Managing Margins: PE Effects on Financial, Physical, and Human Capital

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Private equity (PE) plays an increasingly important role in the modern US economy. However, its impacts on owned-firms are incompletely understood. We exploit a historically large leveraged buyout of a national hospital chain to examine how the full life cycle of PE influences hospital-level revenues, technology sourcing, labor use, and financial performance. We find permanent improvements in hospital volumes and revenues. PE also reduces growth in full-time employees, with a suggestive partial substitution toward part-time workers. Technology adoption is restrained, but the number of vendors expands. Overall, PE has nuanced effects on hospital management, which translate to improved operating margins.

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I. Introduction

Private equity (PE) has emerged as a dominant form of financial investment across modern economies (Mauboussin and Callahan 2020; Bernstein 2022; McKinsey & Company 2022). PE firms typically raise or borrow money to fund short- to medium-term acquisitions, with the intent to exit the investment in 5-10 years and return the proceeds to investors. PE firms' profits originate from both the sale of the owned-asset and through management fees accrued to the PE firm over the lifetime of ownership. Divestment can include one of several strategies, including returning the purchased company to public markets or selling to another private buyer—which may be another PE firm.

Compared to other forms of financial transactions, the rise of PE has attracted greater scrutiny among industry stakeholders and regulators due to the PE business model, which is focused on relatively quick turnarounds. Specific concerns over the involvement of PE in a firm's ownership structure center on the tension between seeking a short-run payout and the long-run viability of the acquired company. The differing time horizons between PE owners and other stakeholders suggest challenges akin to classic principal-agent problems. For example, PE may underinvest in the acquired asset or trade off the company's long-term business interests to boost near-term financial metrics. Yet, PE can also provide nimble and flexible capital that allows firms to expand and meet new forms of consumer demand. PE ownership may additionally offer managerial expertise and industry-specific knowledge that improves firm efficiencies (Cumming, Siegel, and Wright 2007; Kaplan and Stromberg 2009; Cornelli and Karakas 2013; Bloom, Sadun, and Van Reenen 2015; Bernstein *et al*. 2017; Cumming *et al*. 2023). Consequently, whether PE engages in beneficial value creation or rent extraction is inherently an empirical question.

Such questions are not easily answered, however. The impacts of PE can be varied and multifaceted, which necessitate detailed data spanning multiple dimensions of firm production and performance. The literature to date is just beginning to open the "black box" with respect to how PE affects upstream firm strategy, management, and operations in order to improve downstream profitability (e.g., Bloom, Sadun, and Van Reenen 2015; Agrawal and Tambe 2016; Bernstein and Sheen 2016; Eaton, Howell, and Yannelis 2020; Cohn, Nestoriak, and Wardlaw 2021; Gupta *et al*. 2023; Richards and Whaley 2024). Capturing the arrival and departure of PE is also critical in order to compare and contrast short-run changes against long-run firm conduct. However, studies of the full life cycle of PE (i.e., investment and divestment) are currently rare. The incomplete

understanding of PE's potentially diverse effects suggests the need for more research, especially as new and targeted policy momentum grows. For example, widening concerns over the increasing PE involvement in healthcare markets, which could adversely impact patient welfare, have led to federal legislators and state policymakers to introduce bills strengthening oversight over or even curtailing private equity investments in US healthcare businesses (Ashely 2024; Wallace 2024). Yet, policy interventions can be blunt instruments, with unintended side effects, which underscores the value of greater empirical guidance.

To shed new light in this area, we exploit one of the most extensive leveraged buyouts (LBOs) in financial history, which took place within the US healthcare sector—currently a $4 trillion piece of the US economy. Besides being a noteworthy transaction due to its sheer size, PE investments in healthcare may be particularly sensitive since public and private spending is high, market imperfections are rife, and deteriorations in firm performance and/or product quality can be especially harmful (e.g., adverse medical events). Moreover, since 2000, healthcare-focused PE investments are up 20-fold and involved approximately 8,000 separate transactions across the country. This aggressive uptick in PE activity has culminated in nearly $1 trillion of healthcare targeted financing, with a $100 billion worth of deals in 2018 alone (Appelbaum and Batt 2020; Schulte 2022).

Our analytic context specifically focuses on the largest for-profit hospital chain (Hospital Corporation of America: HCA) in the US being wholly acquired by a consortium of private equity investors. The deal took place in late 2006 and represented the most expensive LBO across all industries in terms of purchase price ($33 billion) at that time.[1] PE ownership also lasted approximately 4.5 years before the hospital chain returned to public markets. Despite its significance, the deal's potential impacts are unclear *a priori* and surprisingly understudied. PE ownership of a hospital chain could theoretically lead to greater standardization and cost-cutting––including a slimmed down organization through jettisoning underperforming hospitals. On the other hand, healthcare markets are typically local, which can subject the chain's member hospitals to differing demand- and supply-side factors and constraints. Varied market conditions could consequently beget more tailored management approaches, which might contrast with PE activity in other industries.

[1] More expensive acquisitions have since taken place, however.

We are aware of a single study that has explicitly investigated this momentous transaction in detail. Richards and Whaley (2024) examine HCA's marketing expenditures and joint venture investments as the chain moved under PE ownership and following its subsequent initial public offering (IPO). Consistent with PE owners bringing fresh ideas and capital to the firm, the authors document a marked and persistent uptick in advertising expenditures and outpatient surgery joint ventures once under PE direction. The authors supplement their findings with an assessment of clinical delivery patterns for affected hospitals in Florida. Using all-payer discharge data, they demonstrate increased hospital admission volumes and less treatment intensive stays across all insurance segments (i.e., Medicare, commercial, Medicaid, and others) during and after PE's arrival.

This paper extends the Richards and Whaley (2024) analyses in several important ways. First, we benefit from national data across all of our outcomes of interest, which avoids the geographic constraint of a single and perhaps unrepresentative state. Second, we are able to leverage transaction data to quantify PE effects on actual revenue flows, as opposed to just care volume, to affected hospitals. Third, the authors' most novel empirical aspects (i.e., changes in advertising and joint venture investments) are focused on the implications of PE on business development—namely efforts to deploy newly available financial resources to alter business strategy and drum up opportunities for increased revenue. In contrast, our work focuses on how PE owners manage *existing* operational outlays, such as labor and technology, and how adjustments along these margins translate to improvements in financial metrics.

To analyze changes in these firm behaviors, we first compile a unique collection of complementary data sets which each span over a decade. We then conduct a detailed examination of the more than 100 hospitals spread across much of the US that were affected by this transaction in terms of firm-level throughput, revenues, staffing, and health information technology (IT) adoption as well as contracting. Importantly, the wide time horizons belonging to each of our data assets allows us to implement a difference-in-differences (DD) event study framework that quantifies the effects of PE ownership during the period of investment as well as divestment. Doing so can reveal if PE changes to hospitals' management and operations are transient or permanent. We formally test for differential changes in our hospital-level outcomes by comparing HCA member hospitals to other, out-of-market system affiliated hospitals spanning the US. Leveraging an out-of-market sample for controls allows us to avoid estimation bias due to any spillover effects

onto HCA competitors (e.g., via strategic complementarities among within-market hospitals). We also benefit from a uniformly implemented shock (i.e., simultaneous exposure to PE ownership), which avoids the known estimation challenges in the context of varied treatment timing.

We begin by looking at revenue flows from a key payer for the hospital industry: Medicare. We show that the average affected hospital has a 20-30% relative increase in Medicare patient volumes, which translates to a commensurate increase in Medicare revenues. Importantly, the PE effect along these margins reflects a sharp trend change that persists years after PE ownership has ceased. While the Medicare patient mix is not obviously different over this period, we find that hospital stays become shorter—consistent with an operational emphasis on greater throughput to improve the hospital's bottom line.

We next examine to hospitals' management of costs since cost minimization across human and physical capital (i.e., workers and health IT) is a standard strategy to strengthen financial margins, especially in the context of improving revenues (e.g., greater Medicare payment flows). Starting with labor, we observe a quick and approximately 10-15% relative reduction in the number of full-time workers that outlasts PE ownership. The number of part-time workers offers only suggestive increases over the relevant time frame, and the point estimates are typically less than half those found for full-time employees—indicating a smaller overall workforce than pre-PE trends would predict. Additionally, these employment patterns are present for some of the hospital's most numerous and critical sources of labor: nurses. While such a pattern could reflect trying to spread a larger volume of customers (i.e., patients) over a smaller workforce to enhance profits, the estimated decline in full-time nurses is driven by restrained labor growth, as opposed to sweeping cuts, under PE ownership.

