Measures the percent of patient revenue generated from outpatient services. A value closer to 1 indicates hospital focuses more on outpatient services relative to inpatient services.
Occupancy Rate	Inpatient days of care / Bed days available	Measures the proportion of bed capacity occupied on average.
Inpatient Discharge		Measures the release of a patient who has stayed at least one night in the hospital

I chose profit margins as my main profitability metric. To better comprehend the source of profits, I examine net patient revenue and operating expenses, as well as their values on a per-patient basis. I assess cost-to-charge ratio (CCR) as it is an important indicator of hospital markups, a basis CMS uses to set future Medicare payment rates. A lower CCR indicates a higher markup, meaning a higher charge to patients and insurers. For example, a CCR of 0.25 means the hospital marks up its cost by a multiple of 4x, whereas a 0.2 CCR indicates markups by a multiple of 5x. Unlike publicly insured patients who rely on governmental funding of care, privately insured and uninsured patients bear the burden of higher charges in the form of inflated medical bills or increased premiums. I examine the percent outpatient to total patient revenue to gather insight on the revenue mix of a facility. Since inpatient services tend to be more expensive, a lower outpatient percentage potentially suggests the hospital provides more high-margin services. On the other hand, a higher outpatient percentage may indicate the hospital is prioritizing lower-cost services at higher volumes. Alternatively, changes to percent outpatient revenue may suggest changes in the hospital's procedure mix. I analyze occupancy rate to understand the capacity of beds demanded across hospitals. The average occupancy rate in my full sample is 41%. Hospitals with too low occupancy may be losing money from over-staffing, but too high occupancy could lead to declines in quality due to staff shortages.

Hospital Closure Model

Furthermore, I conduct a secondary analysis on the correlation between private equity ownership and hospital closure. Using cross-sectional data, I analyze the probability of hospital closure within a 15-year span. I employ a binary logistic regression to estimate the impact of rural status and private equity affiliation on hospital closure:

$$Pr(Closure)_i = \beta_0 + \beta_1 EverPE_i + \beta_2 Rural_i + \beta_3 (Rural*EverPE)_i + \beta_4 BedCnt2018_i + \beta_5 CriticalAccess_i + \beta_6 CHOWCnt_i + \beta_7 HRRwithPE + \varepsilon_i \quad (3)$$

The closure outcome is a binary variable of whether facility *i* closed between 2006-2020. Carrying over from specifications (1) and (2), the first three explanatory variables are binary indicators reflecting PE ownership status, rural hospital status, and their interacted statuses, respectively. Due to the cross-sectional approach, I dropped control variables that varied over time for specification (3). I use *BedCnt* from 2018 to control for relative hospital size, segmented into discrete quartiles. *CriticalAcces* controls for acute care versus critical access hospital classification, and *CHOWCnt* considers the number of ownership changes sustained by hospital *i*. Finally, *HRRwithPE* is a binary indicator denoting if hospital *i* is located in the same hospital referral region (HRR) as another hospital owned by private equity, excluding the PE-owned hospitals themselves. This variable captures the possible spillover effects of private equity grouped by distinct healthcare markets.

5. Results

To assess the impact of private equity acquisitions on rural hospitals' financial and utilization outcomes, I use panel regressions with fixed effects, clustering standard errors by hospital for both models. For each outcome variable, I run two panel regressions: specification (1) with year fixed effects and specification (2) with hospital and year fixed effects.

Table 6. Regression Output for Overall Financial Metrics using Specification (1)

VARIABLES	(1) Profit Margin	(2) Net Patient Revenue (NPR)	(3) Operating Expense	(4) Cost-to-charge Ratio
Mean	0.0224	1.65e+08	1.67e+08	0.382
Current PE	0.0444***	-5.773e+06	-2.182e+07***	-0.00356
	(0.00945)	(5.185e+06)	(4.672e+06)	(0.00384)
Rural*Current PE	-0.0261**	-5.136e+07***	-4.032e+07***	-0.0212***
	(0.0127)	(5.436e+06)	(4.637e+06)	(0.00766)
Bed Count (Q1)	-0.00234	-7.619e+07***	-6.782e+07***	0.0160*
	(0.0444)	(8.814e+06)	(7.338e+06)	(0.00821)
Bed Count (Q2)	0.0160	-7.049e+07***	-6.401e+07***	0.00963
	(0.0389)	(8.920e+06)	(7.336e+06)	(0.00707)
Bed Count (Q3)	0.00611	-4.405e+07***	-3.587e+07***	0.00340
	(0.0254)	(5.051e+06)	(4.779e+06)	(0.00520)
Constant	0.0210	2.133e+08***	2.106e+08***	0.375***
	(0.0270)	(5.376e+06)	(4.710e+06)	(0.00460)
Hospital F.E.	Yes	Yes	Yes	Yes
Observations	78,439	78,437	79,223	72,189
Adj. R-squared	0.113	0.870	0.891	0.919

