The Effects of Leveraged Buyouts on Health Outcomes

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Abstract

Private equity firms first began acquiring hospitals in the United States during the early 1990s, yet the effects of private equity ownership on patient outcomes and treatment costs are still not clear. Some argue that although private equity firms are adept at improving operating efficiencies and introducing managerial expertise, these cost-cutting measures may come at the expense of patient outcomes.

Because acute myocardial infarctions (AMIs) serve as proxies for patient outcomes and treatment costs, I collect information on 30-day mortality rates and Medicare reimbursements for treatments of AMIs at US Medicare-certified short-term acute care general hospitals from 2014 to 2019. This paper uses fixed effects models to analyze the impact of leveraged buyouts, relative to strategic acquisitions, on patient outcomes. After integrating both hospital and time fixed effects, I find that private equity ownership does not lead to significant changes in Medicare reimbursements or mortality rates for AMI treatments.

JEL Classification: G340, I110, I180, M0

Keywords: Private equity, leveraged buyouts, mergers and acquisitions, business economics, patient outcomes, heart attacks, acute myocardial infarctions, acute care hospitals

I. Introduction

Although private equity firms are active in nearly every sector of the healthcare industry, these investors' impacts on patients are still not well understood. Private equity firms first entered the healthcare market in the 1990s and 2000s, purchasing nursing homes, urgent care clinics, and hospitals. Ultimately, these firms began engaging in "bolt-on acquisitions," as they continued to purchase facilities and consolidate them (Appelbaum, 2019). Some claim that private equity investors, as "turnaround specialists," may improve the operations of consolidated companies (Shryock, 2020). Others claim that the interests of private equity firms and patients are irreconcilable (Perlberg, 2020). More recently, two of the largest private equity firms, KKR and Blackstone, have been under intense scrutiny for their portfolio companies' surprise billing practices (Appelbaum et al., 2020). To examine how private equity ownership affects patients, I isolate the effects of leveraged buyouts, relative to strategic acquisitions, on Medicare reimbursements and mortality rates for acute myocardial infarctions, otherwise known as heart attacks, at short-term acute care general hospitals.

Mergers and acquisitions (M&A) refer to the "consolidation of companies or assets through various types of financial transactions."[1] Acquisitions may also be classified as horizontal, when two comparable companies merge, or vertical, when a company purchases another in its supply chain. Furthermore, the post-acquisition entity may emerge as a new company, with certain divisions and assets from the merging parties. Many factors, such as sources of financing (equity, debt, and cash considerations), buyer competition, and consumer spending, are determinants of each acquisition. However, one of the most important considerations is the type of buyer.

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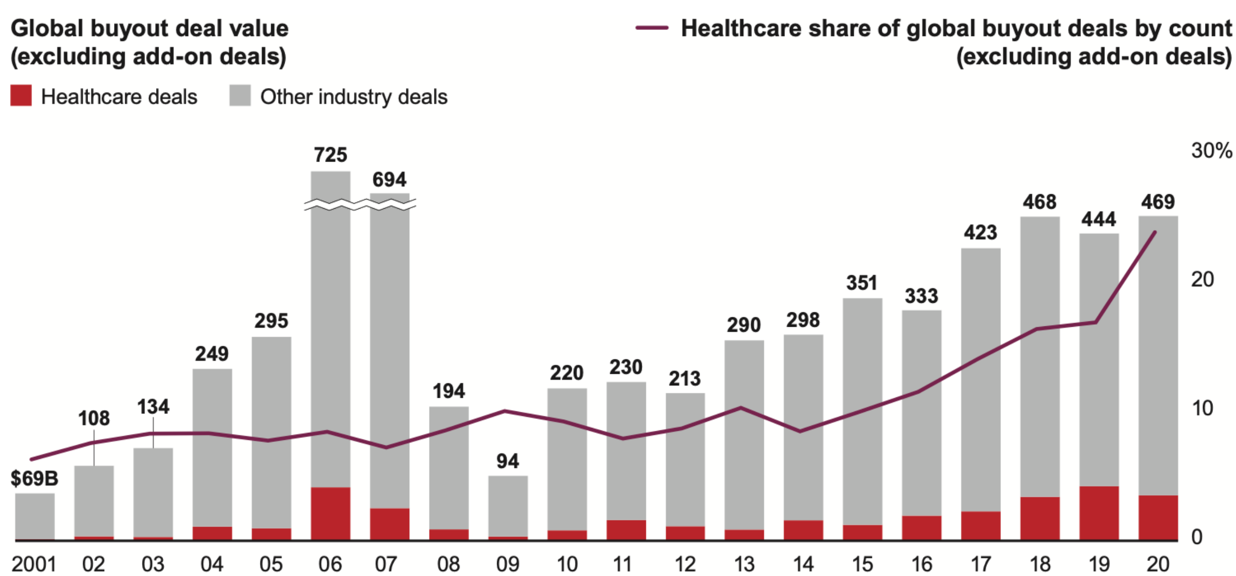
[1] Hayes, A. (2020, August 21). How Mergers and Acquisitions – M&A Work. Retrieved September 08, 2020, from https://www.investopedia.com/terms/m/mergersandacquisitions.asp

The acquirer can be classified as a strategic or financial buyer. Strategic buyers may engage in offensive or defensive acquisitions. Through offensive M&A, strategic buyers purchase a company to expand its products and services, access new geographies, or unlock synergies. Defensive acquisitions, on the other hand, are used to protect the incumbent by purchasing firms that pose a threat to future business. Although these are two distinct strategies, this paper will not distinguish between offensive and defensive M&A, as strategic buyers may be reluctant to discuss defensive M&A strategies. Examples of strategic acquisitions include Gilead's $21B purchase of Immunomedics in September 2020, executed to grow Gilead's oncology offerings (Gilead, 2020). Through these offensive acquisitions, strategic buyers often have a long-term vision for the target company and they typically pay a higher premium for the targets. However, synergies play a critical role in the success of strategic acquisitions and, if synergies are unrealized, companies may be penalized by investors and have difficulty raising additional capital.

Financial buyers, including private equity firms, acquire companies with the intent of selling them within a 5 to 7 year investment horizon. Private equity firms purchase companies through leveraged buyouts (LBOs), acquisitions in which high amounts of debt are used to fund the transaction and achieve the desired internal rate of return (IRR) on the investment. Examples of LBOs include KKR and Bain Capital's purchase of HCA Healthcare, a US for-profit operator of hospitals, for $33B ($21B in cash, $11.7B in debt) in 2006, which was the largest LBO ever at the time (Pitchbook, 2017). Typically, private equity firms set a desired IRR and determine the maximum purchase price to reach the return, based on various pro forma projections. As a result, private equity firms typically pay lower premia for targets, yet the private equity partners' managerial expertise may be sufficient to save struggling businesses.

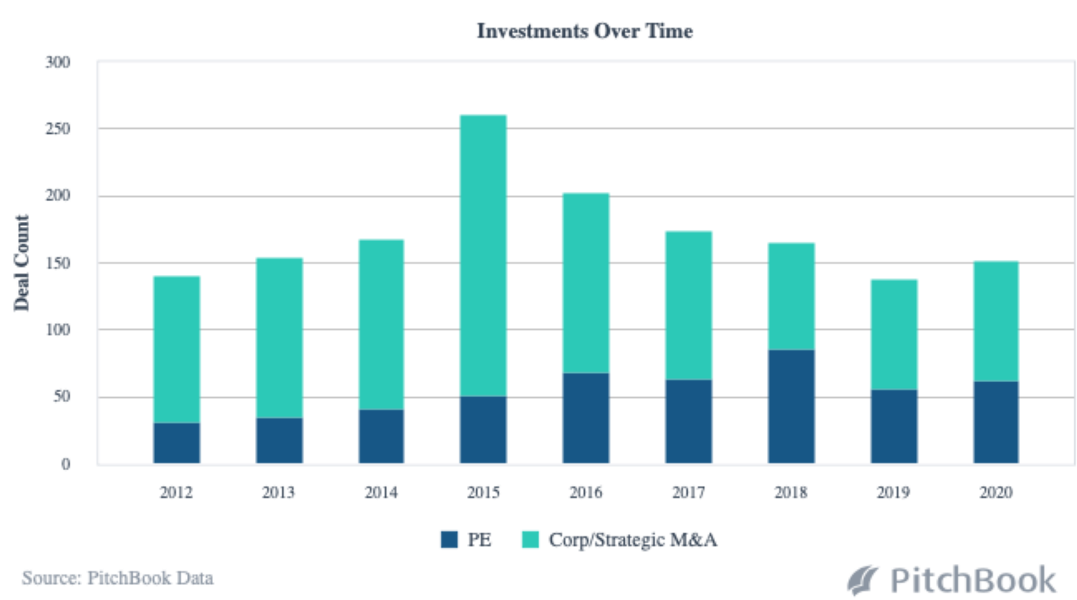
Although the focus on IRR may result in higher cash flows, Ayash (2019) finds that PE-owned businesses were 10 times more likely to declare bankruptcy than non-PE-owned units from 1980 to 2006. The higher rates of bankruptcy may be a function of the high loads of debt used for an LBO, as leverage ratios reached a peak of 6.97 in 2018 (Schwarzberg, 2019). However, because PE firms search for undervalued businesses to boost IRR, distressed companies are occasionally ideal candidates for an LBO. The selection bias for distressed companies may be embedded in the higher rates of bankruptcy observed in PE-owned businesses. To avoid bankruptcy, private equity firms often seek asset-intensive targets with stable cash flows, whose property can be liquidated in the event of bankruptcy and whose cash flows can meet interest payments. Because financial and strategic buyers have fundamentally different incentives, I will incorporate strategic M&A to better assess leveraged buyouts.

Figure 1: Global healthcare leveraged buyout deal value and share of deal count from 2001 to 2020 (Bain & Company, 2021).



Although private equity firms invest across industries, a significant portion of capital is allocated to the healthcare sector.[2] In 2019, private equity firms closed a record $78.9B worth of healthcare transactions, which accounted for 18% of all buyout volumes (Bain & Company, 2020). In 2020, due to fewer larger leveraged buyouts, healthcare deal value fell to $66B despite volumes increasing 21% to 380 deals from 2019. (See Figure 1.) Despite the COVID-19 pandemic and M&A value falling from $541B in 2019 to $339B in 2020, healthcare private equity activity proved to be resilient, largely supported by investments in the healthcare provider and pharmaceuticals sectors (Bain & Company, 2021). Trademarks of the healthcare industry, such as the aging US population and innovations in healthcare technology and payments, have catalyzed the growth of healthcare buyouts. Furthermore, the healthcare industry is largely fragmented, providing a steady pipeline of consolidation and merger opportunities (Bain & Company, 2020).

Figure 2: Number of hospital and inpatient services acquisitions executed by private equity firms and strategic acquirers from 2012 to 2020 (Pitchbook, 2021).



[2] Global healthcare leveraged buyouts totaled 380 in 2020, accounting for 12.3% of total leveraged buyouts. Healthcare private equity deal value fell to $66B in 2020 from the all-time record of $78.9B in 2019 (Bain & Company, 2021).