Some of our most unique and novel results pertain to hospital adoption of health IT and the accompanying engagements with suppliers. The PE acquisition takes place during a period of rapid growth in health IT products and spending across the healthcare sector, and members of the for-profit chain demonstrated above average adoption behavior at baseline. However, PE owners restrain the degree of growth in health IT going forward. Just as before, the PE ownership effect is not a level change but a trend change that appears permanent. Implementation of new health IT solutions is reduced by as much as 10% in the presence of PE ownership, with the effect growing to roughly 25% in the years following PE divestment. We also find that once these strategic labor

and capital decisions have been made, affected hospitals' net income and operating margins—two key performance indicators for the industry—are improved by 50-100%.

Yet, the PE impact for health IT is not confined to just downward pressure on purchasing trends. Interactions with suppliers are also sharply changed. While hospitals could be disciplined by their PE owners to engage in greater supply-chain simplification and standardization—which would imply a reduction in the number of health IT vendors for the average hospital—that is not what is observed. Instead, the number of unique vendors expands by as much as 25% when the hospital chain is under PE direction. This behavior change is consistent with avoiding legacy suppliers when entering into new contracts. Moreover, in what appears to be a pivotal year for adjusting hospital's health IT procurement strategy, the number of suppliers without a previous contract with the hospital approximately triples, with nearly one-fourth of those new vendors being new market entrants to the entire health IT industry. As a result, affected hospitals are, on average, relying more on vendors with lower local as well as national market shares within the health IT product space. New relationships with smaller market suppliers could plausibly transfer some bargaining power to the hospital (i.e., allow hospital to extract a more favorable deal) and facilitate lower expenditures within its health IT domain than what would be possible by maintaining the hospital's status quo purchasing behavior.

Although specific to healthcare, our findings align with theoretical predictions of how PE ownership influences firms' management and operations in ways that have lasting impacts. Revenues are improved via enhanced occupancy and throughput while changes to labor and technology utilization—two of hospitals' largest operational expenses—are consistent with efficiency gains. The effects across all three production margins can positively impact downstream financial performance indicators, especially when implemented in conjunction. And even firms' business-to-business contracting is altered once PE is involved.

It is often argued that PE may be attracted to imperfect markets where profitable arbitrage opportunities as well as further consolidation potential exists—market features that are common throughout US healthcare (Wollmann 2020; Singh *et al*. 2022; Asil, Barrios, and Wollmann 2023). As a consequence, increasing PE involvement seems to be encouraging a push for greater regulatory oversight and even policy proposals aiming to arrest further dealmaking within

healthcare industries.[2] Our results from the hospital industry point to PE ownership effects that do not obviously diverge from general management strategies and could be applied to a variety of firms across economic sectors. In other words, PE may have unique approaches to financing acquisitions and perhaps comparatively less binding liquidity constraints, but its motivations and actions as a corporate owner may mirror those exhibited by other vested owners and managers. Regulatory interventions targeting PE would need to demonstrate that the implications of PE ownership for the conduct of the relevant firm(s) in a given industry are, in fact, different than actions desired by other types of corporate owners, including public market shareholders.

II. Brief Background

A. Hospital Chain PE Acquisition

In the final quarter of 2006, financial history was made when Bain Capital, Kohlberg Kravis Roberts (KKR), and Merrill Lynch Global Private Equity collectively acquired the largest for-profit hospital chain, Hospital Corporation of America (HCA), for $33 billion—marking the largest LBO in the US economy up to that point. The HCA chain extended to over 100 hospitals that spanned 21 states. It was also publicly traded on the NYSE prior to the PE acquisition and would return to public markets following its IPO in the first quarter of 2011 (HCA Healthcare 2006; Sorkin 2006; Dowd 2017). Notwithstanding the size, scope, and importance of this healthcare "mega deal", as discussed further in Section IIB, relatively little is known about its long-run impact on the hospital chain—including any changes to its business conduct and if such changes diverge from what might be expected from PE involvement in other industries and sectors of the economy.

[2] For example, the California legislature recently went as far as introducing a bill to curtail private equity investments in healthcare firms within the state. A media description and legislative history can be found here: https://www.wsj.com/articles/california-bill-to-rein-in-private-equity-health-care-buyouts-dies-11599250052. The Federal Trade Commission has also initiated a legal challenge to PE backed staffing company operating in Texas in 2023 and is taking a growing interest in PE involvement elsewhere throughout the US healthcare system (e.g., see here: https://www.fiercehealthcare.com/regulatory/federal-regulators-clinicians-make-their-case-against-private-equity-healthcare).

B. PE Effects in Healthcare

The compatibility between private equity's business objectives and patients' best interests has recently been called into question (e.g., see Gondi and Song 2019; Gustafsson, Seervai, and Blumenthal 2019; Sanger-Katz, Creswell, and Abelson 2019; Sharfstein and Slocum 2019; Scheffler, Alexander, and Godwin 2021). The profit motive, coupled with set financial endpoints over relatively short time horizons, could encourage rent-seeking behavior as well as efforts to distort provider agency away from what is optimal for patients. But as previously noted, private equity could also benefit healthcare firms, just like those from non-healthcare industries, through needed capital infusions as well as improving business management—interventions that have the potential to strengthen performance over the longer run.

Given the theoretically ambiguous and opposing possibilities for private equity in US healthcare, a nascent literature has emerged to empirically examine their implications. Recent research has explored private equity effects focused on nursing homes (Huang and Bowblis 2019; Braun *et al*. 2020, 2021a; Gandhi, Song, and Upadrashta 2020a, 2020b; Gupta *et al*. 2023), ambulatory surgery centers (Bruch *et al*. 2022; Lin *et al*. 2023) as well as physician practices (Tan *et al*. 2019; Konda *et al*. 2019; Braun *et al*. 2021b; La Forgia *et al*. 2022; Singh *et al*. 2022; Bruch *et al*. 2023; La Forgia 2023). There is evidence of higher service prices and care quality erosion, but the results are mixed and inconclusive across and within the different strands of literature.

Studies of PE and the hospital industry are similarly varied in their data quality, empirical approaches, and strength of findings. Bruch, Gondi, and Song (2020) find hospital charges and income to be elevated during the first three years of PE ownership. Offodile *et al*. (2021) also report higher charges and operating margins when comparing these metrics in 2003 to 2017 across PE-owned hospitals and other US hospitals. Relatedly, Cerullo *et al*. (2021) interpret their evidence as suggesting that hospitals substitute toward more profitable services following a PE acquisition. To move into healthcare delivery focused outcomes, Cerullo *et al*. (2022) examine utilization and health outcomes for Medicare beneficiaries afflicted with one of five conditions but are unable to detect any effects of PE ownership among this small subset of patients. The study most closely related to ours is Richards and Whaley (2024). The authors find large increases in HCA's marketing expenditures as well as joint venture activity under PE ownership, which are both consistent with fresh capital facilitating short- and long-run business enhancements. The authors additionally document growth in affected hospitals' patient volumes—though the analyses are limited to

Florida-specific hospital markets and lack information on financial measures (e.g., insurer payments).[3]

We consequently extend this modest literature to date in a variety of important ways. First, we follow Richards and Whaley (2024) and take advantage of the fact that 57% of all US hospitals exposed to PE ownership in recent decades are tied to a single transaction: the HCA LBO. We can therefore use this single and well-documented market event impacting over 100 hospitals to carefully examine firm behavior before, during, and after the PE acquisition (i.e., the full life cycle of PE ownership), which is largely absent from existing studies.[4] Second, we bring a unique and more comprehensive combination of national data to assess operational and strategic changes across a variety of hospital business functions (fully described in Section III). Third, our estimation strategy allows for a transparent display of PE effects and more credible inferences to be drawn than what is commonly found in the hospital-focused literature to date. While the estimates pertain to a chain of hospitals impacted by a single PE purchase, they can inform what, if any, firm conduct changes are pursued under PE ownership and how closely they map to findings from other recent studies aiming to open the PE "black box."