Standard errors clustered by hospital in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 6 displays the panel regression output for four baseline financial characteristics. Hospital fixed effects allow comparison within hospitals pre-acquisition compared to post-acquisition. Primarily focusing on the estimates for the first two variables, results show that the profit margin is approximately 4.4% higher post-PE acquisition relative to pre-PE acquisition. This signifies that private equity ownership is correlated with an approximate 200% increase in profit margins. My results are consistent with Offodile II et al.'s findings in sign and magnitude, although Offodile II et al. (2021) reported data

cross-sectionally in 2003 and 2017. The interaction of rural and private equity is -2.6%, suggesting that rural status offsets the positive profit margin private equity otherwise experienced by private equity acquired facilities, though the net profit margin for rural hospitals post-PE is still 1.8% higher than pre-PE acquisition. This result is statistically significant at a p-level of 0.05, indicating that both rural and urban hospitals become considerably more profitable through private equity ownership, though the magnitude of profitability is higher in urban PE hospitals relative to rural ones. Hospitals' cost-to-charge ratio, on the other hand, is not significantly impacted by private equity control. Only among rural PE-owned hospitals, data demonstrates that rural PE hospitals undergo an additive decrease in the cost-to-charge ratio by 2.12, corresponding to an increase in hospital markups. Consistent with Bruch et al. (2020)'s findings, lowered cost-to-charge ratios may lead to higher payments from patients and insurers. Regarding hospital revenues, I find that private equity has a small negative impact on net patient revenue (NPR), though results are not significantly different pre and post private equity control. For rural hospitals, however, I find that private equity causes lower net patient revenues by $51.36 million, which is significant with a p-value of <0.01. On the cost side, I determine that PE-acquired hospitals experience lower operating expenses by $21.82 million, whereas rural PE-acquired hospitals experience even lower operating expenses of $62 million. Taken together, my findings suggest that private equity firms focus on increasing profitability primarily by reducing hospital costs rather than increasing revenues.

Table 7 shows regression results of more granular financial measures alongside utilization metrics. Hospitals post private equity control are correlated with a decrease in net revenue (NPR) by $16,000 per patient and a decrease in costs by nearly $21,000 per patient. Since the magnitude of cost reduction is larger than that of revenue reduction, the hospital generates a net profit. Relative to their urban counterparts, rural PE-acquired hospitals reduce revenues and costs by a smaller magnitude with a

Table 7. Regression Output for Utilization and Per Patient Financial Metrics using Specification (1)

VARIABLES	(1) Net patient rev., per patient	(2) Total Cost, per patient	(3) Outpatient to Total Revenue	(4) Occupancy Rate	(5) Inpatient Discharges
Mean	41,052	45,962	0.570	40.88	6,802
Current PE	-16,311***	-20,706***	-0.0301***	2.566***	279.6
	(1,112)	(1,418)	(0.00348)	(0.746)	(176.2)
Rural*Current PE	5,561***	6,003***	0.0386***	-7.188***	-722.8***
	(2,128)	(1,906)	(0.00711)	(1.363)	(197.9)
Bed Count (Q1)	8,102*	9,283**	0.0491***	5.105***	-3,100***
	(4,258)	(4,226)	(0.00716)	(0.314)	(207.8)
Bed Count (Q2)	3,471	2,867	0.0381***	5.461***	-2,992***
	(2,933)	(2,472)	(0.00510)	(0.384)	(207.3)
Bed Count (Q3)	1,502	2,704**	0.0176***	1.868***	-2,075***
	(965.2)	(1,058)	(0.00295)	(0.374)	(155.7)
Constant	38,110***	42,627***	0.544***	37.90***	8,846***
	(1,846)	(1,760)	(0.00341)	(0.175)	(139.5)
Hospital F.E.	Yes	Yes	Yes	Yes	Yes
Observations	78,208	78,946	78,450	83,498	79,235
Adj. R-squared	0.722	0.745	0.902	0.890	0.975