Private equity firms are now active across healthcare subsectors, including healthcare services, information technology, and pharmaceuticals. However, they first began investing in the healthcare sector via hospital acquisitions, and they are still actively doing so given these units' stable revenue streams (Appelbaum et al., 2020). Furthermore, transactions in this sector have posed interesting antitrust situations, such as Geisinger Health's attempt to buy Evangelical Community Hospital in August 2020, which the Department of Justice ultimately blocked (Justice, 2020). Because the market for hospitals provides an excellent microcosm for studying healthcare buyouts, I will focus on short-term acute care hospital (STACH) acquisitions.

The Centers for Medicare and Medicaid Services defines a short-term acute care hospital as "a hospital that provides inpatient medical care and other related services for surgery, acute medical conditions or injuries (usually for a short term illness or condition)" (CMS, 2021). In 2018, there were 5,198 community (nonfederal, short-term general, and other special) hospitals in the United States, of which 1,296 were investor-owned (AHA, 2020). From 2000 to 2020, private equity firms and strategic buyers executed 1,965 hospital and inpatient services acquisitions, of which 34% were completed by private equity firms (Pitchbook, 2021). (See Figure 2.) Not only do STACHs provide a large dataset, but they also allow researchers to better measure the quality of care since it is significantly more difficult to assess the quality of treatment for a chronic condition. While STACHs cover myriad short-term illnesses and injuries, one of the most common conditions for patients admitted to STACHs is acute myocardial infarctions (AMIs), commonly known as heart attacks, with over one million cases annually (Sweis et al., 2020). Furthermore, because hospitals may vary in terms of services offered, examining the overall mortality rate is subject to the types of services offered. For this reason, I will use AMI mortality rates and claims-based payments, respectively, as proxies for quality and cost of care in United States STACHs.

II. Literature Review

A. Private Equity and Leveraged Buyouts

As private equity assets under management (AUM) are forecasted to reach $5.8T by 2025, the pivotal role these firms play in providing liquidity and reshaping the ecology of various industries is difficult to ignore (Deloitte, 2020). To determine how private equity affects businesses, many researchers have analyzed the relationship between private equity ownership and outcomes of PE-backed businesses and their customers. In response to criticism surrounding private equity's ineffective approach to improving business operations, Davis (2014) analyzes 3,200 PE-backed firms from 1980 to 2005 and finds that although leveraged buyouts lead to job losses, target firms undergo significant post-LBO job creation and total factor productivity gains, reaffirming Joseph Schumpeter's concept of "creative destruction." Furthermore, the researchers find that this creative destruction ultimately boosts total factor productivity in the manufacturing sector via closures of less productive units (Davis et al., 2014). Private equity's focus on efficiency and operational improvements, one may argue, can improve utility for the overarching industry.

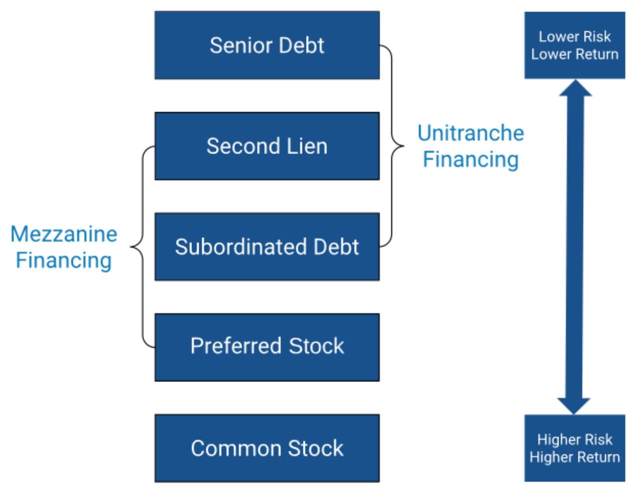
While private equity firms excel at financial engineering and, depending on the firm's strategy, are occasionally able to turnaround struggling businesses, the costs of doing so are not fully understood. Studying health inspection records at restaurant chains, Bernstein and Sheen (2016) find that after LBOs, PE-backed restaurants experience operational improvements likely accomplished through the financial buyers' managerial expertise. Through "twin restaurant" analyses, they also find that these improvements are more profound in units that are directly operated by private equity firms (Bernstein and Sheen, 2016).

To test how PE ownership affects management practices, Bloom (2015) conducts a double-blind management survey of PE-backed and non-PE-backed manufacturing plants across 34 countries. The researchers quantify the quality of management through interviews of managers, who are evaluated on 18 different criteria. They conclude that PE-owned firms have significantly better management practices than nearly all of the other control groups, which included founder-owned, family-run, and government-owned firms. The only firms that had similar management scores were family firms run by nonfamily CEOs and publicly listed firms (Bloom et al., 2015). Consequently, the injection of additional human capital during a leveraged buyout may lead to better management practices and business outcomes.

Despite these findings, the current literature still has not reached a consensus as to whether or not private equity firms ultimately benefit target firms. Tykvová and Borell (2011) find that from 2000 to 2008, while PE firms were more likely to purchase less financially distressed companies and post-LBO distress risk increased, the bankruptcy risk did not surpass that of non-PE-backed companies. Furthermore, they find that as PE investor experience increases, the risk of post-buyout bankruptcy falls, suggesting managerial expertise plays a critical role in mitigating financial risk (Tykvová and Borell, 2011).

Studies of 1980s buyouts, however, have yielded different results. Kaplan and Stein's research of 1980s buyouts shows that excessive deployment of private capital led to poorly executed, overpriced leveraged buyouts. The LBO boom of the 80s ultimately led to higher enterprise value to free cash flow ratios, and the desire to deploy dry powder led firms to undertake more risky investments in less stable industries. Along with increased issuances of subordinated debt, a form of mezzanine debt, the higher leverage ratios observed in 1980s LBOs support the "overheated buyout market hypothesis." The greater use of subordinated debt as sources of financing led to less financially sound investments, exacerbating the financial risk associated with leveraged buyouts (Kaplan and Stein, 1993). (See Figure 3.) Consequently, while private equity firms introduce exceptional management, the financial engineering required to meet the desired IRR may increase bankruptcy rates. Although private equity firms' injection of managerial expertise may improve business operations, leveraged buyouts may come at the cost of increased financial risk. While the majority of the private equity literature focuses on profitability and management of targets, this paper seeks to determine how private equity ownership affects the consumer, which, in the case of acute care hospitals, is the patient.

Figure 3: Capital structure and sources of financing: private equity firms often issue mezzanine debt to fund leveraged buyouts.[3]



B. Leveraged Buyouts of Hospitals and Healthcare Services Businesses

Due to private equity first entering the healthcare space in the 1990s, the research on hospital and healthcare services LBOs is rather nascent. Bruch (2021) conducts a cross-sectional analysis of PE-owned acute care hospitals in 2018 and, after comparing PE-owned hospitals with non-PE-owned hospitals of similar size and location, finds that PE-owned units on average were located

[3] Mezzanine debt, senior to equity but subordinate to pure debt, is a financial instrument that, like debt, pays a fixed coupon yet, unlike senior debt, it may be converted to equity through embedded call options (Hayes, 2020).

in more rural regions with lower household income. The reason for this phenomenon is unknown, yet it is conceivable that rural regions may provide more opportunities for consolidation of hospital facilities. Although the researchers also conclude that PE-owned units reported lower patient experience scores and had fewer employees per bed, it is unknown if private equity firms target hospitals with these characteristics or if PE ownerships leads to worse patient experiences and fewer employees per bed (Bruch et al., 2021). However, unlike this paper, this analysis fails to properly assess patient outcomes, and the cross-sectional approach does not consider pre, during, and post-buyout changes. Additionally, the researchers do not separate the non-PE-owned units into independent and strategic acquirer-owned hospitals.

Casalino (2019) also notes the lack of research addressing "the effect of private equity acquisitions on the quality and cost of patient care." The researchers discuss the implications of PE involvement in the acute care hospital ecosystem, highlighting the EBITDA multiple arbitrage opportunities for smaller practices (Casalino et al., 2019). For this reason, the number of hospital beds may be correlated with higher rates of PE ownership, potentially explaining Bruch's observation that PE-owned facilities tended to be located in rural areas. Additionally, although specialties with elective procedures (plastic surgery, dermatology, etc.) provide greater top-line growth opportunities, measuring the quality of care for these procedures is more difficult. For this reason, I focus on the treatment of AMIs at acute care hospitals.

Although the research on AMI treatments at hospitals is limited, in a sample of Florida nursing homes from 2000 to 2007, researchers found that LBOs resulted in increases in operating margins and operating revenue per patient day (Pradhan et al., 2013). However, PE-owned businesses have been reported to have an average default rate of 20%, ten times higher than the average for non-PE-owned units from 1980 to 2006 (Ayash et al., 2019). Pradhan (2013) suggests the higher probability of default among PE-owned units coerces management to improve operations, potentially explaining the higher margins observed in PE-owned nursing homes (Pradhan et al., 2013). While cost-cutting measures may boost margins, their effects on patients are unknown. These conclusions, however, were strictly limited to financial information, the long-term effects of buyouts were not considered, and strategic acquisitions were not used as a benchmark.

C. Strategic Acquirers and Private Equity Firms

Although this paper focuses on private equity firms, because various buyers participate in the M&A process, I will distinguish between strategic buyers and private equity firms. Although few papers have compared strategic and financial buyers, the isolated effects of mergers on costs or quality of care have been well documented, albeit leading to mixed results. Connor (1998) finds that horizontal mergers resulted in operating efficiencies of approximately 5% in a sample of 3,500 STACHs from 1986 to 1994. The researchers claim that the lower costs ultimately translated to lower prices for consumers. Interestingly, cost synergies were directly proportional to the relative size and degree of overlap in services of the involved parties (Connor et al., 1998). Although the researchers do not examine PE versus non-PE buyers and do not consider the quality of care, Connor's empirical approach serves as a foundation for my approach to isolating the effects of PE ownership on health outcomes, as Connor provides a variety of factors to consider when examining the effects of acquisitions.

Despite Connor's conclusions, not all researchers have found that mergers resulted in cost reductions for consumers. After the 1999 merger, the Sutter-Summit hospital's post-merger price increase was 28.4% to 44.2% larger than the price changes of comparable hospitals. Still, the researchers did not account for the quality of care or examine leveraged buyouts (Tenn, 2011). Furthermore, the researchers did not note how the hospital increased the cost of care.

Hayford (2012) finds that horizontal mergers between California STACHs from 1990 to 2006 were reported to be correlated with a 3.7% increase in the number of bypass surgeries and angioplasties and a 1.7% increase in heart attack mortality rates. It is conceivable that the greater use of angioplasties and bypass surgeries may be a pathway for revenue growth. While the 1.7% increase in heart attack mortality rates may suggest a lower quality of care, it is possible that this is the result of angioplasties and bypass surgeries. On the other hand, Bruch (2020) examines leveraged buyouts in US hospitals from 2005 to 2017 and finds that the quality score for AMIs, derived from the Centers for Medicare and Medicaid Services, increased by 3.3% post-buyout. Consequently, the research on the effects of acquisitions, both strategic and financial, on healthcare outcomes is also mixed.