III. Data

A. Hospitalizations and Revenues

Our hospital-level information on patient volumes and associated payments comes from 100% inpatient Medicare fee-for-service (i.e., Traditional Medicare) claims data, spanning 2003 through 2014. With the universe of national data, we calculate the annual number of hospital stays, the number of unique Medicare beneficiaries hospitalized, total Medicare revenue, patient mix, treatment intensity (e.g., length of stay), and 30-, 60-, and 90-day mortality rates following the index hospitalization for Medicare patients. Tracking these measures over time facilitates a detailed examination of hospitals' core business: caring for patients within an inpatient setting. We also supplement these data with audit rates from Centers for Medicare and Medicaid Services

[3] Of note, the Liu (2022) working paper finds positive associations between hospital transaction prices and PE ownership; however, the data span 2013-2019 and are restricted to outpatient, as opposed to inpatient, claims—making it harder to compare with existing studies.

[4] The lone exception that we are aware of is Richards and Whaley (2024), which also stresses and demonstrates the importance of capturing the full PE life cycle for understanding changes to firm behavior.

(CMS) that targeted hospitalizations believed to be inappropriately billing the Medicare program––especially for excessively short stays (see Shi 2024). Doing so allows us to assess if any PE-induced changes to hospital care delivery trigger greater scrutiny and sanctions by regulatory agencies.

B. Labor Inputs

Information on hospital-level employment comes from the American Hospital Association (AHA) annual survey. The survey years include 2003 through 2014. We focus on measures of full-time employees and part-time employees belonging to the hospital's entire workforce. We additionally examine the size of full-time and part-time workers for registered nurses (RNs) and licensed practical nurses (LPNs), specifically. Nurses of varying skill types are some of the most numerous and vital labor inputs for most hospital operations, but efficient nurse staffing is also a perennial challenge for many hospitals.

C. Health IT Purchasing

These data come from the Health Information Management Systems Society (HIMSS) annual survey, which provide detailed information on hospital-level health IT use across a variety of business domains (e.g., clinical care and tracking, revenue cycle management, and back-office functions). We use survey years 2002 through 2014 and construct a hospital-level measure of aggregate number of software health IT solutions implemented and operational in a given year to reflect adoption and outsourcing activity over time. Additionally, an important and relatively unique feature of these data is the ability to observe information on health IT vendors as well. We leverage these rich data details to likewise construct a measure of total unique vendors a given hospital contracts with in a given year and to explore characteristics of vendors ultimately chosen. These data are a novel contribution to the healthcare and PE ownership literature, which helps fill an important knowledge gap. The data and associated findings also nicely align with other recent studies outside the healthcare sector that examine IT capital expenditures in the presence of PE ownership—e.g., see Agrawal and Tambe (2016).

D. Hospital Financials

To measure changes in hospital financial status, we use publicly-available data from the CMS Hospital Cost Reporting Information System (HCRIS). On an annual basis, all hospitals participating in the Medicare system are required to certify and report information on hospital financial measures, including operating revenues and expenses. We use these components to measure changes in both hospital net income and operating margin following the investment and divestment periods of HCA, relative to similar hospital systems. While the HCRIS data contain system linkages, we analyze financial outcomes at the individual hospital level, which allows for a more direct comparison with other hospitals. The HCRIS data have been used to examine hospital financial performance in related settings, including financial outcomes following hospital mergers (Gaynor *et al*. 2023).

IV. Empirical Strategy

We utilize a standard difference-in-differences (DD) research design applied to each of our hospital-level analytic data sets described in Section III. Our treatment group is comprised of hospitals with a consistent HCA affiliation reported in the AHA data over the 2003 to 2014 period and a balanced panel of information for our outcomes of interest. Of note, hospital divestures were not a prominent PE strategy when taking over the HCA chain (see Richards and Whaley (2024)). The consistent affiliation requirement is neither overly restrictive nor resulting in a select subset of hospital members. For our control group, we use a balanced panel of hospitals that are never affiliated with the HCA hospital chain but are consistently affiliated with another hospital system (i.e., we exclude standalone hospitals from the sample). We further restrict the control group hospitals to only include those that operate in a hospital market (i.e., HRR) that is never exposed to any HCA-owned hospital during our study period. Doing so minimizes the risk of any PE ownership effects on HCA spilling over to within-market competitors (e.g., if there are strategic substitution or strategic complementary behaviors between HCA hospitals and their local competing hospitals). Our resulting analytic sample includes 122 HCA hospitals that experience PE investment as well as divestment and 876 other system-affiliated, out-of-market hospitals that serve as controls.[5]

[5] We do note that the analytic samples are slightly reduced for the AHA- and HIMSS-specific analyses due to a few hospitals not reporting data in all years.

The accompanying event study DD estimating equation is both straightforward and parsimonious:

$$Y_{ht} = \alpha_h + \theta_t + \sum_{\substack{j=-4 \\ j\neq -2}}^{7} \delta_j \left(Treated_h \times time = j\right) + \varepsilon_{ht} \quad (1)$$

We include hospital (α) and year (θ) fixed effects. The *Treated* variable is equal to one for all HCA-owned hospitals in our analytic sample and zero otherwise. We use the 2005 year (*time* = –2) as the omitted time point since 2006 (*time* = –1) is a partially treated year for PE ownership (i.e., the buyout was completed in the fourth quarter of 2006). Recall, the nature of the transaction resulted in all hospitals coming under PE direction simultaneously, which obviates recent econometric developments to address variation in treatment timing. The series of δ_j coefficients flexibly test for parallel trending in the lead up to PE ownership and then differential changes during and after the PE ownership event. Standard errors are clustered at the hospital level throughout.

V. Results

A. Hospitalizations and Revenues

Table 1 displays the annual Medicare hospitalizations, patient mix, and mortality rates for the 2003 to 2005 period for the treatment and control group hospitals. The average member of the PE-owned hospital chain has a Medicare market profile closely aligned with the average out-of-market, system-affiliated control group hospital. Each can expect just over 4,000 inpatient admissions per year, with the typical stay lasting five days. The aggregate patient demographics and mortality risk measures are nearly identical across the two groups of hospitals in Table 1.

Figure 1 panels (a) and (b) present our first event study DD estimates capturing log changes in the volume of inpatient stays as well as the number of unique beneficiaries hospitalized at a given facility. Both outcomes demonstrate an identical pattern. HCA hospitals are tracking with the control group hospitals during the years leading up to the PE acquisition, but at approximately the midpoint of the PE ownership window, affected hospitals exhibit a pronounced differential trend change that persists beyond the PE divestment point. By the conclusion of our analytic period, hospital volumes and unique beneficiaries cared for are 20-25% higher than they otherwise

would have been. These findings align with what other work observes when focused on clinical care delivery in Florida markets (Richards and Whaley 2024). Panel (c) in Figure 1 shows that the greater care volumes translate to as much as a 25% improvement in Medicare revenues. The commensurate increase in unique Medicare patients as inpatient volumes grow also goes against an interpretation that more hospital stays are the result of readmitting the same patient, which could otherwise have been indicative of worsening quality of care when under PE direction. The results in Figure 1 also speak to key performance indicators for the hospital industry—i.e., inpatient occupancy and throughput as well as revenue flows. PE ownership seems to act on these margins and to permanently impact the operational behavior of and associated payments to the hospital chain when compared to peer hospitals. Such changes are likely of interest to potential investors, especially at the time of the hospital chain's eventual return to public markets via an IPO.

Appendix Figure 1 generally shows unremarkable changes in patient mix over time. The average age offers no differential changes, with only suggestive changes to the percentage of beneficiaries that are female or white. The coefficients are also small when compared to the baseline levels (Table 1). These patterns additionally contrast with recent work on the nursing home industry, which finds substantial patient composition effects consistent with cream-skimming behavior (i.e., the positive selection of healthier patients) following PE ownership (Gupta *et al*. 2023). The three mortality rate measures in Appendix Figure 2 demonstrate an upward trend prior to and during PE ownership that eventually reverses. The conservative interpretation for Appendix Figure 2 is that mortality is not obviously affected by the presence or absence of PE ownership. There are some indications that as the hospital chain is experiencing growing Medicare beneficiary volumes, stays are becoming shorter. Such a pattern can be indicative of greater emphasis on hospital throughput and is consistent with Richards and Whaley (2024) findings from their all-payer data in Florida where the authors demonstrate higher volumes across all patients—driven by increased admitting behavior by hospitals' emergency department clinicians as well as a greater acceptance of transfer patients. Interestingly, HCA hospitals are less likely to be audited for inappropriate billing tied to short-stay hospitalizations over most of this analytic period. This is true even when further restricting the control group hospitals to those in the same geographic audit regions as HCA hospitals (Appendix Figure 4).