Standard errors clustered by hospital in parentheses
*** p<0.01, ** p<0.05, * p<0.1

net profit as well. This suggests that hospitals are switching to a different procedure mix with more profitable service lines, which is consistent with conclusions drawn by Offodile et al. (2021b). In assessing if the capital stream is flowing to predominantly inpatient or outpatient services, I examine outpatient to total patient revenue. I find a three percentage point decrease in outpatient revenue post-PE acquisition relative to pre-PE, which is offset in rural post-PE hospitals for a net increase in outpatient services relative to the control. These findings imply that urban PE hospitals are more likely to target high-margin inpatient care whereas rural PE hospitals focus on maximizing outpatient service delivery. Finally, results indicate that private equity firms increase occupancy rates post-acquisition by around 2.6 percentage points, along with increases in inpatient discharges. Looking at rural PE-acquired hospitals specifically, occupancy rate decreases by around 4.6 percentage points relative to pre-PE rural hospitals. This is consistent with inpatient discharges, where I find that rural post-PE hospitals receive around 700

fewer inpatient discharges each year. Rural hospitals historically have lower hospital volumes, and further reductions in occupancy rate and patient discharges may lead to long-term financial distress (Jiang et al., 2022).

Table 8. Regression Output for Overall Financial Metrics using Specification (2)

VARIABLES	(1) Profit Margin	(2) Net Patient Revenue (NPR)	(3) Operating Expense	(4) Cost-to-charge Ratio
Mean	0.0224	1.65e+08	1.67e+08	0.382
Ever PE	-0.0143*	-8.542e+07***	-8.826e+07***	-0.0425***
	(0.00798)	(1.061e+07)	(1.002e+07)	(0.00759)
Current PE	0.0603***	1.705e+07	-6.939e+06	-0.000853
	(0.00946)	(1.079e+07)	(9.856e+06)	(0.00688)
Rural	0.00243	-5.189e+07***	-5.624e+07***	0.0290***
	(0.00894)	(3.327e+06)	(3.540e+06)	(0.00549)
Rural*Ever PE	0.0189	8.653e+07***	9.145e+07***	-0.00641
	(0.0135)	(1.282e+07)	(1.242e+07)	(0.0114)
Rural*Current PE	-0.0695***	-2.103e+07	3.430e+06	-0.0357**
	(0.0192)	(1.424e+07)	(1.360e+07)	(0.0151)
Bed Count (Q1)	-0.0368	-3.336e+08***	-3.435e+08***	0.138***
	(0.0430)	(1.071e+07)	(1.137e+07)	(0.0123)
Bed Count (Q2)	-0.0260*	-3.158e+08***	-3.245e+08***	0.0503***
	(0.0149)	(1.037e+07)	(1.103e+07)	(0.00764)
Bed Count (Q3)	-0.0143	-2.646e+08***	-2.725e+08***	0.00706
	(0.00924)	(9.885e+06)	(1.044e+07)	(0.00605)
Critical Access Status	0.0142	-3.202e+06	-4.320e+06	0.140***
	(0.0298)	(2.791e+06)	(2.920e+06)	(0.0120)
Non-profit	0.0261***	6.102e+06	-4.440e+06	-0.0749***
	(0.00869)	(4.949e+06)	(5.412e+06)	(0.00648)
For-profit	0.0393***	-4.150e+07***	-5.681e+07***	-0.166***
	(0.0137)	(5.377e+06)	(5.766e+06)	(0.00748)
Num. Ownership Change	-0.00207	-483,232	-591,151	-0.00552***
	(0.00148)	(1.751e+06)	(1.845e+06)	(0.00138)
Market Share	0.0165	2.667e+08***	2.276e+08***	-0.0236
	(0.0665)	(4.302e+07)	(4.334e+07)	(0.0225)
Constant	0.0200**	3.989e+08***	4.219e+08***	0.391***
	(0.00875)	(1.252e+07)	(1.341e+07)	(0.00922)
Hospital F.E.	No	No	No	No
Observations	64,115	64,113	64,717	57,750
Adj. R-squared	0.003	0.446	0.443	0.405