Although the current literature has found relationships between mergers and cost and quality of care, researchers have not synthesized these indicators to holistically assess the effects of buyouts on healthcare outcomes. Ariste (2007) finds that while costs for AMI treatments increased from 1995 to 2000 in Canada, quality-adjusted costs, measured through the cost-of-living index, decreased. The service price index (SPI) was used to determine the cost of AMI treatments, and the cost-of-living index (COLI) was used to measure outcome-adjusted costs for AMI treatments. Thus, while the SPI increased, the COLI decreased for AMI treatments. However, the COLI is difficult to compute, and, while this paper considers both cost and quality of care, future researchers should explore a better metric for synthesizing these factors.

D. Acute Myocardial Infarctions

Acute myocardial infarctions are one of the most common complications with variable mortality rates, and, as such, they provide proxies for measuring the cost and quality of care for hospital patients (Becker Hospital Review, 2020). While previous literature has considered either cost or quality, there is little research on both the cost and quality of care. To examine both of these, I use data on 30-day mortality rates and Medicare reimbursements for AMI treatments. However, in addition to the hospital owner, there are various factors that may play a role in regulating the occurrence and severity of AMIs.

Obesity, specifically measured by the waist-to-hip ratio, an alternative to BMI, has been reported to have a significant causal effect on one’s likelihood of AMIs (Yusuf et al., 2005). Furthermore, smoking bans in northern Italy have resulted in fewer cases of AMIs, suggesting smoking also determines one’s likelihood of an acute myocardial infarction (Barone-Adesi et al., 2006). Because I am considering the average prices and mortality rates for AMIs at hospitals across the US, higher rates of AMIs would not directly affect these measures. However, higher rates of obesity and other factors affecting AMI likelihood may increase the severity, and hence cost, of AMI treatments.

Physical exercise has also been reported to have a significant effect on the risk of AMI. Although anaerobic physical activities, such as weightlifting, are correlated with higher risks of AMI, aerobic physical activities, such as running and biking, are correlated with lower risks of AMI (Frannson et al., 2004). However, for those who exercise infrequently, strenuous exercise has been reported to trigger heart attacks (Willich et al., 1993). Thus, physical exercise plays a significant role in one’s risk of cardiovascular disease and, as such, will be considered in this analysis.

Although environmental and physical factors play a more direct role in the causal chain leading to a heart attack, social factors have also been shown to determine one's risk of cardiovascular disease (CD). Degano (2017) finds that, although the causal chain is not yet known, there exists an inverse relationship between levels of education attainment and rates of CD. Van Lenthe (2002) also finds an inverse relationship between educational levels and AMI rates in a sample of 9,872 45 to 74 year-old adults. However, the researchers acknowledge that the relationship between education levels and risk of AMI may be facilitated by levels of income (Van Lenthe et al., 2002). It is conceivable that higher rates of education are associated with higher-paying jobs, which may in turn be associated with access to high-quality food and exercise opportunities. These jobs, however, also may be associated with higher stress levels and less non-leisure physical activity. Regardless of this mechanism, I will consider levels of education to address social characteristics that play a role in regulating one's risk of AMI.

III. Theoretical Framework

A. Free Cash Flow Theory

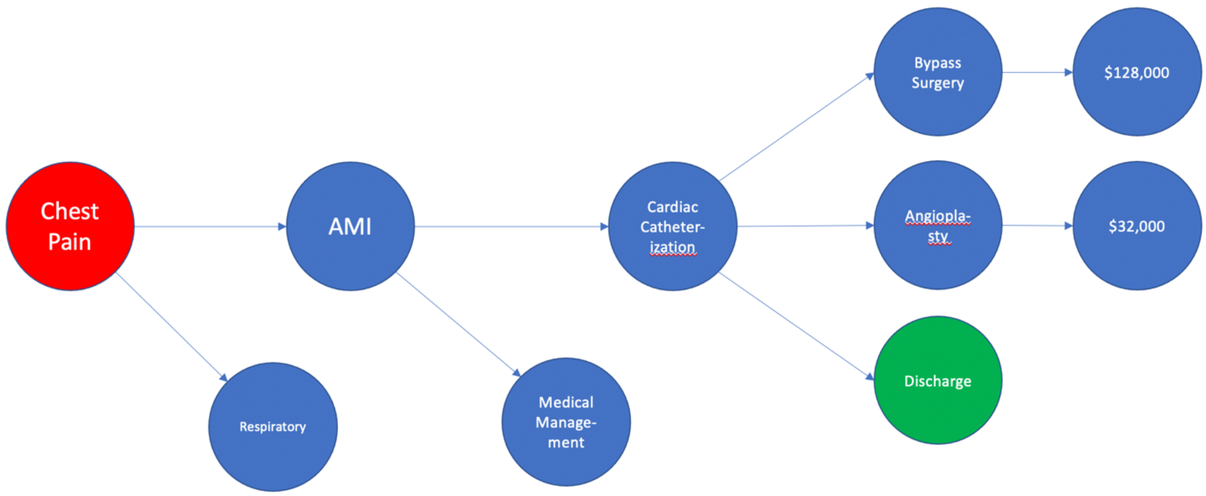
Although private equity firms have engaged in hospital acquisitions since the 1990s, there is little consensus as to whether or not private equity ownership is beneficial for patients. Additionally, most of the literature has not distinguished private equity buyers from strategic buyers. Hospital mergers have been associated with higher rates of profitable, intense procedures such as bypass surgeries (Hayford, 2012). Private equity buyouts have been correlated with strong improvements in operating margins in Florida nursing homes (Pradhan et al., 2013). For these reasons, further classifying acquisitions into LBOs and strategic acquisitions may better elucidate the effects of ownership type on health outcomes.

As stated previously, private equity firms and strategic buyers have fundamentally different incentives. Strategic buyers purchase a hospital to integrate its patients, resources, reputation, and other assets. Private equity firms, on the other hand, purchase hospitals, often consolidating them, before selling the units 5-10 years later (Appelbaum, 2019). Pradhan (2013) proposed that high amount of leverage on PE-owned units, in addition to management changes, often force the company to focus on free cash flow production. This may be accomplished via cost reductions, such as layoffs or divestitures, or revenue improvements, such as cross-selling services.

Although private equity firms excel at improving operating margins and profitability, whether or not managing hospitals is a zero-sum game is unknown. As discussed earlier, Bernstein and Sheen (2016) find that PE ownership results in operational improvements, and Bloom (2015) finds that PE-owned manufacturing plants had significantly better management practices. Thus, operational improvements observed at PE-owned businesses may not be the result of mere financial engineering.

While free cash flow theory may explain how private equity firms improve operations, it fails to explain how these investors manage quality of care. The high loads of leverage used during an LBO may force management to focus on improving profitability, which could, in theory, result in lower quality of care for patients. However, the injection of managerial expertise may offset any leverage-induced reductions in quality. As a result, I expect PE-owned hospitals to have greater top-line growth, yet the mechanism in which this may occur, such as higher uses of profitable procedures including angioplasties, is unknown. (See Figure 4.) Perhaps, these costly procedures improve patient outcomes, yet these improvements could be offset by cost reductions. These competing effects may result in mixed outcomes for quality of care.

Figure 4: AMI triage and potential mechanism for top-line growth at PE-owned hospitals.



To isolate the effects of private equity ownership on hospitals, I identify the year of the acquisition and run various fixed effects models, to be shown in the Results section. However, synergies, economies of scale, and management changes are unlikely to be realized immediately after the buyout. Although some hospitals were acquired twice, I only consider the most recent hospital acquisition, also noting the number of times a change in ownership occurred. As a result, the influences of private equity ownership may be more or less pronounced depending on the given hospital's acquisition history.

B. Estimating Healthcare Outcomes

AMIs are one of the most common complications with variable mortality rates, and, as such, they provide proxies for measuring hospital costs and quality of care (Becker Hospital Review, 2020). While previous literature has considered either cost or quality, there is little research on cost and quality of care, and even less examining both at private equity-owned hospitals. To estimate the cost and quality of care, I use data on 30-day Medicare reimbursements and mortality rates for AMI treatments. Furthermore, because factors such as physical exercise, education attainment, and obesity have been shown to play roles in one's risk of developing an AMI, I will consider various county-level control variables.

C. Hospital Markets, Competition, and the Medical Arms Race

Although standard economic theory would suggest that hospital competition leads to lower payments, this has not been shown empirically. After analyzing appendectomy, carotid endarterectomy, bariatric surgery, radical prostatectomy, and pyloromyotomy hospital charges for 162,823 patients across 1,492 hospitals, Chang (2011) finds that higher rates of competition, measured by the Herfindahl-Hirschman Index (HHI), were associated with higher gross hospital charges. Examining 5,732 hospitals in 1982, Robinson (1987) also finds that average costs per admission were 26% higher for hospitals in more competitive markets.

Researchers have referred to this phenomenon as the "medical arms race." In the mid-1990s, hospitals largely competed with one another by offering services to managed care plans. These "wholesale" strategies were a form of price competition. However, Devers (2003) finds that in 2001 hospitals largely competed through "retail strategies," a form of nonprice competition in which hospitals tailor their offerings for individual patients. Since the medical arms race has augmented the relationship between competition and costs at hospitals, I will incorporate the Herfindahl-Hirschman Index (HHI) to estimate hospital competition and control for competition-induced changes in cost and quality of care.

IV. Data

Table 5: Data used for the empirical analysis, along with reason of inclusion and expectations.

Source	Variables of Interest	Rationale	Expectation
Centers for Medicare and Medicaid Services (CMS): Complications and Deaths and Payments and Value of Care	Risk-standardized payments, 30-day mortality rates	Payments and mortality rates used to approximate cost and quality of care	Expect PE-owned units to have greater increases in payments relative to strategic acquirer-owned units
Pitchbook: M&A Database	Year of acquisition, type of acquirer	Year of change in ownership and type of buyer will be noted to isolate effects of PE ownership on patient outcomes	Expect greater number of strategic acquisitions relative to leveraged buyouts
University of Wisconsin Population Health Institute: County Health Rankings	Obesity, smoking, physical activity, high school graduation rates, college education, unemployment, poor health, food quality, alcohol, primary care physicians per capita	These variables are used to control for regional characteristics of the population that may indirectly lead to higher or lower rates of acute myocardial infarctions	Expect obesity, smoking, unemployment, poor health, alcohol use to be positively correlated with AMI costs and mortality rates; expect the opposite for physical activity, food quality, primary care physician rates
Centers for Medicare and Medicaid Services (CMS): Provider of Service (POS) Files	Ownership type, urban/rural, bed count, total staff per bed, cardiac catheterization rooms per bed	Variables from the POS files will be used to control for hospital characteristics that may lead to higher or lower costs/quality of treatment for AMIs	Expect PE-owned units to have fewer staff per bed and, on average, be located in rural regions, based on the findings of Bruch (2020)

A. Cost and Quality of Care for Acute Myocardial Infarctions

For information on payments and quality of care, I will utilize the Centers for Medicare and Medicaid Services (CMS) Complications and Deaths and Payment and Value of Care datasets. Bruch (2020) also uses CMS datasets for AMI data, albeit for quality scores instead of prices. Since 2012, the CMS has identified Medicare-certified providers and collected a wide array of information, including ambulatory surgical center quality, healthcare-associated infections, and hospital readmissions rates. For this paper, I will utilize the Complications and Deaths and Payment and Value of Care datasets to collect information on 30-day risk-standardized Medicare reimbursements and mortality rates at short-term acute care general hospitals. The risk-standardization process accounts for the underlying health status of individual beneficiaries.