B. Labor Inputs

While there is near parity across the treatment and control group hospitals for the metrics in Table 1, their respective staffing patterns differ in Table 2. HCA hospitals' average total number of full-time and part-time workers are only 66% and 40% of the levels observed among the out-of-market, system-affiliated control hospitals—despite handling almost identical patient volumes over the course of a year (Table 1). The proportion of full-time labor belonging to nursing is 36% for the for-profit hospital chain but only 26% for the control, comparison group. And at baseline, HCA hospitals average a 14.9 ratio of Medicare hospital stays to full-time nurse employees. The control group average ratio is 13.9.

The event study DD estimates in Panel A of Figure 2 for full-time employees indicate a relative decline for these workers that begins in 2006 (t – 1) and persists over the remainder of the study period, including after PE divests. Recall that the PE deal finalized in the fourth quarter of 2006, so it is a partial transition year for the hospital chain. There are also suggestive increases in part-time workers over time, but the magnitudes are a fraction of the decreases in full-time workers and lag the changes in full-time staffing by several years. Similar patterns are present when restricting to nurse labor, specifically in Figure 3. Appendix Figure 5 further homes in on nurse labor inputs according to RN and LPN status (i.e., relatively higher versus lower skilled nurse workers).

The approximately 10-15% decline in full-time nurses relative to pre-PE levels (Figure 3 and Table 2) could suggest skimping on a key source of hospital labor. However, by 2012 (one year since PE divestment), the affected hospital chain's ratio of Medicare admissions to full-time nurses has actually declined to 11.5—implying a larger full-time nurse workforce relative to current hospital inpatient volumes. The average control group system-affiliated hospital ratio has also fallen to 9.1, which reveals a widening gap between the two sets of hospitals for this metric when compared to the pre-PE period (Table 2). The movement in these ratios is driven by the fact that both treatment and control hospitals grow their aggregate number of full-time nurses but do so in the context of a secular decline in their number of hospitalizations. Under PE ownership, hospitals restrain some of that labor growth, which preserves a higher ratio of admissions to aggregate nurse staffing when compared to the control group hospitals. Additionally, full-time nurses reflect 40% of the hospital chain's average full-time employees by 2012—an increase of 4-percentage points over their pre-PE share. These labor inputs are only 29% of the full-time

workforce, on average, for the out-of-market, system-affiliated hospitals in our control group. Taken together, and when placed into a hospital operations context, the relative declines in full-time nurse workers with the arrival of PE ownership appear less consistent with sweeping labor cuts and more consistent with intentionally managed labor growth to match trends in inpatient care demand.

C. Health IT Purchasing

Table 3 summarizes the 2002-2006 health IT utilization and contracting baselines for our treatment and control group hospitals. Prior to the PE takeover, the average HCA hospital has deployed approximately seven more IT solutions for its clinical and business operations while relying on one less contracting vendor when compared with the peer hospitals in the control group.

Consistent with the findings from Section VA and VB, these hospital-level decisions change once PE ownership is in place. In Figure 4, the event study DD estimates reveal a fairly stable trend among both the hospital chain's members and our out-of-market, system-affiliated hospitals (i.e., controls) until roughly the midpoint of the PE ownership window.[6] At that time, a relative trend change emerges—similar to what was observed for Medicare inpatient volumes and revenues (Section VA). The decline in the number of IT solutions the hospital is actively using continues beyond the hospital chain's IPO in 2011, and by the end of our study period, the affected hospitals are using 25-30% fewer IT products than they plausibly would have in the absence of experiencing PE ownership and management.

Interestingly, prior work finds that PE is associated with increases in IT expenditures (Agrawal and Tambe 2016), but business context and trends appear influential in our analytic setting. Just as before with the labor use margins of action, the relative declines in Figure 4 are not indicative of fewer IT solutions implemented in absolute terms; instead, the estimates in Figure 4 are reflecting restrained growth in IT adoption when compared to the control group hospitals. In fact, by the 2012-2014 period in our analytic data, the average HCA hospital has 74.5 active health IT solutions in use while the average control group hospital has 74.4. In other words, PE

[6] While the t = –3 (2004) coefficient in Figure 4 appears off-trend, the 2004 to 2005 also marks a substantial update to the HIMMS survey where key questions and eligible responses were significantly revised. Thus, that particular survey administration transition point may account for additional noise in the data in that year.

management reduced the rate of growth in IT adoption among its owned-hospitals and brought them in-line with industry averages among peer hospitals.

Notwithstanding the pattern from Figure 4, in Figure 5, we can see that the number of vendors actually increases as the pace of outsourcing additional IT products slows. A priori a plausible expectation would have been a reduction in unique vendors to facilitate more efficient contracting (i.e., negotiate with fewer parties) and/or seek greater standardization across members of the hospital chain. But aligning with the timing of the trend change observed in Figure 4, the number of software vendors spikes by approximately 25% and then remains elevated over the subsequent five years.

Within Figures 6 and 7, we further unpack characteristics of these health IT vendors. Panel A of Figure 6 shows that in 2009, the average HCA hospital sharply increases the number of novel vendors it relies upon across all types of outsourced IT solutions (i.e., these vendors had no prior business dealings with the relevant hospital). The 2009 spike in new IT suppliers is 2- to 3-times the baseline rate. No such trend break is observed among our control group hospitals at any point over our study period. Moreover, in Panel B of Figure 6, there is even suggestive evidence that a subset of these novel vendors to the PE-owned hospitals are also new market entrants for health IT products nationally.[7] Given these previous patterns, the vendors utilized from 2009 and going forward unsurprisingly capture smaller local and national market shares, on average (Figure 7). In combination, these findings reveal an active role for PE owners when it comes to the management and strategy of IT adoption. Additionally, rather than rely more on legacy suppliers, there is greater receptivity to newer and smaller market players, which may offer more favorable terms to the large hospital corporate chain.

D. Hospital Financials

Figure 8 displays the DD event study results for our two key financial metrics of interest: net income (in millions of dollars) and operating margin. Members of the hospital chain, on average, captured $16.7 million in net income, with a 7.8% operating margin, over the 2003-2006 period. Relative to controls, both financial metrics improved under private equity ownership, and the better

[7] Of note, other research likewise finds that PE firms refrained from more dealmaking and focused more on the management of their existing portfolio companies in the midst of the global financial crisis (Bernstein, Lerner, and Mezzanotti 2019), which is at least consistent with our collection of DD and descriptive results in Section VC.

financial performance sustained beyond private equity's divestment. The average affected hospital benefits from $10-20 million in higher net income and an operating margin improved by 4-6 percentage points. Relative to the pre-period averages, net income is approximately doubled, on average, while the operating margin is increased by roughly 50-75% over baseline. The timing of the differential changes observed in Figure 8 also align with the documented efforts to control labor and physical capital cost growth in Sections VB and VC.

VI. Heterogeneity

A. Estimation Approach

Our final empirical exercises revisit our main findings in Section V to test for heterogeneity in the hospital-level responses to PE ownership. We focus these supplementary analyses on the baseline (i.e., 2006) market position of a given HCA hospital belonging to our treatment group. For each hospital market (i.e., Hospital Referral Region: HRR) containing one or more treatment hospitals, we calculate HCA's share of the total available inpatient beds within the market as well as its share of total acute care inpatient facilities in the market using the AHA data. The resulting geographic variables aim to proxy for chain members' potential market strength vis-à-vis local competitors. When HCA controls a larger fraction of the available beds and/or facilities, a more dominant position seems plausible for its local hospitals, at least in comparison to HCA hospitals located within HRRs with a weaker HCA presence in terms of available capacity and inpatient facility density. In turn, PE managers could preferentially target certain chain members for bespoke strategy and operational interventions based on the hospitals' underlying market positions, rather than pursuing a standardized approach across the entire hospital chain. A comparatively stronger market position could also confer greater bargaining leverage with local labor (e.g., nurses) and suppliers (e.g., health IT vendors), which could make feasible or amplify certain PE tactics devoted to these margins.

Figure 9 displays the distribution of these market characteristics among our treatment group hospitals from Section V. HCA hospitals typically compete in markets where the chain captures 10-30% of available inpatient beds and 10-20% of available facilities. We subsequently create indicators for being below the median for each of the two geographic variables, respectively, and while the resulting two indicators are related, they are not perfectly correlated ($\rho = 0.6$).