Standard errors clustered by hospital in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 9. Regression Output for Utilization and Per Patient Financial Metrics using Specification (2)

VARIABLES	(1) Net patient rev., per patient	(2) Total Cost, per patient	(3) Outpatient to Total Revenue	(4) Occupancy Rate	(5) Inpatient Discharges
Mean	41,052	45,962	0.570	40.88	6,802
Ever PE	-974.5	1,119	0.00295	-3.018***	-2,107***
	(1,771)	(2,205)	(0.00732)	(1.061)	(374.1)
Current PE	194.4	-209.8	-0.0358***	3.830***	846.4**
	(1,924)	(2,512)	(0.00722)	(1.120)	(385.0)
Rural	-29,189***	-34,588***	0.0727***	-10.53***	-1,811***
	(6,647)	(8,202)	(0.00552)	(0.565)	(104.1)
Rural*Ever PE	13,133***	15,228**	0.0314***	1.276	1,786***
	(4,591)	(5,933)	(0.0116)	(1.730)	(483.8)
Rural*Current PE	-1,541	-1,815	0.0125	0.0530	-360.8
	(4,058)	(4,675)	(0.0151)	(2.843)	(544.3)
Bed Count (Q1)	116,136***	147,184***	0.206***	-26.14***	-15,915***
	(19,617)	(28,471)	(0.0139)	(0.899)	(265.1)
Bed Count (Q2)	40,521***	47,454***	0.172***	-17.77***	-14,670***
	(10,720)	(11,964)	(0.00678)	(0.665)	(256.2)
Bed Count (Q3)	10,396***	12,935***	0.0845***	-7.871***	-11,313***
	(3,794)	(4,287)	(0.00448)	(0.502)	(243.5)
Critical Access Status	-58,891***	-80,005***	0.0281**	-4.772***	247.9***
	(16,461)	(23,782)	(0.0125)	(0.895)	(80.94)
Non-profit	-10,206**	-20,908***	0.0182***	4.060***	223.3*
	(4,920)	(6,165)	(0.00408)	(0.441)	(122.4)
For-profit	-24,028***	-41,551***	-0.0317***	-2.917***	-926.9***
	(6,824)	(9,182)	(0.00611)	(0.647)	(153.2)
Num. Ownership Change	-1,288**	-1,147	-0.000904	-0.235*	12.51
	(618.2)	(864.0)	(0.00112)	(0.136)	(43.19)
Market Share	29,630	34,654	0.0293	7.496***	9,641***
	(29,901)	(32,968)	(0.0184)	(2.012)	(1,291)
Constant	31,010***	40,751***	0.390***	59.19***	17,697***
	(4,049)	(5,538)	(0.00543)	(0.615)	(298.5)
Hospital F.E.	No	No	No	No	No
Observations	63,926	64,489	64,127	65,901	64,717
Adj. R-squared	0.057	0.056	0.486	0.541	0.734

Standard errors clustered by hospital in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Regression results of specification (2) are displayed in Tables 8 and 9 above, with interpretation of coefficient estimates in Table 10. I find that the coefficient estimate of profit margin is negative for ever-PE hospitals ($p<0.1$) and positive for current PE hospitals ($p<0.01$), suggesting that savvy investors acquire slightly less profitable hospitals and generate high returns with a quick turnaround time. Notably, I find that hospital profitability does not vary considerably between urban and rural hospitals, although I see significant variability between urban and rural PE-acquired hospitals. Similar to results in Table 7, ownership by private equity is correlated with significantly higher profit margins for both rural and urban hospitals, though the magnitude of profitability for rural PE-owned hospitals is much smaller by comparison. Since Medicaid patients tend to be less profitable than other payers, a common way to drive profitability is by shifting the patient mix to favor Medicare and private payer patients (Duggan et al., 2023). Braun et al. (2021) reported such maneuvers, which may explain, in some part, the increases in profitability with decreased patient volumes in PE-owned rural hospitals. Relative to pre-PE ownership, I do not find that private equity has a significant impact on net patient revenue or operating expenses of hospitals for rural or urban hospitals. Although the source of profitability – whether from increased revenues or decreased cost – differs between coefficient estimates in specifications (1) and (2), it is consistent that rural PE-owned hospitals are less profitable, overall, compared to urban PE-owned hospitals. I find that, similar to specification (1), cost-to-charge ratios are not significantly different pre- and post-PE for urban hospitals, but are significantly lower for rural PE-owned hospitals. In fact, rural hospitals generally have lower hospital markups compared to their urban counterparts, yet rural PE-owned hospitals experience a 3.6 percentage point increase in markups.