The information from the CMS is publicly available from 2012 to 2020. However, because the CMS began collecting information on payments at both the treatment and hospital level in 2014 and the 2020 data is not fully available, I will use data from 2014 to 2019. The CMS surveyed 4,706 hospitals in 2014 and 3,510 in 2019. Furthermore, since the data is reported on a yearly basis, I merge the 2014 to 2019 reports based on the American Hospital Association (AHA) IDs to generate a longitudinal dataset.

For hospital-level datasets, the CMS identifies facilities using AHA IDs and provides information on average annual payments and mortality rates for a variety of complications. However, because jointly-owned, consolidated hospitals may have different AHA IDs, which could distort the classification of strategic-acquired, PE-owned, and standalone hospitals, the ID of the largest hospital, in terms of revenue, should be used to identify the jointly-owned facilities. Due to lack of access to joint ownership data, this paper treats these hospitals independently, and future researchers should consider accounting for joint ownership.

The CMS Payment and Value of Care dataset includes hospital-level average payments for patients who were admitted for pneumonia, hip or knee replacements, heart failures, or heart attacks. The CMS includes all payments for 30 days after the patient is admitted to the hospital. The 30 day window is utilized since it is consistent with the classification of readmission for the Hospital Readmissions Reduction Program of Section 3025 of the Affordable Care Act. (The CMS uses 90 days for knee and hip replacements.) Payments may include those made to the doctor's office, nursing facility, hospice care, copayments, and hospital, and these payments can be made from patients, Medicare, or other insurers. The CMS also risk-standardizes the payments by accounting for the severity of the complication and variations in medical care costs depending on location. However, these measures only include payments made by Medicare beneficiaries who are at least 65 years old, and, in some cases, these measures are omitted due to too few cases of the respective complication. Furthermore, the metric does not capture payments made outside of the 30 day window.

For each provider, the CMS Complications and Deaths dataset includes rates of complications for hip and knee replacements, colon surgery, abdominal hysterectomy, along with infections such as methicillin-resistant *Staphylococcus aureus* (MRSA) and *Clostridium difficile*. Notably, the dataset includes the average mortality rates for heart attacks, heart failures, chronic obstructive pulmonary disease (COPD), pneumonia, stroke, and coronary artery bypass graft (CABG) surgery. Data on AMI treatments are collected largely because AMI treatments account for a significant portion of the national hospital bill. The death rates reflect the percentage of Medicare patients who die within 30 days of admission to the hospital. However, for some hospitals, the number of cases of heart attacks (AMIs), for example, is too small to have a reliable estimate for mortality rates. In these cases, the mortality rates may be omitted. Consequently, the number of annual admissions and the number of beds may inform the researcher of the accuracy and availability of these estimates.

B. Identifying Buyers for Mergers and Acquisitions

To identify hospital acquisitions during the period, I utilize Pitchbook's M&A database.[4] Researchers at Duke's Fuqua School of Business have identified acquisitions executed by strategic

[4] Bruch (2020) uses M&A reports from Irving Levin Associates, yet these reports are not publicly available.

buyers and private equity firms from 2000 to 2014 and 2000 to 2017, respectively. Target hospitals are identified using AHA IDs and the year the acquisition is completed is noted.

To update these datasets, I screened for strategic acquisitions and leveraged buyouts for the respective time periods. To update the leveraged buyouts dataset, I screened for acquisitions of hospitals and inpatient services in the United States executed by private equity firms from January 1, 2017 to December 31, 2020. For the strategic acquisitions dataset, I screened for acquisitions of hospitals and inpatient services in the United States executed by strategic buyers from January 1, 2014 to December 31, 2020.[5] Because I focus on the 2014 to 2019 period, however, acquisitions during 2020 were not captured in this analysis.

Then, targets on Pitchbook's database were cross-referenced with hospitals on the CMS dataset. For some acquisitions, a chain of hospitals was acquired and, therefore, the chain owner's name was listed on Pitchbook. For these cases, all hospitals owned by the parent company were added to the acquisition datasets. However, this may not accurately reflect the terms of the acquisition. Furthermore, for some acquisitions, I was unable to match the target with hospitals on the CMS dataset, so these acquisitions were excluded. Finally, the terms of every acquisition may vary significantly, and future researchers should consider adding detailed information regarding the acquisition, such as purchase price, operating margins, and the percent ownership gained by the acquirer. Non-controlling interests and private investments in public equity (PIPEs) may also be worth noting. Finally, although other types of buyers, such as venture capital firms, are outside the scope of this paper, future researchers may consider including these other M&A participants.

[5] 248 leveraged buyouts were noted by Pitchbook for the January 1, 2017 to December 31, 2020 period. 749 strategic acquisitions were noted for the January 1, 2014 to December 31, 2020 period.

C. Classifying Local Markets

To approximate market competition for the hospitals, I use the Herfindahl-Hirschman Index (HHI). A high HHI indicates a high degree of concentration, while a low HHI indicates a high degree of competition. Melnick (1992) finds that Blue Cross paid higher prices to hospitals in counties with high HHI values, suggesting that local market competition plays a significant role in determining prices. However, Melnick calculates the HHI at the county-level, which may not be the best method for classifying markets due to high flows of patients across certain county boundaries.

To correct this, Connor (1998) uses hospital service areas (HSAs) to define market geographies and, ultimately, assess hospital competition. Because some adjacent counties experience high traffic of patients across county borders, these counties effectively operate as one market. Makuc (1991) first identified these HSAs using hierarchal cluster analyses to group counties based on the intercounty flow of hospital patients. A high degree of patient flow across two counties would suggest that the respective hospitals compete for the same patients, so Makuc's technique would bundle these counties into one HSA. However, HSAs need not include hospitals that perform major cardiovascular procedures. Hospital referral regions (HRRs) further cluster HSAs based on cardiovascular procedures and must have a minimum population size of 120,000. Because the focus of this paper is on acute myocardial infarctions, unlike Connor (1998), I will use HRRs to define hospital markets.

In order to map hospitals to HRRs, I will use the Dartmouth Atlas Project's dataset, which maps zip codes to HRR IDs. These regions are used to determine market competition. However, because HRRs may encompass multiple counties, I only use HRRs for finding the market competition. Counties will be used for other region-specific characteristics. In total, there are 306 hospital referral regions across the US.

To compute the HHI for each HRR, I use the number of beds, which serves as a proxy for market share. For each HRR, I identify all hospitals located in the region, along with their bed counts. Then, I sum the squares of the bed counts and divide by the square of the sum of the bed counts. If, for example, a HRR had two hospitals, one with 20 beds and one with 30 beds, the HHI would be $(20^2 + 30^2) / (20+30)^2$. A higher HHI indicates less competition, and a lower HHI indicates greater competition.

D. Hospital Characteristics

Although the hospitals I consider are all short-term acute care hospitals, they vary considerably in terms of size, location, financials, and employment. For this reason, I use the Centers for Medicare and Medicaid Services' Provider of Services (POS) files. The POS files include characteristics for all Medicare-certified facilities and providers, noting the type(s) of services provided. Every quarter, CMS Regional Offices collect information on Medicare-certified providers, including hospitals, skilled nursing facilities, and ambulatory surgical centers, and report the information to the CMS for publishing. For this paper, I use the December 2020 POS files for hospitals, filtering out any non-STACH facilities, and assume that characteristics such as the number of beds, staff count, and cardiac catheterization rooms are time-invariant. However, future researchers may consider using the POS files for all years, noting any time invariances. Although I use the most recent dataset, the COVID-19 pandemic may have resulted in abnormally high demand for nurses and physicians and perturbed other control variables. The pandemic also may have discouraged non-COVID patients from visiting hospitals.

Like the CMS Complications and Deaths and Payment and Value of Care datasets, the POS files identify facilities using AHA IDs. However, because the POS files include all Medicare-certified facilities, the December 2020 POS file includes information on 65,534 facilities. Depending on the type of facility, different information is provided. For hospitals, notable variables include the number of beds, nurses, physicians, and cardiac catheterization rooms, among others. Because hospitals may expand their bed counts and staff, future researchers should consider these variables for all years of interest. The POS dataset was merged with the CMS Complications and Deaths and Payment and Value of Care datasets and, consequently, all non-hospital facilities were dropped.

E. Local Population Health and Other Characteristics

Because behaviors such as alcohol consumption, smoking, and physical inactivity play significant roles in determining the likelihood one develops heart disease, I will use 2020 county-level data from the University of Wisconsin Population Health Institute's County Health Rankings dataset. Although previous researchers have used the Bureau of Health Profession's Area Resource File (ARF), which is government regulated, for demographic data, the ARF is not publicly available. Consequently, I use the County Health Rankings files, which are publicly available and include a vast array of information for all counties in the United States.

The County Health Ranking datasets are published for all 50 states on an annual basis, and the datasets were first published in 2010. For this paper, the most recent datasets (2020) were merged to encompass all US counties. Because the files identify counties using Federal Information Processing System (FIPS) codes, I use a FIPS to zip code crosswalk to merge the county data with the zip codes, which are linked with each hospital AHA ID. The files include valuable information on local demographics, including obesity, smoking, physical activity, and high school graduation rates. However, like the POS file data, these characteristics are assumed to be time-invariant for this study and future researchers may consider including the County Health Rankings files for all years of interest.

F. Summary Statistics

Figure 6: 30-day Medicare reimbursements for acute myocardial infarctions by history of ownership: independent, only acquired by a private equity firm, only acquired by a strategic buyer, and acquired by both private equity firms and strategic buyers.