Since these variables are inherently tied to hospital markets where HCA is present, they have no relevance to our controls, which were selected to be out-of-market by design (see Section IV). Thus, we cannot rely on triple differences estimation and instead need to implement the standard DD approach twice for each outcome of interest. The first instance will only include HCA hospitals in the treatment group that fall below the median in their baseline (2006) market position. The second iteration will restrict the treatment group hospitals to all remaining chain members (i.e., the hospitals excluded from the first estimation). The control hospitals are identical for both versions of the DD. We then qualitatively compare the resulting DD patterns across the two, mutually exclusive treatment groups to see if our overall findings from Section V are appreciably driven by either subset of HCA hospitals based on their respective market positions prior to the PE transaction.

Our estimating equation follows the standard and parsimonious "2x2" DD setup when there is no variation in treatment timing. We also pool the PE investment and divestment periods into a single post-period since the effects we observed for our key outcomes of interest all persisted beyond the IPO (see Section V). The accompanying equation is as follows:

$$Y_{ht} = \alpha_h + \gamma\, Post_t + \delta(Treated_h \times Post_t) + \varepsilon_{ht} \quad (2)$$

We include hospital fixed effects (α) just as before, and cluster the standard errors at the hospital level. The *Treated* variable has the same definition as Equation (1). The *Post* variable is equal to one for the year 2007 and thereafter. It is zero otherwise.

B. Findings

Table 4 reexamines our hospital throughput measures as well as revenue flows when stratifying the treatment group hospitals as described in Section VIA. Whether the demarcation is based on percent of beds or percent of facilities, HCA hospitals are generating more hospital stays and accruing greater revenues after coming under PE ownership—irrespective of baseline market position. The DD estimates are all substantive in magnitude and statistically significant in Panel (a) and Panel (b) of Table 4. The 95% confidence intervals are also overlapping when comparing

each column belonging to a given outcome, so there is no clear evidence of a differential impact by pre-PE market position.

There is more suggestive evidence of a heterogeneous impact of PE on labor inputs in Table 5. Columns 1 and 2 in Panel (a) reveal an 8.5% and 11.7% relative decline in full-time workers, respectively, according to the hospitals' pre-PE market conditions. Similarly, in columns 1 and 2 in Panel (b) there is a 5.3% and 15.7% relative reduction in full-time labor inputs for the respective treatment group compositions. The full-time nursing results in Panel (a) and Panel (b) of Table 5 also mirror the findings for the overall hospital workforce. While we cannot strictly rule out that the PE effects are the same across the two versions of DD estimation, there seems at least be a pattern that is consistent with PE managers homing in on certain HCA hospitals to improve operational efficiencies. Moreover, in Table 6, the treatment group hospitals that exist in more HCA-dominated markets seem to drive the overall negative effect on health IT adoption observed in Section V—though an opposite pattern is present for the increase in health IT vendors.[8]

VII. Conclusions

We leverage unique data and a large-scale transaction affecting over 100 US hospitals to further open the "black box" of PE influence on firms' operations and management strategy to drive downstream outcomes. We document that PE reshapes hospitals' operations along several margins, including patient occupancy and throughput, the levels and composition of labor, as well as technological inputs and related business-to-business dealings. These changes eventually lead to improvements in overall hospital financial performance as well. The fact that these effects outlive the PE investment is also of importance and is consistent with the remaining managers embracing successful strategic changes, even when no longer under PE direction. And while some might interpret slowed growth in labor and technology inputs as indicative of perverse behavior, when put into broader context, PE ownership seems to increase the sensitivity and responsiveness to industry norms as well as industry trends when adjusting human and physical capital over time.

[8] Of note, there is no clear indication that HCA hospitals with plausibly stronger market positions have systematically better or worse finances at baseline. The average operating margin over the 2003-2006 period for HCA hospitals stratified into the four treatment subgroups used in Section VI is 7.4%, 8.2%, 8.5%, and 7.1%, respectively. Relatedly, exploring for heterogeneity in hospital behavior under PE ownership according to hospitals' starting financial position (rather than market position) did not yield any additional insights (results available by request).

Specifically, the affected hospitals restrain the size of their full-time workforces, including nurses, as the broader industry faces declining inpatient volumes. In contrast, peer hospitals allow a worsening balance between total Medicare hospital stays—and hence revenues—and their staffing commitments over this period. Likewise, at baseline the hospital chain had 18% more implemented health IT solutions in comparison to peer hospitals (Table 3). Slowing down the upward trajectory of IT adoption ultimately brings the average PE-owned hospital in alignment with the average level of health IT use among industry peers. Taken together, these management changes are not necessarily indicative of excessive short-termism on the part of PE, but instead, could reflect a more disciplined approach to firm-level cost containment. They also seem to translate to improved key financial performance indicators, such as net income as well as operating margin for the hospital.

Our findings also complement PE studies outside of the healthcare sector, which comprise an evolving and expanding literature. Specifically, recent work has found mixed evidence of the effects of PE ownership on outcomes tied to operational efficiency and firm performance across various industries. For example, PE appears to lower safety and health code violations as well as injury rates within the restaurant industry (Bernstein and Sheen 2016; Cohn, Nestroiak, and Wardlaw 2021). Yet, nursing home patient mortality climbs under PE direction, and students have worse labor market outcomes when graduating from PE-backed higher education institutions (Gupta *et al*. 2023; Eaton, Howell, and Yannelis 2020). The commonalities as well as departures in findings across studies and industries points to the importance of understanding the implications of PE tied to particular industries and market contexts.

More generally, our collection of results suggests that there is not a one-size-fits-all playbook imposed by all PE acquisitions, even within industries from the same sector of the economy. Managerial and operational changes are likely tailored to the targeted firm(s)—and perhaps even specific to differing market conditions when an acquisition involves a large geographic footprint. These nuanced approaches can also have varied long-run implications. Attempts for bespoke healthcare policy or regulatory interventions focused solely on PE should first consider the existing heterogeneity in estimated PE effects within the healthcare sector, and second, consider if PE owners' observed actions diverge from what would be expected by other owners taking into account existing business opportunities as well as challenges.

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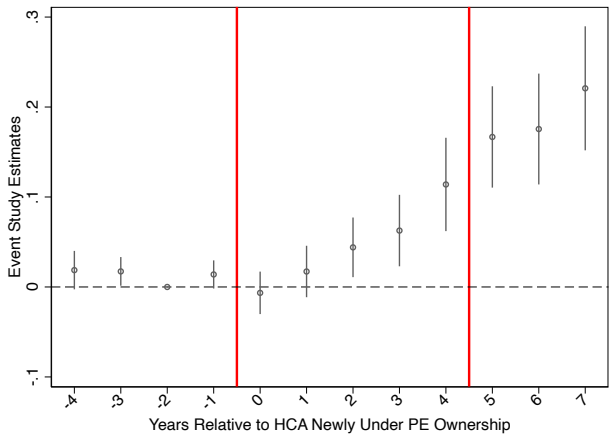
MAIN RESULTS

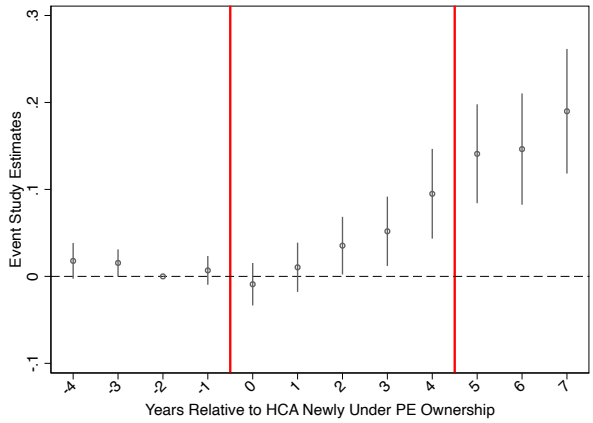
TABLE 1
Annual Summary Statistics for Hospitals 2003-2005