Specification (2) contextualizes the results proposed earlier and provides insight on utilization characteristics. I find that hospital costs decrease and net patient revenue increases after acquisition by private equity, though results are not statistically significant ($p>0.1$) and the adjusted R-squared value is

6%, indicative of low explanatory power. For rural PE hospitals, my findings suggest that PE firms acquire hospitals with higher-than-average costs and revenues, and aims to decrease hospital expenses. Similar to specification (1), I conclude that urban PE-acquired hospitals focus more on inpatient revenues and rural PE-acquired hospitals invest in similar ratios relative to non-acquired facilities (control). Regarding occupancy rate and discharges, I find that hospital occupancy rates increase after private equity ownership, as seen by increased inpatient discharges. For rural post-PE hospitals specifically, however, I find negligible impacts to occupancy rate coupled with decreases in inpatient discharges.

Table 10. Interpretation of Interaction Terms of Difference-in-Difference using Specification (2)

	Urban			Rural		
	Never PE	Pre-PE	Post-PE	Never PE	Pre-PE	Post-PE
Profit Margin	0.02	0.0057	0.066	0.02243	0.02703	0.01783
Net Patient Rev., *$m*	398.9	313.5	330.5	347.0	348.1	344.1
Operating Expense, *$m*	421.9	333.6	326.7	365.6	368.9	365.3
Cost-to-charge Ratio	0.391	0.3485	0.347647	0.42	0.37109	0.334537
Net Patient Rev., per patient	31,010	30035.5	30229.9	1821	13,979.5	12,632.9
Total Cost, per patient	40,751	41870	41660.2	6163	22,510	20,485.2
Outpatient to Total Revenue	0.39	0.39295	0.35715	0.4627	0.49705	0.47375
Occupancy Rate	59.19	56.172	60.002	48.66	46.918	50.801
Inpatient Discharges	17,697	15590	16436.4	15886	15565	16050.6

Furthermore, I estimated a logistic regression to assess the correlation between private equity acquisition and closure of rural and urban hospitals (Table 11). Controlling for urban PE-affiliated hospitals, I find a significant negative association between rural PE-owned hospitals and probability of closure ($p<0.05$). This indicates that rural hospitals acquired by a private equity firm are less likely to

close relative to their urban counterparts. I find that non-PE affiliated hospitals in the same hospital referral region (HRR) as a PE-affiliated hospital is more likely to close, significant at a 5% level. My results suggest that smaller hospitals have a higher probability of closure, as hospitals with bed counts in the lower two quartiles are more likely to close. Interestingly, critical access hospital status is associated with a negative likelihood of closure, relative to short-term hospitals. My results do not show a significant correlation between ownership changes and likelihood of closing, nor rural status and closure.

Table 11. Closure Logit Regression Output

VARIABLES	(1) Closure	(2) /
Ever PE	0.349	
	(0.222)	
Rural	-0.151	
	(0.122)	
Rural*Ever PE	-1.210**	
	(0.483)	
Bed Count (Q1)	2.210***	
	(0.387)	
Bed Count (Q2)	1.843***	
	(0.332)	
Bed Count (Q3)	0.899***	
	(0.179)	
Critical Access Status	-2.357***	
	(0.341)	
Num. Ownership Change	0.0379	
	(0.0305)	
HRR with PE	0.224**	
	(0.107)	
lnsig2u		-1.439
		(5.199)
Constant	-2.987***	
	(0.568)	
Observations	5,292	5,292
Number of Hospitals	5,292	5,292

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

6. Discussion

Compared to their non-private equity affiliated counterparts, private equity acquired hospitals tend to be larger, located in urban areas, and less likely to have critical access hospital designation. Although private equity firms are less likely to target rural hospitals, there may be mutually beneficial synergies between rural providers and private equity firms that enable a strong partnership. Rural providers are generally more in need of capital and could benefit from consolidation to avoid financial distress or closure. On the other hand, investors may be attracted to rural hospitals due to the Medicare payment models, for many rural hospitals benefit from a CMS rural payment designation that provides additional financial support (Gliadkovskaya, 2023).