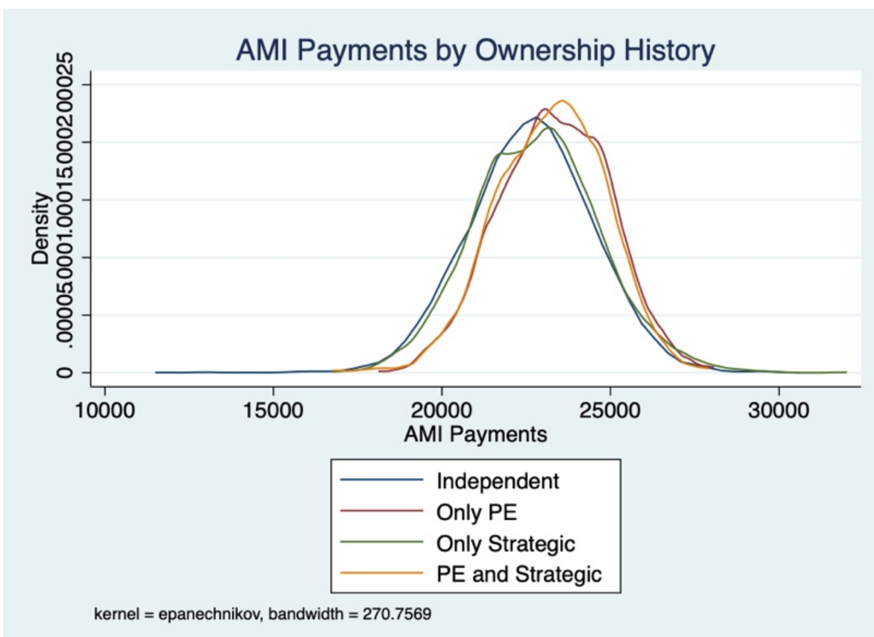
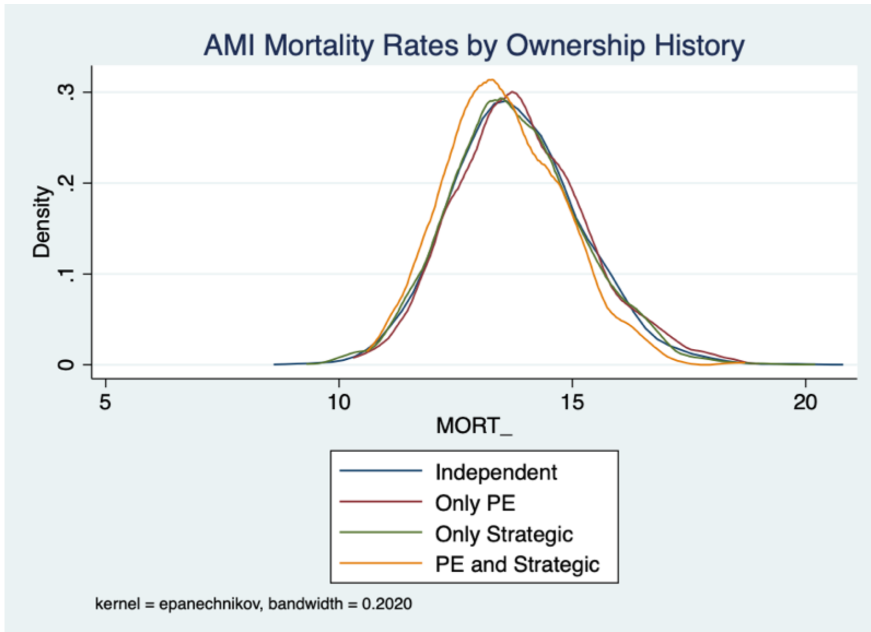


Figure 7: 30-day mortality rates for acute myocardial infarctions by history of ownership: independent, only acquired by a private equity firm, only acquired by a strategic buyer, and acquired by both private equity firms and strategic buyers.



Using the datasets on private equity and strategic acquisitions, I identified hospitals from 2014 to 2020 that were previously acquired by a private equity firm, acquired by strategic buyer, or are independent (neither). Using this ownership history, Figures 6 and 7 were generated. Since I am considering two types of buyers, in a given year, there are four classes of hospitals: those that were never purchased by a strategic or a private equity buyer, those that were only purchased by a private equity firm, those that were only purchased by a strategic buyer, and those that were purchased by both private equity and strategic buyers.

However, throughout the results section and the rest of this paper, I will use the most recent buyer type for hospitals that were once purchased by private equity firms and strategic acquirers. That is, if a company was purchased by a private equity firm in 2014 and a strategic acquirer in 2017, it will be classified as one purchased by a private equity firm in 2014 to 2016 and one purchased by a strategic acquirer for 2017 and all years afterwards. While a given hospital may be in each group for different years, this method was used to avoid hospitals being treated as both private equity and strategic acquirer-owned facilities.

Table 8: T-test for AMI payments for hospitals purchased by strategic acquirers (SA, group 1) and private equity firms (PE, group 2).

	obs1	obs2	Mean1 (SA)	Mean2 (PE)	dif	St Err	t-stat	p value
30-Day Medicare Reimbursements	3084	852	22891.5	23233.7	-342.234	70.126	-4.9	0.000

To explore how the AMI payments and mortality rates differ at private equity-owned and strategic acquirer-owned hospitals, I run t-tests for both payments and mortality rates. As shown in Table 8, private equity-owned facilities had average AMI payments of $23,233.68 and strategic acquirer-owned facilities had average AMI payments of $22,891.45. The difference is significant at the 0.1% level, suggesting that private equity-owned hospitals do indeed have significantly higher payments than strategic acquirer-owned hospitals. Table 9 shows the t-test results for 30-day AMI mortality rates. Private equity-owned units had mean mortality rates of 13.82%, and strategic acquirer-owned units had mean mortality rates of 13.75%. Although private equity-owned units had slightly higher mortality rates, this difference is not significant at the 5% level. Thus, private equity-owned facilities, relative to strategic acquirer-owned facilities, have significantly higher payments but not significantly higher mortality rates.

Table 9: T-test for AMI mortality rates for hospitals purchased by strategic acquirers (SA, group 1) and private equity firms (PE, group 2).

	obs1	obs2	Mean1 (SA)	Mean2 (PE)	dif	St Err	t-stat	p value
30-Day Mortality Rates	3749	1001	13.745	13.819	-0.075	0.050	-1.500	0.133

To understand how the control variables are related, correlation matrices for county-level and hospital control variables are generated. As seen in Table 10, all regional control variables, except for the HHI, are significantly correlated with one another at the 0.1% significance level. Smoking is positively correlated with physical inactivity, and unemployment rates are negatively correlated with access to exercise opportunities, quality of food, excessive drinking, and the rate of primary care physicians. While the factors driving these results are unknown, it is conceivable that higher rates of unemployment may lead to greater rates of behaviors that impact the likelihood of AMIs, such as smoking, while simultaneously negatively impacting access to high-quality food and exercise opportunities.

Table 10: Pairwise correlation matrix for regional control variables.

Variables	Poor-Health	Smo-king	Obes-ity	Food-Qual	Phys-Inactive	Exer-Access	Alcohol	PCPhys	HSG-Rate	Unem-ployed	HHI
PoorHealth	1.00										
Smoking	0.66*	1.00									
Obesity	0.46*	0.61*	1.00								
FoodQual	-0.63*	-0.55*	-0.43*	1.00							
PhysInactive	0.63*	0.65*	0.65*	-0.44*	1.00						
ExerAccess	-0.41*	-0.43*	-0.53*	0.33*	-0.56*	1.00					
Alcohol	-0.55*	-0.36*	-0.39*	0.38*	-0.55*	0.45*	1.00				
PCPhys	-0.40*	-0.32*	-0.46*	0.23*	-0.49*	0.49*	0.32*	1.00			
HSGRate	-0.17*	-0.10*	0.06*	0.24*	0.04*	-0.20*	0.02**	-0.10*	1.00		
Unemployed	0.56*	0.50*	0.41*	-0.46*	0.43*	-0.25*	-0.32*	-0.26*	-0.17*	1.00	
HHI	0.04*	0.09*	0.15*	-0.03*	0.07*	-0.13*	-0.03*	-0.04*	0.02***	0.07*	1.00

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

The HHI is significantly positively correlated with smoking, obesity, physical inactivity, excessive alcohol consumption, and unemployment rates and negatively correlated with access to exercise opportunities and primary care physicians per capita. For this reason, the socioeconomic dynamics and behaviors of counties must be considered when assessing heart attack treatment prices and mortality rates. Likewise, in Table 11, the real-valued hospital controls are used to generate a correlation matrix. The number of cardiac catheterization rooms per bed is significantly positively correlated with the total staff per bed and significantly negatively correlated with the number of times a change in ownership has occurred.

Table 11: Pairwise correlation matrix for real-valued hospital control variables.

Variables	CardiacRoomsPerBed	TotalStaffPerBed	CHOWCount
CardiacRoomsPerBed	1.000		
TotalStaffPerBed	0.037*	1.000	
CHOWCount	-0.030*	-0.012	1.000

* $p<0.01$

V. Empirical Specification

For the models, I regress risk-standardized payments and mortality rates on independent variables for acquisition, hospital, and region characteristics. The work of Connor (1998) and Pradhan (2013) provides a framework for this regression, as I use Connor's approach to examining mergers and Pradhan's approach to analyzing buyouts.

$$(1)\quad Y_{it} = \beta_0 + \beta_{1,it}\, \textit{AcquisitionInfo}_{it} + \beta_{2,it}\, \textit{HospitalInfo}_{it} + \beta_{3,it}\, \textit{RegionInfo}_{it} + \alpha_i + \varepsilon_{it}$$

I use a panel data regression, specifically using both hospital and time fixed effects. The α_i term in equation (1) specifies the hospital fixed effect. Because Hausman tests for payments and mortality rates models yielded p-values that were significant at the 5% level, I focus on fixed effects models and exclude any discussion of random effects models. Additionally, I also include standard OLS models for payments and mortality rates to demonstrate the relationships between the outcome and control variables, despite the high degree of correlation among the controls.

Dependent Variables ($Y_{i,t}$)

To understand the relationship between ownership history and hospital characteristics, I consider two outcome variables. First, I consider risk-standardized Medicare reimbursements for AMI treatments, which I refer to as "payments." Then, I consider 30-day mortality rates for patients admitted for AMI treatments, which I use interchangeably with "outcomes" and "quality of care." The facility and year will be denoted by *i* and *t* respectively.

- $Payments_{i,t}$: the average 30-day risk-standardized payment for AMIs at facility *i* in year *t*.
- $Mortality_{i,t}$: the 30-day fatality rate for AMIs at facility *i* in year *t*.

Independent Variables

Acquisition-Related Variables ($AcquisitionInfo_{i,t}$)

- $PEBuy_{i,t}$: a dummy variable for whether or not facility *i* was purchased by a private equity firm during or before year *t*. If a facility was purchased in 2016, for example, the variable will be 0 for all years before 2016 and 1 for all years after (and including) 2016. The variable also accounts for any future strategic acquisitions. If, for example, the hospital was then purchased by a strategic acquirer in 2017, the variable will be 0 for years 2017 and after, allowing the strategic dummy variable to capture the new owner type.
- $StratBuy_{i,t}$: a dummy variable for whether or not facility *i* was purchased by a strategic buyer during or before year *t*. Like the dummy variable for private equity ownership, this variable also accounts for an LBO after a strategic acquisition.

Hospital Characteristics ($HospitalInfo_i$)

- $CHOWCount_i$: the number of times the hospital has undergone a change of ownership before December 2020.

- *OwnerType*$_i$: indicates the ownership type of the provider. The variable is 1 for church, 2 for private not-for-profit, 3 for other, 4 for private for-profit, 5 for federal, 6 for state, 7 for local, 8 for hospital district or authority, 9 for physician ownership, and 10 for tribal.
- *UrbRur*$_i$: indicates if the hospital is located in an urban or rural region, based on the Core Based Statistical Area (CBSA). The variable is 1 if the hospital is located in an urban environment and 0 if it is located in a rural environment.
- *BedCount*$_i$: total number of beds at the provider, including those at non-participating or non-licensed areas.
- *CathProvType*$_i$: indicates how cardiac catheterization is provided. The variable is 1 if the service is not offered, 1 if provided by staff, 2 if provided under arrangement, and 3 if provided by staff and under arrangement.
- *ThorProvType*$_i$: indicates how cardiac thoracic surgery is provided. The variable is 1 if the service is not offered, 1 if provided by staff, 2 if provided under arrangement, and 3 if provided by staff and under arrangement.
- *CoroProvType*$_i$: indicates how Coronary Care Unit services are provided. The variable is 1 if the service is not offered, 1 if provided by staff, 2 if provided under arrangement, and 3 if provided by staff and under arrangement.
- *CardiacRoomsPerBed*: number of cardiac catheterization rooms per hospital bed.
- *TotalStaffPerBed*: number of full-time vocational nurses, nurse practitioners, physicians, physician assistants, physician residents, and registered nurses per hospital bed.