	Treatment Group Hospitals	Control Group Hospitals
	Mean (SD)	Mean (SD)
No. of Hospital Stays	4,195.3 (2,676.1)	4,201.2 (3,563.6)
No. of Unique Beneficiaries Hospitalized	2,588.4 (1,648.1)	2,570.2 (2,113.5)
Medicare Inpatient Revenues ($millions)	35.5 (25.8)	39.6 (44.2)
Length of Stay	5.4 (0.8)	5.1 (1.0)
% Female	57.7 (5.5)	57.4 (4.6)
% White	84.3 (12.8)	83.8 (18.9)
Age	73.7 (2.9)	74.2 (2.8)
30-day Mortality Rate	0.08 (0.02)	0.08 (0.02)
60-day Mortality Rate	0.11 (0.02)	0.12 (0.02)
90-day Mortality Rate	0.14 (0.03)	0.14 (0.03)
Number of Hospitals	122	876

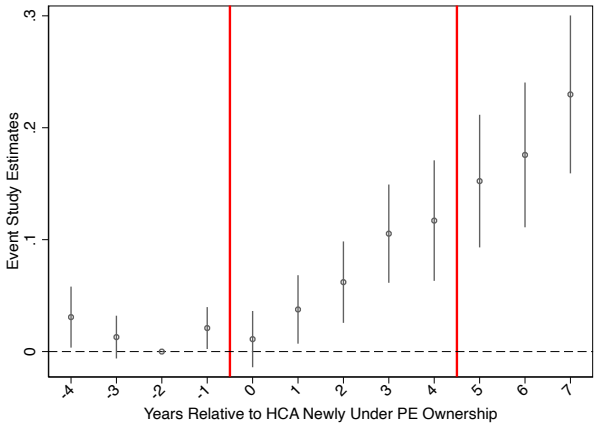
Notes: Data are from 100% inpatient Medicare claims 2003 through 2005.



(a) Number of Hospital Stays (in logs)



(b) Number of Unique Medicare Beneficiaries Hospitalized (in logs)



(c) Hospitalization Revenues (in logs)

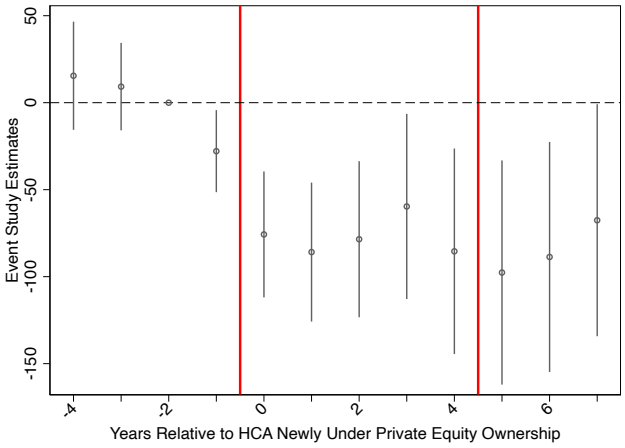
FIG 1—PE Effects on Hospitalization Throughput and Revenues

Notes: Analytic data derived from 100% Medicare inpatient claims. Estimation using Equation (1).

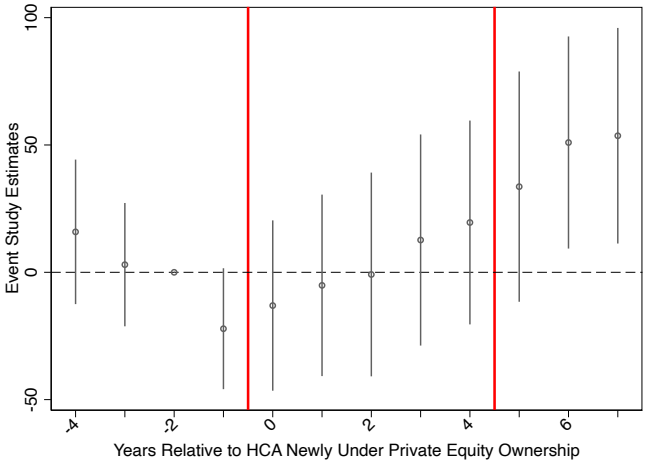
TABLE 2
Annual Summary Statistics for Hospitals 2003-2006

	Treatment Group Hospitals	Control Group Hospitals
	Mean (SD)	Mean (SD)
Full-Time Employees	778.1 (477.8)	1,170.7 (1,425.1)
Part-Time Employees	192.5 (163.0)	486.4 (528.2)
Full-Time Nurses	281.4 (183.6)	302.7 (341.6)
Part-Time Nurses	82.5 (75.2)	180.9 (214.6)
Full-Time RNs	253.8 (171.6)	277.2 (325.4)
Full-Time LPNs	27.6 (20.5)	25.6 (30.4)
Part-Time RNs	76.0 (71.8)	168.6 (206.8)
Part-Time LPNs	6.6 (6.5)	12.3 (16.3)
Number of Hospitals	120	866

Notes: Data are from AHA survey data 2003 through 2006.



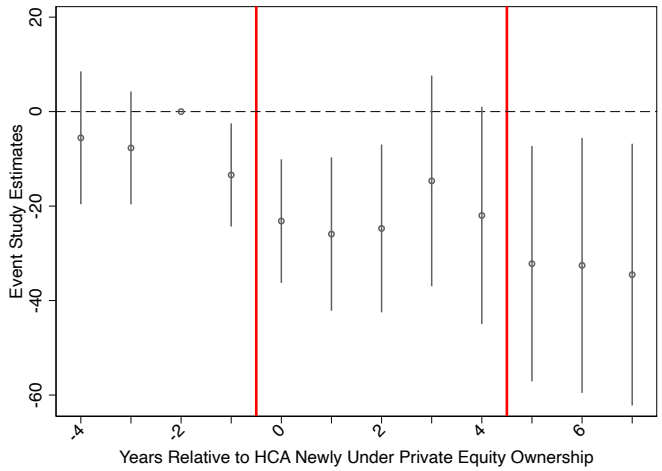
(a) Full-Time Workers



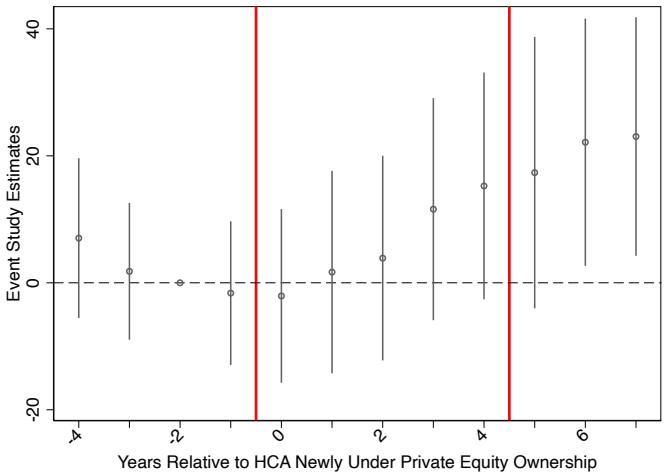
(b) Part-Time Workers

FIG 2—PE Effects on Hospital Employment

Notes: Analytic data derived from AHA annual surveys. Estimation using Equation (1).



(a) Full-Time Nurses



(b) Part-Time Nurses

FIG 3—PE Effects on Hospital Employment of Nurse Labor

Notes: Analytic data derived from AHA annual surveys. Estimation using Equation (1).

TABLE 3
Annual Summary Statistics for Hospitals 2002-2006

	Treatment Group Hospitals	Control Group Hospitals
	Mean (SD)	Mean (SD)
No. of Implemented Health IT Solutions	44.2 (8.9)	37.4 (11.7)
No. of Health IT Vendors	9.8 (2.1)	10.8 (4.2)
Number of Hospitals	118	824

Notes: Data are from HIMSS survey data 2002 through 2006.

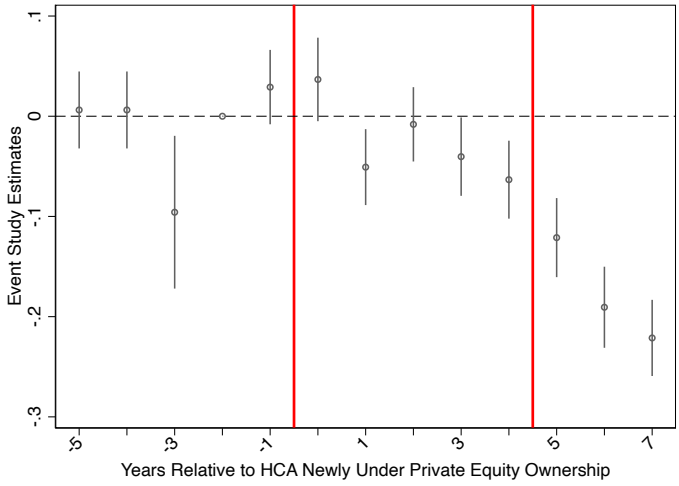


FIG 4—PE Effects on the Number of Health IT Solutions Implemented (in logs)

Notes: Analytic data derived from HIMSS annual surveys. Estimation using Equation (1).