Private equity's presence in the healthcare provider industry has marked impacts across various financial and utilization measures. Overall, I notice that the rural private equity produces significant results – whether positive or negative – across all nine financial and utilization outcomes ($p<0.05$). This highlights a differential impact of private equity ownership on rural hospitals relative to their urban counterparts, likely due to the structural, organizational, and demographic differences between the two subgroups.

My analysis of all US hospitals finds that private equity acquisition of urban hospitals is correlated with increases in profitability and occupancy rates, decreases in operating expenses and percent outpatient-to-total revenue, and negligible effects on cost-to-charge ratio, net patient revenue, and discharges. For PE-acquired rural hospitals, however, I find increases in profitability, outpatient-to-total revenue, and discharges, decreases in cost-to-charge ratio, and inconclusive findings regarding the source of increased profits. Private equity leads to more profitable urban and rural hospitals, though profits are much higher for urban hospitals relative to rural ones. PE firms seem to focus on methods that reduce hospital costs, which potentially includes cutting staffing, as seen by higher occupancy rates

in urban PE-acquired hospitals. Since Medicare sets fixed payment rates, reducing operating expenses stands out as the primary strategy private equity firms employ to improve profitability. Though the margin of profits for rural PE-owned hospitals is smaller relative to their urban counterparts, it is likely that private equity companies are generating more profits from privately insured patients, which is not reported in the CMS cost reports. Furthermore, decreases in patient revenue and costs may suggest that hospitals are altering their procedure mix, switching to more profitable service lines. Though these tactics seemingly improve financial performance, it raises some concerns regarding Medicaid patients' accessibility of care and long-term health outcomes. The higher charge-to-cost ratios may indicate that rural hospitals acquired by private equity firms began charging more for services, cutting operating costs, or both after the acquisition. In the long run, this may disproportionately impact uninsured patients and out-of-network privately insured patients, who have limited-to-none bargaining power against hospitals. Ultimately, although I find increased profitability in rural and urban hospitals post-private equity acquisition, more research is needed to understand the changes to healthcare quality in conjunction with improved hospital efficiency.

Regarding impacts to hospital utilization, I find that there is a 2.6 percentage point increase in occupancy rates post-PE relative to pre-PE acquisition. Capital investments often funds advanced medical equipment and technologies, potentially leading to an influx of patients choosing that hospital. However, I find that rural PE-acquired hospitals experience a decrease in occupancy rate by 4.6 percentage points and in inpatient discharges relative to pre-acquisition. Given rural hospitals' challenges with low patient volumes and staff shortages, there may be negative long-term implications to consistent decreases in occupancy rates and discharges.

Surprisingly, my results indicate that rural private equity-owned hospitals are less likely to close relative to their urban counterparts. This runs counter to conventional beliefs that private equity leads to

short-term gains at the expense of long-term viability. My findings suggest that private equity firms improve the long-term financial health of rural hospitals. However, I find that private equity ownership in a healthcare market, as defined by hospital referral regions, is correlated with an increased likelihood of a neighboring non-PE affiliated hospital closing. More research is needed to understand the spillover effects within markets and in nearby markets as private equity influence permeates more of the healthcare sector.

My study has several limitations that may provide direction for future research. Firstly, I could not access data on other hospital consolidation impacts – including mergers and acquisitions, joining hospital systems, and reason for termination – to further understand the effect of private equity in provider markets. Additionally, my models do not control for regional-level characteristics such as per capita income, population, and percent of population insured by Medicare or Medicaid. I also did not consider changes to the procedure mix, which could elucidate specifically where the revenue and cost changes arise from. Despite the data limitations, this study presents novel information on the interplay between financial, utilization, and survivorship performance in private equity-owned rural markets, which may serve as a foundation for future research.