Regional Characteristics (*RegionInfo*$_i$)

- *HHI*$_i$: the Herfindahl-Hirschman Index (HHI) for each hospital referral region (HRR).
- *Region*$_i$: a dummy variable specifying the hospital region.[6] The variable is 1 for East North Central, 2 for East South Central, 3 for West South Central, 4 for West Mountain, and 5 for West Pacific. (New England is the base case with a value of 0.)
- *PoorHealth*$_i$: percentage of adults reporting fair or poor health in 2020.
- *Smoking*$_i$: percentage of adults reporting currently smoking in 2020.
- *Obesity*$_i$: percentage of adults reporting a BMI of at least 30 in 2020.

[6] Regions are specified based on the work of Connor (1998). The regions are New England (ME, VT, MA, NH, CN, or RI), East North Central (OH, MI, IN, IL, WI), East South Central (KY, TN, MS, AL), West South Central (AK, LO, TX, OK), West Mountain (MT, WY, CO, NM, AZ, UT), and West Pacific (WA, OR, CA, AL, HW).

- *FoodQual$_i$*: indicator of access to healthy foods (0 being the worst, 10 the best) in 2020.
- *PhysInactive$_i$*: percentage of adults reporting no leisure-time physical activity in 2020.
- *ExerAccess$_i$*: percentage of individuals having access to locations for physical exercise in 2020.
- *Alcohol$_i$*: percentage of adults reporting excessive consumption of alcohol in 2020.
- *PCPhys$_i$*: number of primary care physicians per 100,000 individuals in 2020.
- *HSGRate$_i$*: high school graduation rate of the county in 2020.
- *Unemployed$_i$*: the percentage of unemployed population aged 16 and over looking for work in 2020.

VI. Results

To assess the effects of leveraged buyouts, relative to strategic acquisitions, on payments and mortality rates for acute myocardial infarctions, I use ordinary least squares (OLS) and fixed effects (FE) models. For each outcome variable, four regressions are used: ordinary least squares, hospital fixed effects, hospital and year fixed effects, and hospital fixed effects with time trends. Because the Hausman test yields a p-value of 0.000 for both outcome variables, the null hypothesis that the random effects model is appropriate is rejected. For this reason, I exclude any discussion of the random effects model. I will first discuss the reimbursements results, followed by the mortality rates results, before ultimately discussing the overall impacts of leveraged buyouts.

A. 30-Day Medicare Reimbursements for Acute Myocardial Infarctions

Before examining the fixed effects models, I use ordinary least squares (OLS) to demonstrate potential relationships among the control variables and payments. Although the Breusch-Pagan test yields a p-value of 0.0653 and hence the model is homoscedastic, I nevertheless use robust estimators. The coefficient for Strategic Acquirer Ownership (SAO) is 68.55, yet it is not significant at the 5% level. (See Appendix A.) The coefficient for Private Equity Ownership (PEO), on the other hand, is 257.88 and is significant at the 0.1% level. Thus, the results seem to support the notion that leveraged buyouts are associated with higher payments. However, as shown in Tables 10 and 11, the control variables are highly correlated, and this model does not account for these interaction effects. For this reason, although the coefficient on the HHI is negative and significant, supporting the findings of Robinson (1987), Devers (2003), and Chang (2011), I exclude discussion of the impacts of these control variables on payments.

To mitigate the effects of omitted variable bias, I use a hospital fixed effects model. Before estimating the coefficients, I conduct a modified Wald test to check for heteroscedasticity. The null hypothesis is that σ_i^2 is equal to σ^2 for all i, the index for cross-sectional units. Because the chi-squared value is 1.2E+30, the null hypothesis is rejected and hence the fixed effects model for Medicare reimbursements exhibits heteroscedasticity. For this reason, I ensure the fixed effects model is robust and, for consistency, use robust estimators for all subsequent fixed effects models.

Average payments for AMI treatments at each facility and across years 2014 to 2018 were used as the outcome variable for the reimbursements hospital fixed effects regression. (See Table 12.) As such, the panel dataset was strongly balanced. All county-level and hospital factors listed in the Data section were used as control variables. However, because I assume that factors such as obesity rates and the number of hospital beds are not significantly variable across a 5 year period, only the most recent values for all of the controls were used. Hence, these time-invariant factors were eliminated in the fixed effects model.

Table 12: Heteroscedasticity-consistent hospital fixed effects model for AMI reimbursements from 2014 to 2018.

30-Day Medicare Reimbursements	Coef.	St.Err.	t-stat	p-value	[95% Conf	Interval]	Sig
Private Equity Ownership	1244.311	267.616	4.65	0.000	719.48	1769.142	***
Strategic Acquirer Ownership	1293.238	111.45	11.60	0.000	1074.67	1511.805	***
Constant	22289.386	40.339	552.55	0.000	22210.275	22368.496	***
Mean dependent var		22757.505	SD dependent var			1818.780	

R-squared	0.020	Number of obs	9392.000
F-test	72.752	Prob > F	0.000
Akaike crit. (AIC)	158018.149	Bayesian crit. (BIC)	158032.445

*** *p<.01,* ** *p<.05,* * *p<.1*

Due to the assumption of time-invariance of controls, the fixed effects model generated two treatment effects: one for Private Equity Ownership (PEO) and one for Strategic Acquirer Ownership (SAO).[7] PEO is 0 for all years before an LBO and 1 for the year of and all years after the LBO, up to any subsequent strategic acquisition. The approach holds mutatis mutandis for SAO. The coefficients for PEO and SAO are respectively 1,244.31 and 1,293.24, and the p-values for both are significant at the 0.1% level. The R^2 value is 0.02, which is low yet not unusual for this type of model, and the adjusted R^2 value is also 0.02.

Both coefficients are positive, which, without further analysis, would suggest that both strategic acquisitions and leveraged buyouts are associated with higher payments for AMI treatments. (Strategic acquisitions are associated with larger increases in reimbursements.) T-tests comparing Medicare reimbursements at private equity-owned hospitals show that, on average, payments at private-equity owned facilities are $531.26 greater relative to independent facilities and $342.23 greater relative to strategic acquirer-owned facilities. (See Appendix B and Table 8.) The results of the fixed effects model in Table 12, in conjunction with these t-tests, seem to suggest that while private equity-owned facilities, on average, have higher payments, strategic acquisitions are associated with greater increases in payments.

Although the fixed effects model improves upon the OLS model by reducing omitted variable bias, the hospital fixed effects model does not account for time. For this reason, I cannot use the OLS and hospital fixed effects results to conclude that leveraged buyouts lead to higher

[7] Private Equity Ownership (PEO) and Strategic Acquirer Ownership (SA) are equivalent to *PEBuy* and *StratBuy* in Section V.

payments. While including time may lead to overdamping of the PEO and SAO coefficients, it is a critical factor to account for, as there may be systematic changes in payments, and more noise is controlled for.

After introducing year fixed effects, private equity and strategic acquirer ownership no longer have significant effects on payments for AMI treatments. (See Table 13.) Every year fixed effect is both positive and significant at the 0.1% level. The Year 2017 coefficient, for example, shows that, relative to 2014, Medicare reimbursements are $1,600.11 higher in 2017. Notably, as the year increases, the magnitude of the year fixed effect coefficient increases monotonically, suggesting that Medicare reimbursements for acute myocardial infarctions increased systematically from 2014 to 2018. The R^2 value of 0.51 is also significantly higher than that of the hospital fixed effects model in Table 12, suggesting that time explains a considerable amount of variation in AMI payments during the sample period.[8] While drivers of this systematic increase in reimbursements are beyond the scope of this paper, it seems that the true effects of private equity and strategic acquirer ownership on payments were masked by time in Table 12. Therefore, I cannot conclude that private equity ownership leads to significant changes in reimbursements.

Table 13: Heteroscedasticity-consistent hospital and time fixed effects for AMI reimbursements from 2014 to 2018.

30-Day Medicare Reimbursements	Coef.	St.Err.	t-stat	p-value	[95% Conf	Interval]	Sig
Private Equity Ownership	-115.295	198.045	-0.58	0.561	-503.687	273.097	
Strategic Acquirer Ownership	-112.822	111.193	-1.01	0.310	-330.885	105.242	
Year 2015	473.942	20.924	22.65	0.000	432.907	514.978	***
Year 2016	1328.429	30.111	44.12	0.000	1269.378	1387.479	***
Year 2017	1600.105	36.728	43.57	0.000	1528.076	1672.134	***
Year 2018	2242.052	38.12	58.82	0.000	2167.293	2316.81	***
Constant	21685.39	41.201	526.33	0.000	21604.59	21766.19	***

Mean dependent var	22757.505	SD dependent var	1818.780
R-squared	0.508	Number of obs	9392.000
F-test	702.743	Prob > F	0.000

[8] The adjusted R^2 value is 0.5072.

Akaike crit. (AIC)	151564.524	Bayesian crit. (BIC)	151607.410

**** p<.01, ** p<.05, * p<.1*

To further examine the interplay between time and payments, I also include a hospital fixed effects with year time trends. When the year fixed effects are replaced with time trends, the coefficients for PEO and SAO are still insignificant, with p-values of 0.54 and 0.33. (See Table 14.) Like the hospital and year fixed effects model in Table 13, time also has a significant effect on AMI payments. While the coefficient for the second order term is negative, the net effect of the year on payments is positive. (Higher order terms were excluded due to multicollinearity.) The R^2 and adjusted R^2 values are both 0.499, further confirming time explains a significant amount of the variation in payments. Overall, this model also supports a systematic increase in Medicare reimbursements during the sample period.

Table 14: Heteroscedasticity-consistent hospital fixed effects model with year time trends for AMI reimbursements from 2014 to 2018.

30-Day Medicare Reimbursements	Coef.	St.Err.	t-stat	p-value	[95% Conf	Interval]	Sig
Private Equity Ownership	-121.533	198.829	-0.610	0.541	-511.462	268.397	
Strategic Acquirer Ownership	-108.471	111.604	-0.970	0.331	-327.341	110.4	
Year	69868.331	21318.936	3.28	0.001	28059.093	111677.57	***
$Year^2$	-17.189	5.287	-3.25	0.001	-27.559	-6.82	***
Constant	-70970063	21489682	-3.30	0.001	-1.131e+08	-28825969	***

Mean dependent var	22757.505	SD dependent var	1818.780
R-squared	0.499	Number of obs	9392.000
F-test	791.225	Prob > F	0.000
Akaike crit. (AIC)	151722.016	Bayesian crit. (BIC)	151750.606

**** p<.01, ** p<.05, * p<.1*

Overall, I conclude that private equity ownership does not lead to significant changes in 30-day Medicare reimbursements for acute myocardial infarctions. Although Bruch (2020) found that private equity-owned hospitals demonstrated increases in total charges per inpatient day, this paper only considers reimbursements for AMI treatments. The findings of this paper also differentiate from those of Connor (1998), who found that horizontal mergers resulted in operating efficiencies, which were passed onto consumers via lower net patient revenues per admission. However, this study considered the 1986 to 1998 period and also did not consider AMI-specific charges.