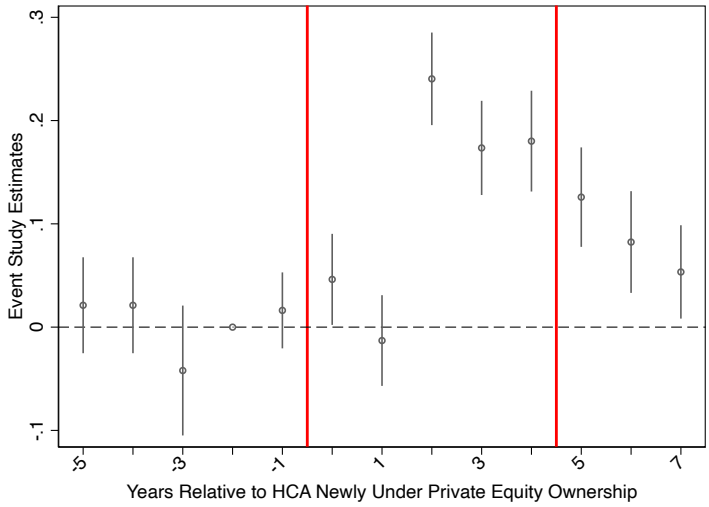
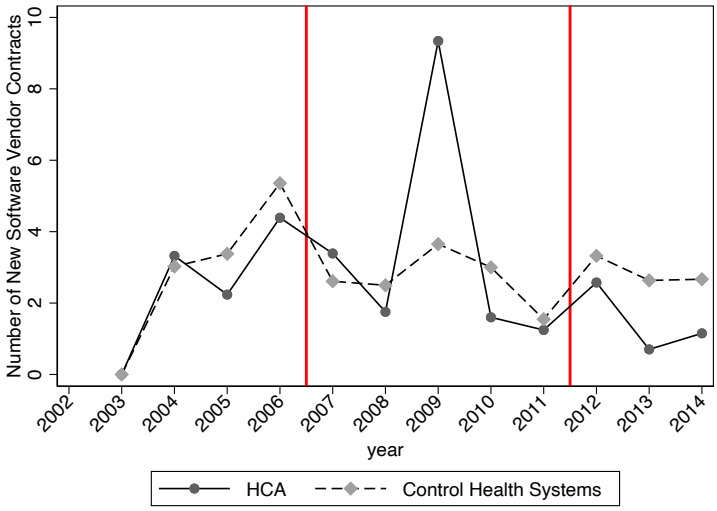
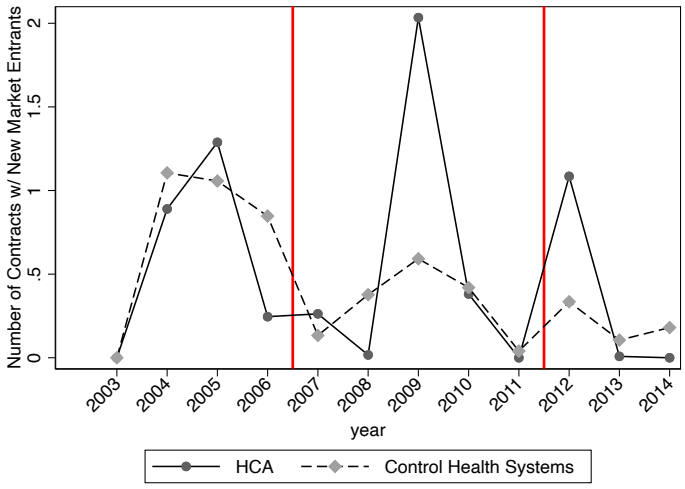


FIG 5—PE Effect on Number of Health IT Vendors Utilized

Notes: Analytic data derived from HIMSS annual surveys. Estimation using Equation (1).



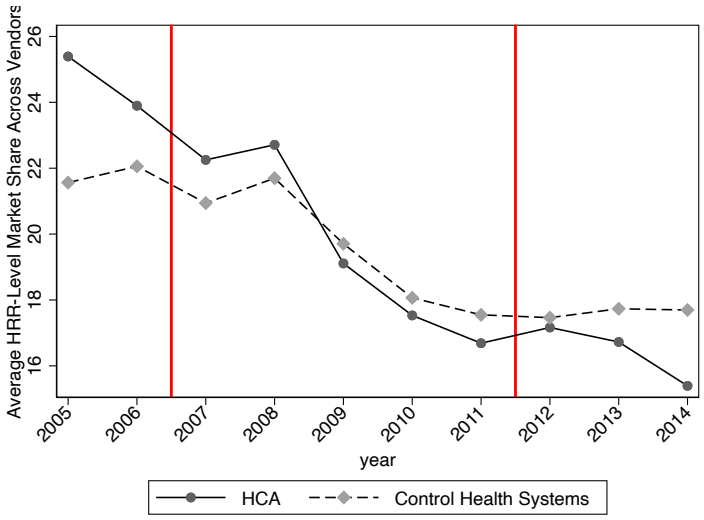
(a) Number of Novel Vendors



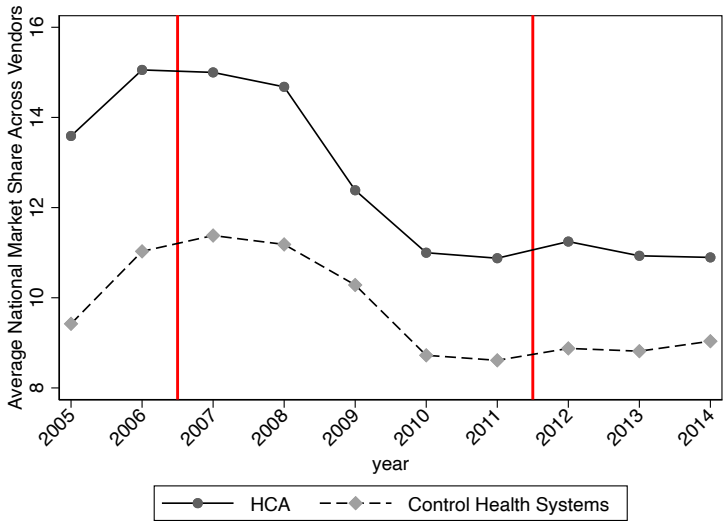
(b) Number of Novel Vendors that Are New Market Entrants

FIG 6—Trends in Health IT Vendor Contracting 2003-2014

Notes: Analytic data derived from HIMSS annual surveys.