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Appendix

Table 1. Descriptive Statistics

	Mean	Median	Standard Deviation	Minimum	Maximum	Skewness
Independent Variable						
PE hospitals, ever	0.067	0	0.25	0	1	3.5
Rural Status	0.49	0	0.5	0	1	0.058
Dependent Variable						
Profit margin	0.025	0.037	1.5	-310	12.6	-116
Net patient revenue, *$m*	165	68	285	-3293	6419	5.5
Operating expense, *$m*	167	68	294	0.78	7241	5.9
Cost per patient, *$t*	46	24	156	0.56	10291	25
Cost-to-charge ratio	0.38	0.33	0.22	0.093	1.3	1.6
Total income, *$m*	179	73	321	-3122	7218	5.9
Total cost, *$m*	169	69	296	0.78	7002	5.8
Net patient revenue per discharge, *$t*	0.041	0.024	0.12	-0.73	6.2	23
Outpatient to total revenue, %	0.57	0.58	0.19	-0.0057	1	-0.24
Occupancy Rate, %	41	41	23	0.0055	286	0.12
Controls						
Bed Count	144	80	176	1	2812	2.9
Short-term hospital	0.73	1	0.44	0	1	-1.06
Critical access hospital	0.26	0	0.44	0	1	1.1
Non-profit	0.58	1	0.49	0	1	-0.32
For-profit	0.18	0	0.38	0	1	1.7
Government-run	0.24	0	0.43	0	1	1.2

Figure 1. Sample Construction Flow Diagram

Sample constructed from primary sources (dashed boxes) to final sample of short-term general hospitals.

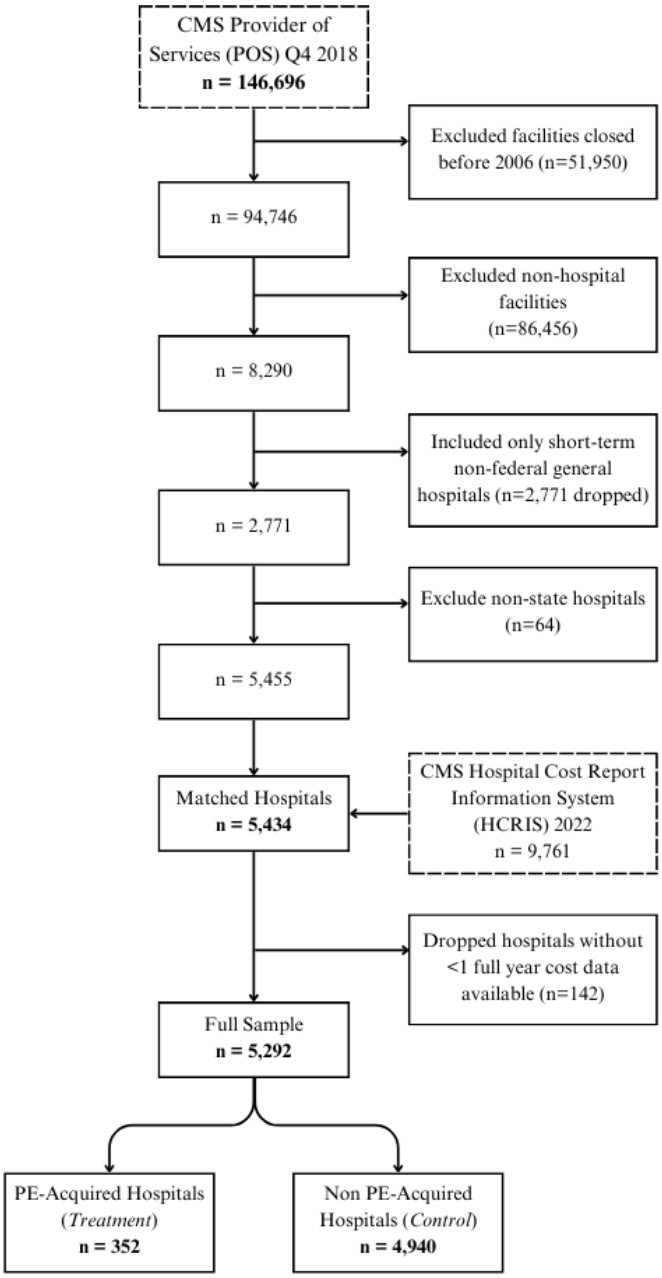

Figure 2. Hospital-Year Observations from Final Dataset, by Ever-PE and Never-PE Hospitals