Additionally, while private equity-owned facilities may be expected to charge more for their services, this paper only considers Medicare reimbursements. The Centers for Medicare and Medicaid Services determines the reimbursement amounts, and, because the program is government-funded, private equity firms may have less negotiating power in regards to Medicare payments. As a result, future researchers may consider examining payments to private insurers, as in the case of Melnick (1992), which private equity firms may be better equipped to negotiate with.

B. 30-Day Mortality Rates for Acute Myocardial Infarctions

Before estimating the ordinary least squares model, I conduct a Breusch-Pagan test to check for heteroscedasticity. Because the chi-squared value of 33.23 is significant at the 0.1% level, the null hypothesis that the estimators are homoscedastic is rejected. I therefore use robust estimators. The coefficients for Private Equity Ownership (PEO) and Strategic Acquirer Ownership (SAO) are -0.136 and -0.125, with p-values significant at the 5% level. (See Appendix C.) Without further analysis, it seems that private equity ownership is indeed associated with significant reductions in mortality rates. Nevertheless, the OLS model fails to account for interaction effects among the highly correlated control variables, so this is the extent to which I will discuss this model.

To reduce omitted variable bias and directly examine the effects of private equity and strategic acquirer ownership, I estimate a hospital fixed effects model. Because the modified Wald test yields a chi-squared value of 7.2E+32, the null hypothesis that the estimators are homoscedastic is rejected. Therefore, when running the hospital fixed effects for mortality rates, I use heteroscedastic-consistent estimators. For consistency, I use robust estimators for all fixed effects models.

Table 15: Heteroscedasticity-consistent hospital fixed effects model for mortality rates from 2014 to 2019.

30-Day Mortality Rates	Coef.	St.Err.	t-stat	p-value	[95% Conf	Interval]	Sig
Private Equity Ownership	-1.056	0.239	-4.42	0.000	-1.524	-0.588	***
Strategic Acquirer Ownership	-1.138	0.085	-13.32	0.000	-1.305	-0.97	***
Constant	14.208	0.033	430.64	0.000	14.143	14.273	***

Mean dependent var	13.790	SD dependent var	1.405
R-squared	0.022	Number of obs	11345.000
F-test	93.462	Prob > F	0.000
Akaike crit. (AIC)	31642.709	Bayesian crit. (BIC)	31657.382

**** p<.01, ** p<.05, * p<.1*

Average 30-day mortality rates for AMI treatments at each facility and across years 2014 to 2019 were used as the outcome variable for the mortality rates hospital fixed effects regression. As shown in Table 15, the hospital fixed effects regression yielded two treatment effects: Private Equity Ownership (PEO) and Strategic Acquirer Ownership (SAO). As discussed previously, time-invariant control variables were eliminated. The coefficients for PEO and SAO are -1.06 and -1.14 and are significant at the 0.1% level. The R^2 and adjusted R^2 values are 0.022, in line with the results of Table 12.

Without further analysis, one would conclude that leveraged buyouts are associated with a 1.06% decrease in mortality rates and strategic acquisitions are associated with a 1.14% decrease in mortality rates. T-tests comparing mean mortality rates show that mortality rates at private equity-owned facilities are 0.075% higher relative to those at strategic acquirer-owned facilities and 0.022% lower relative to those at independent facilities. However, both of these are insignificant at the 5% level. (See Table 9 and Appendix D.) The results of the fixed effects model in Table 15 would suggest that private equity ownership is associated with a -1.06% reduction in mortality rates, which is not as large as the -1.14% decrease associated with strategic acquirer ownership.

Similarly to the OLS model, the hospital fixed effects model also suffers from a critical flaw. Although the hospital fixed effects model improves upon the OLS model by mitigating omitted variable bias, the model fails to account for any time-dependent changes in mortality rates. Therefore, I cannot use the hospital fixed effects model to conclude that leveraged buyouts lead to reductions in AMI mortality rates.

Table 16: Heteroscedasticity-consistent hospital and year fixed effects for mortality rates from 2014 to 2019.

30-Day Mortality Rates	Coef.	St.Err.	t-stat	p-value	[95% Conf	Interval]	Sig
Private Equity Ownership	0.085	0.195	0.43	0.665	-0.298	0.468	
Strategic Acquirer Ownership	-0.022	0.086	-0.25	0.801	-0.191	0.147	
Year 2015	-0.638	0.019	-32.75	0.000	-0.677	-0.6	***
Year 2016	-0.729	0.028	-25.60	0.000	-0.785	-0.673	***
Year 2017	-1.237	0.035	-35.75	0.000	-1.305	-1.169	***
Year 2018	-1.596	0.035	-45.16	0.000	-1.666	-1.527	***
Year 2019	-1.95	0.036	-54.59	0.000	-2.02	-1.88	***
Constant	14.798	0.036	411.88	0.000	14.728	14.869	***

Mean dependent var	13.790	SD dependent var	1.405
R-squared	0.415	Number of obs	11345.000
F-test	522.384	Prob > F	0.000
Akaike crit. (AIC)	25823.317	Bayesian crit. (BIC)	25874.672

*** *p<.01*, ** *p<.05*, * *p<.1*

I use a hospital and year fixed effects model to help capture any systematic changes in mortality rates during the sample period. After integrating the year fixed effects, I find that leveraged buyouts and strategic acquisitions are not associated with significant changes in AMI mortality rates. (See Table 16.) All year fixed effects are both negative and significant at the 0.1% level. Moreover, the coefficients for the year fixed effects are decreasing monotonically, suggesting the sample period experienced a systematic decrease in mortality rates for AMI treatments. Additionally, the R^2 and adjusted R^2 values are 0.415, a significant improvement from the adjusted R^2 value of 0.022 in Table 15 and an indication that time explains a significant amount of the variance in mortality rates.

As shown in Table 17, I also use a hospital fixed effects model with year time trends. When adjusting the hospital fixed effects model for time trends, I find that the coefficients for private equity and strategic acquirer ownership are no longer significant. However, the first and second order time trends are also not significant. (Higher order terms were excluded due to multicollinearity.) The R^2 and adjusted R^2 values are 0.407 and 0.406, a significant improvement to the hospital fixed effects regression in Table 15.

Table 17: Heteroscedasticity-consistent hospital fixed effects model with year time trends for mortality rates from 2014 to 2019.

30-Day Mortality Rates	Coef.	St.Err.	t-stat	p-value	[95% Conf	Interval]	Sig
Private Equity Ownership	0.084	0.197	0.43	0.670	-0.302	0.47	
Strategic Acquirer Ownership	-0.017	0.086	-0.20	0.844	-0.186	0.152	
Year	-28.135	28.458	-0.99	0.323	-83.944	27.675	
$Year^2$	0.007	0.007	0.98	0.329	-0.007	0.021	
Constant	28758.678	28693.18	1.00	0.316	-27511.761	85029.116	

Mean dependent var	13.790	SD dependent var	1.405
R-squared	0.407	Number of obs	11345.000
F-test	617.176	Prob > F	0.000
Akaike crit. (AIC)	25981.459	Bayesian crit. (BIC)	26010.805

*** *p<.01,* ** *p<.05,* * *p<.1*

Ultimately, I conclude that private equity ownership, along with strategic acquirer ownership, does not lead to significant changes in 30-day mortality rates for acute myocardial infarctions. Hayford (2012) found that horizontal mergers among California short-term acute care hospitals were associated with increases in AMI mortality rates, while Bruch (2020) found that leveraged buyouts were associated with greater quality of care for AMIs. Nevertheless, Hayford (2020) did not distinguish between private equity and strategic acquirers and only considered the

1990 to 2006 period among California hospitals. Moreover, Bruch (2020) did not examine mortality rates for AMIs, instead relying on other quality scores. Therefore, the results of this paper do not contradict those of Hayford (2012) and Bruch (2020).

C. Limitations

Although the hospital fixed effects models in Tables 12 and 15 suggest that leveraged buyouts are associated with increases in payments and decreases in mortality rates, I find that, when accounting for time, LBOs do not have a significant impact on payments or mortality rates for AMIs. The results of Tables 12 and 15 seem to be perturbed by a systematic increase in payments and decrease in mortality rates during the sample period. While accounting for time improves these models, the findings of this paper are nonetheless subject to several limitations.

Firstly, the coefficients for private equity and strategic acquirer ownership not only include the treatment effects of LBOs and strategic acquisitions, but also the selection bias due to non-random selection of targets. Private equity firms, as financial buyers, search for hospitals with fundamentally different characteristics from those of independent or strategic acquirer-backed hospitals (Bruch, 2020). To elucidate the selection bias, I conduct t-tests on all control variables, comparing private equity-owned and strategic acquirer-owned facilities. Relative to strategic acquired-owned facilities, private equity-owned facilities, on average, are located in more urban regions with greater competition (lower HHI), lower smoking rates, greater exercise opportunities, lower alcohol consumption rates, lower high school graduation rates, and lower unemployment rates. Additionally, private equity-owned hospitals, relative to strategic acquirer-owned hospitals, have more beds with less total staff per bed. (T-tests are excluded.) Consequently, the effects of these factors are included in the coefficients for private equity and strategic acquirer ownership, potentially confounding the true effects of private equity and strategic acquirer management on payments and mortality rates. Moreover, as shown in Figure 2, private equity activity expanded during the sample period, while strategic acquirer activity contracted. Future researchers should attempt to control for the selection bias caused by non-random selection of targets.

To control for the selection bias, future researchers should incorporate data on control variables for all years of the sample period. The assumption that factors such as county obesity rates, hospital physician counts, and smoking rates are not highly variable may be improper, especially given that the 2020 datasets, which reflect impacts of the COVID-19 pandemic, are used. It is conceivable that, based on local COVID-19 infection rates, certain hospitals increased their staff and others decreased their staff. Certain counties also may have experienced significant changes in unemployment and self-reported health, and non-COVID patients may have been reluctant to visit hospitals.

Classification of the type of buyer is subject to Pitchbook's own standards. Although the Pitchbook M&A database provides an excellent platform for examining acquisitions of hospitals across various years, it is unknown how exactly Pitchbook defines the buyers and, perhaps more importantly, how LBOs or strategic acquisitions are classified. In particular, future researchers should consider how minority investments and private investments in public equity (PIPEs) are treated. Moreover, matching hospitals from Pitchbook's screening results with those on the CMS dataset was an imperfect process subject to human error.

Additionally, this paper has only focused on payments and mortality rates for AMIs. Although heart disease is most prevalent for individuals aged 60 and older, AMI payments only reflect those for Medicare-certified individuals who are at least 65 years of age (Mozaffarian, 2015). Thus, this paper only captures a subset, albeit a significant portion, of the patients admitted to hospitals for acute myocardial infarctions. Furthermore, although AMIs are prevalent across the US, only considering 30-day Medicare reimbursements and mortality rates for AMI treatments may not provide a holistic view of a hospital's cost and quality of service. Future researchers should consider how these buyers may impact Medicare reimbursements, especially in regards to the types of procedures used, as noted in Hayford (2012). Ultimately, however, research on private equity's effects on patient outcomes is still nascent, and this paper helps synthesize approaches researchers have used to study general M&A to better understand how the decisions made by private equity investors affect the patient.

VII. Conclusion

This paper finds that private equity ownership is not associated with significant changes in Medicare reimbursements for acute myocardial infarctions from 2014 to 2018 and mortality rates for acute myocardial infarctions from 2014 to 2019. Nevertheless, this paper is subject to several limitations that future researchers should amend. The assumption that control variables such as obesity rates, total staff per bed, and food quality are time-invariant did not yield any fixed effects other than those for ownership type and time. Additionally, screening for acquisitions on Pitchbook and matching the respective hospitals with AHA IDs is an imperfect process. Finally, I assume that acute myocardial infarctions are an accurate proxy for cost and quality of care and I only consider the 2014 to 2019 period.

In March 2021, Bloomberg published *Private Equity Piles on Debt to Pull Cash From Health Firms*, in which the author claims that private equity's reliance on leverage to fund dividend recapitalizations not only jeopardizes the financial stability of hospitals, but also the quality of care for patients (Willmer, 2021). Senator Elizabeth Warren has also criticized private equity-owned facilities for their surprise billing practices, requesting that private equity firms disclose the financials of their investments in healthcare companies (Olen, 2019). Some, however, argue that private equity investors, as "turnaround specialists," can catalyze critical changes within hospitals, helping them improve business operations and better meet the needs of patients (Shryock, 2019). I hope that, through this paper, I have introduced econometric analyses that may inform policymakers about their approaches to regulating private equity's activity in the United States healthcare market. Perhaps, private equity's introduction of managerial expertise might just be the solution to more efficient and affordable healthcare.

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Appendices

Appendix A: Heteroscedasticity-consistent OLS model for payments from 2014 to 2018.

30-Day Medicare Reimbursements	Coef.	St.Err.	t-stat	p-value	[95% Conf	Interval]	Sig
Private Equity Ownership	257.881	73.309	3.52	0.0	114.179	401.582	***
Strategic Acquirer Ownership	68.545	42.551	1.61	0.107	-14.865	151.954	
HHI	-5440.203	839.155	-6.48	0.0	-7085.13	-3795.276	***
PoorHealth	22.92	9.571	2.39	0.017	4.158	41.682	**
Smoking	-37.42	11.007	-3.40	0.001	-58.997	-15.843	***
Obesity	-53.823	5.613	-9.59	0.0	-64.825	-42.82	***
FoodQual	74.643	32.287	2.31	0.021	11.353	137.932	**
PhysInactive	44.485	6.892	6.45	0.0	30.974	57.995	***
ExerAccess	13.607	1.729	7.87	0.0	10.218	16.996	***
Alcohol	15.608	8.371	1.86	0.062	-.801	32.018	*
PCPhys	-3.553	0.652	-5.45	0.0	-4.83	-2.276	***
HSGRate	36.532	3.691	9.90	0.0	29.297	43.767	***
Unemployment	174.97	23.516	7.44	0.0	128.873	221.068	***
CHOWCount	7.73	13.071	0.59	0.554	-17.893	33.353	
BedCount	0.242	0.08	3.02	0.003	0.085	0.399	***
TotalStaffPerBed	-4.564	3.524	-1.30	0.195	-11.471	2.344	
CardiacRoomsPerBed	2036.654	2336.564	0.87	0.383	-2543.519	6616.828	
2.OwnerType (private not-for-profit)	-128.88	67.998	-1.90	0.058	-262.172	4.411	*
3.OwnerType (other)	-147.797	84.948	-1.74	0.082	-314.314	18.719	*
4.OwnerType (private for-profit)	-68.072	83.397	-0.82	0.414	-231.548	95.405	
5.OwnerType (federal)	-8.12	394.601	-0.02	0.984	-781.624	765.385	
6.OwnerType (state)	-841.566	165.427	-5.09	0.0	-1165.838	-517.294	***
7.OwnerType (local)	-609.445	120.864	-5.04	0.0	-846.365	-372.525	***
8.OwnerType (hospital district)	-287.614	102.936	-2.79	0.005	-489.39	-85.837	***
9.OwnerType	489.241	209.061	2.34	0.019	79.435	899.046	**

(physician owned)							
UrbRur	358.272	62.086	5.77	0.0	236.57	479.974	***
1.CathProvType (staff)	82.884	48.63	1.70	0.088	-12.442	178.209	*
2.CathProvType (under arrangement)	381.617	148.517	2.57	0.01	90.491	672.743	**
3.CathProvType (staff and under arrangement)	223.167	79.011	2.82	0.005	68.288	378.046	***
1.ThorProvType (staff)	189.367	50.593	3.74	0.0	90.193	288.541	***
2. ThorProvType (under arrangement)	-70.581	167.175	-0.42	0.673	-398.28	257.118	
3. ThorProvType (staff and under arrangement)	119.393	81.875	1.46	0.145	-41.099	279.885	
1.CoroProvType (staff)	80.412	43.515	1.85	0.065	-4.886	165.71	*
2. CoroProvType (under arrangement)	-11.319	199.365	-0.06	0.955	-402.117	379.48	
3. CoroProvType (staff and under arrangement)	88.271	91.954	0.96	0.337	-91.98	268.522	
1.Region (East North Central)	236.322	52.564	4.50	0.0	133.285	339.358	***
2.Region (East South Central)	28.241	83.337	0.34	0.735	-135.117	191.599	
3.Region (West South Central)	231.624	83.578	2.77	0.006	67.793	395.455	***
4.Region (West Mountain)	-102.601	137.022	-0.75	0.454	-371.194	165.992	
5.Region (West Pacific)	-518.862	111.811	-4.64	0.0	-738.036	-299.688	***
Constant	17538.808	579.143	30.28	0.0	16403.561	18674.055	***

Mean dependent var	22757.505	SD dependent var	1818.780
R-squared	0.112	Number of obs	9392.000
F-test	29.691	Prob > F	0.000
Akaike crit. (AIC)	166609.872	Bayesian crit. (BIC)	166902.925

*** *p<.01*, ** *p<.05*, * *p<.1*

Appendix B: T-test for payments from 2014 to 2018 for private equity-owned (PE, group 2) and independent (IND, group 1) hospitals.[9]

	obs1	obs2	Mean (Ind)	Mean (PE)	dif	St Err	t-stat	p value
30-Day Medicare Reimbursements	7171	852	22702.4	23233.7	-531.26	66.285	-8.000	0.000

Appendix C: Heteroscedasticity-consistent OLS model for mortality rates from 2014 to 2019.

30-Day Mortality Rates	Coef.	St.Err.	t-stat	p-value	[95% Conf	Interval]	Sig
Private Equity Ownership	-0.136	0.057	-2.38	0.017	-0.248	-0.024	**
Strategic Acquirer Ownership	-0.125	0.03	-4.12	0.0	-0.184	-0.066	***
HHI	0.601	0.736	0.82	0.414	-0.842	2.044	
PoorHealth	-0.006	0.006	-0.92	0.358	-0.019	0.007	
Smoking	0.019	0.008	2.47	0.014	0.004	0.035	**
Obesity	0.01	0.004	2.44	0.015	0.002	0.017	**
FoodQual	-0.126	0.023	-5.43	0.0	-0.172	-0.081	***
PhysInactive	0.002	0.005	0.51	0.608	-0.007	0.012	
ExerAccess	-0.001	0.001	-0.66	0.512	-0.003	0.002	
Alcohol	0.003	0.006	0.42	0.675	-0.009	0.014	
PCPhys	-0.002	0.001	-2.85	0.004	-0.003	0.0	***
HSGRate	-0.003	0.003	-1.14	0.256	-0.008	0.002	
Unemployed	-0.076	0.017	-4.43	0.0	-0.11	-0.043	***
CHOWCount	-0.001	0.01	-0.14	0.889	-0.021	0.018	
BedCount	0.0	0.0	-5.22	0.0	0.0	0.0	***
TotalStaffPerBed	-0.005	0.003	-1.68	0.093	-0.01	0.001	*
CardiacRoomsPerBed	-10.633	1.627	-6.53	0.0	-13.822	-7.443	***
2.OwnerType (private not-for-profit)	-0.051	0.048	-1.06	0.29	-0.144	0.043	
3.OwnerType (other)	0.001	0.061	0.01	0.993	-0.119	0.12	
4.OwnerType	0.149	0.059	2.54	0.011	0.034	0.264	**

[9] Independent hospitals are those such that dummy variables for private equity and strategic acquirer ownership are zero.

(private for-profit)							
5.OwnerType (federal)	-0.525	0.265	-1.98	0.047	-1.044	-0.006	**
6.OwnerType (state)	0.142	0.127	1.12	0.262	-0.106	0.391	
7.OwnerType (local)	0.138	0.076	1.83	0.067	-0.01	0.286	*
8.OwnerType (hospital district)	0.124	0.069	1.78	0.075	-0.012	0.26	*
9.OwnerType (physician owned)	0.053	0.166	0.32	0.749	-0.273	0.379	
UrbRur	-0.124	0.04	-3.10	0.002	-0.202	-0.045	***
1.CathProvType (staff)	0.028	0.034	0.83	0.406	-0.038	0.094	
2.CathProvType (under arrangement)	0.002	0.129	0.01	0.989	-0.252	0.255	
3.CathProvType (staff and under arrangement)	0.092	0.059	1.56	0.118	-0.023	0.208	
1.ThorProvType (staff)	-0.093	0.036	-2.56	0.01	-0.164	-0.022	**
2. ThorProvType (under arrangement)	0.301	0.109	2.76	0.006	0.087	0.515	***
3. ThorProvType (staff and under arrangement)	0.025	0.061	0.41	0.68	-0.094	0.144	
1.CoroProvType (staff)	-0.013	0.03	-0.44	0.658	-0.072	0.045	
2. CoroProvType (under arrangement)	-0.289	0.167	-1.73	0.083	-0.616	0.038	*
3. CoroProvType (staff and under arrangement)	0.136	0.065	2.11	0.035	0.009	0.263	**
1.Region (East North Central)	-0.139	0.038	-3.63	0.0	-0.215	-0.064	***
2.Region (East South Central)	0.18	0.06	3.02	0.003	0.063	0.298	***
3.Region (West South Central)	0.243	0.058	4.20	0.0	0.13	0.357	***
4.Region (West Mountain)	-0.262	0.094	-2.79	0.005	-0.446	-0.078	***
5.Region (West Pacific)	0.497	0.077	6.43	0.0	0.346	0.649	***
Constant	15.156	0.424	35.75	0.0	14.325	15.987	***

Mean dependent var	13.790	SD dependent var	1.405
R-squared	0.056	Number of obs	11345.000
F-test	16.697	Prob > F	0.000
Akaike crit. (AIC)	39340.449	Bayesian crit. (BIC)	39641.247

*** *p<.01*, ** *p<.05*, * *p<.1*

Appendix D: T-test for mortality rates from 2014 to 2019 for private equity-owned (PE, group 2) and independent (Ind, group 1) hospitals.

	obs1	obs2	Mean1 (Ind)	Mean2 (PE)	dif	St Err	t-stat	p value
30-Day Mortality Rates	8381	1001	13.842	13.819	0.022	0.047	0.500	0.633