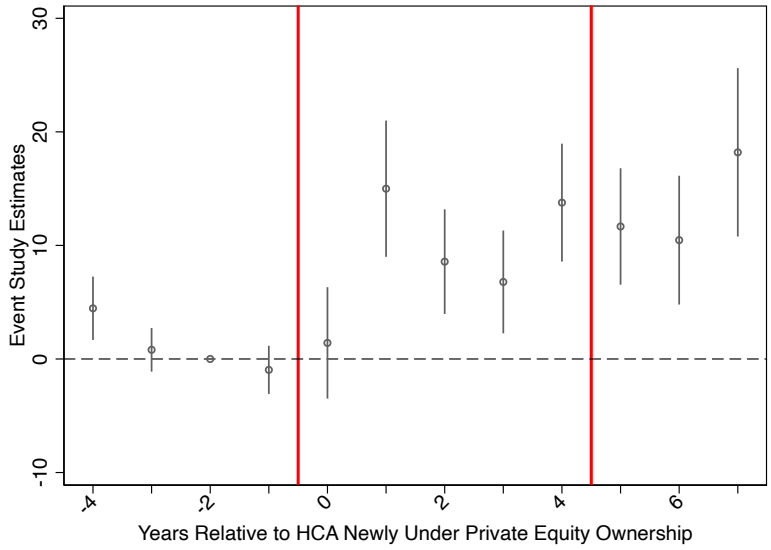
(a) Average Vendor Local Market Share



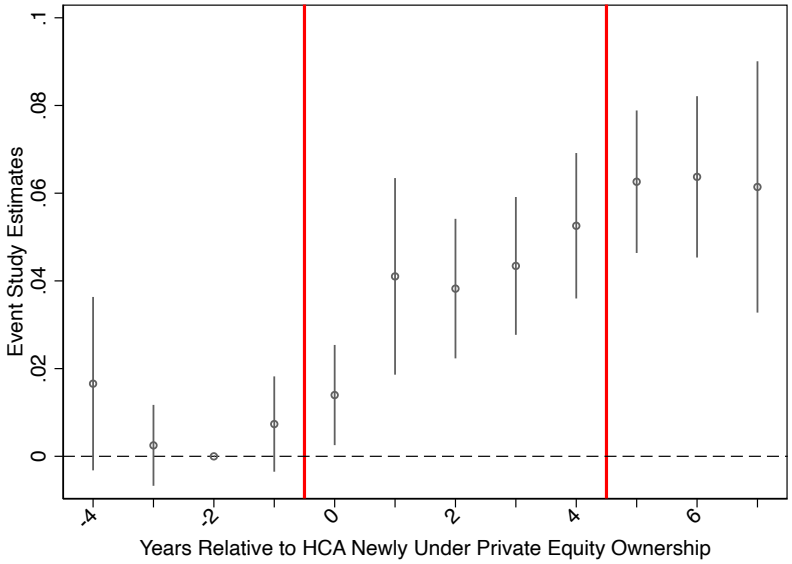
(b) Average Vendor National Market Share

FIG 7—Trends in Health IT Contracted Vendors' Market Shares 2003-2014

Notes: Analytic data derived from HIMSS annual surveys.



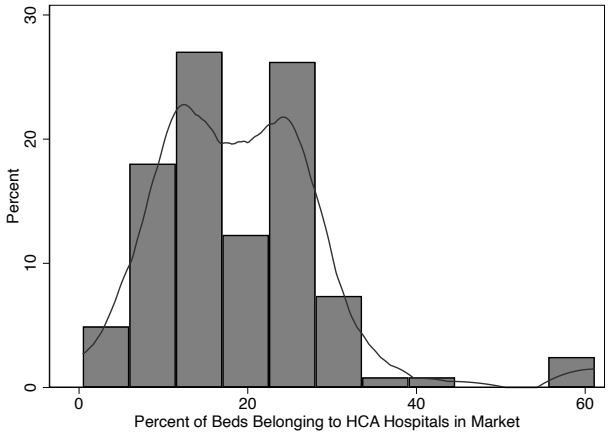
(a) Net Income (nominal millions of dollars)



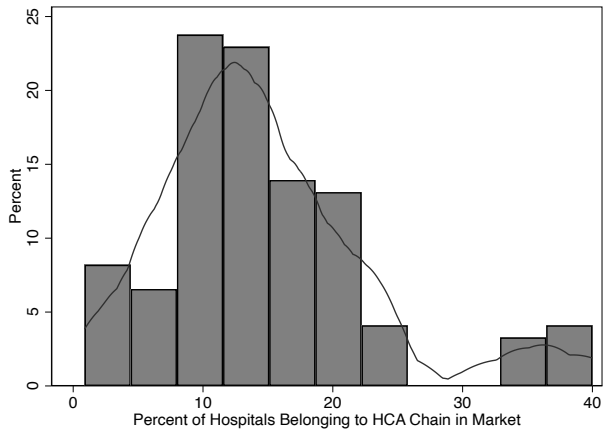
(b) Operating Margin

FIG 8—PE Effects on Hospital Financial Metrics

Notes: Analytic data derived from HCRIS. Estimation using Equation (1). HCA hospitals had $16.7 million of net income (nominal dollars) and a 7.8% operating margin, on average, over the 2003-2006 period.



(a) Percent of Market's Total Beds HCA Owned



(b) Percent of Market's Total Hospitals HCA Owned

FIG 9—Distribution of HCA Market Positions in 2006

Notes: Restricts to HCA hospitals belonging to our main analytic sample. Markets are defined as Hospital Referral Regions (HRRs), and the 2006 AHA data are used to calculate the percent of total hospital beds and percent of total hospitals within each HRR.

TABLE 4
Heterogeneity in PE Effects on Volume and Revenues by Treatment Group Hospitals' Baseline Market Position

PANEL A: Stratifying Treatment Group Hospitals by Share of Local Market Beds

	Hospital Stays (in logs)		**Unique Beneficiaries (in logs)**		**Revenues (in logs)**	
	Below Median %Beds	Above Median %Beds	Below Median %Beds	Above Median %Beds	Below Median %Beds	Above Median %Beds
	(1)	(2)	(3)	(4)	(5)	(6)
Treated x Post	0.098***	0.076***	0.080***	0.065**	0.123***	0.067**
	(0.025)	(0.028)	(0.025)	(0.028)	(0.029)	(0.031)
Hospital FE	Yes	Yes	Yes	Yes	Yes	Yes
Unique Hospitals	937	937	937	937	937	937
Observations (N)	11,244	11,244	11,244	11,244	11,244	11,244

PANEL B: Stratifying Treatment Group Hospitals by Share of Local Market Hospitals

	Hospital Stays (in logs)		**Unique Beneficiaries (in logs)**		**Revenues (in logs)**	
	Below Median %Hospitals	Above Median % Hospitals	Below Median % Hospitals	Above Median % Hospitals	Below Median % Hospitals	Above Median % Hospitals
	(1)	(2)	(3)	(4)	(5)	(6)
Treated x Post	0.111***	0.062**	0.093***	0.052*	0.132***	0.058*
	(0.025)	(0.028)	(0.024)	(0.028)	(0.028)	(0.031)
Hospital FE	Yes	Yes	Yes	Yes	Yes	Yes
Unique Hospitals	937	937	937	937	937	937
Observations (N)	11,244	11,244	11,244	11,244	11,244	11,244

Notes: 'Post' takes the value of 1 in the year 2007 and beyond, which subsequently pools the PE investment and divestment periods. Standard errors clustered at the hospital level. *** P value at 0.01 ** P value at 0.05 * P value at 0.10.

TABLE 5
Heterogeneity in PE Effects on Labor Inputs by Treatment Group Hospitals' Baseline Market Position

PANEL A: Stratifying Treatment Group Hospitals by Share of Local Market Beds

	Full-Time Workers		**Part-Time Workers**		**Full-Time Nurses**		**Part-Time Nurses**	
	Below Median %Beds	Above Median %Beds	Below Median %Beds	Above Median %Beds	Below Median %Beds	Above Median %Beds	Below Median %Beds	Above Median %Beds
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Treated x Post	–64.3***	–93.9***	18.3	21.2	–10.5	–28.6**	11.3	8.3
	(23.1)	(29.4)	(15.6)	(20.6)	(11.0)	(11.6)	(7.1)	(8.8)
Hospital FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Unique Hospitals	926	926	926	926	926	926	926	926
Observations (N)	11,112	11,112	11,112	11,112	11,112	11,112	11,112	11,112
Pre-Period Treated Mean	752.3	803.9	169.3	215.7	270.7	292.1	75.6	92.5

PANEL B: Stratifying Treatment Group Hospitals by Share of Local Market Hospitals

	Full-Time Workers		**Part-Time Workers**		**Full-Time Nurses**		**Part-Time Nurses**	
	Below Median %Hospitals	Above Median % Hospitals	Below Median % Hospitals	Above Median % Hospitals	Below Median % Hospitals	Above Median % Hospitals	Below Median % Hospitals	Above Median % Hospitals
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Treated x Post	–45.1*	–111.9***	9.5	29.7	0.6	–39.0***	8.1	11.4
	(25.5)	(26.7)	(17.6)	(19.0)	(11.3)	(10.8)	(7.9)	(8.1)
Hospital FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Unique Hospitals	925	927	925	927	925	927	925	927
Observations (N)	11,100	11,124	11,100	11,124	11,100	11,124	11,100	11,124
Pre-Period Treated Mean	846.4	712.0	188.3	196.6	307.8	255.8	80.9	84.1

Notes: 'Post' takes the value of 1 in the year 2007 and beyond, which subsequently pools the PE investment and divestment periods. Standard errors clustered at the hospital level. *** P value at 0.01 ** P value at 0.05 * P value at 0.10.

TABLE 6
Heterogeneity in PE Effects on Health Information Technology Inputs and Contracting by Treatment Group Hospitals' Baseline Market Position

PANEL A: Stratifying Treatment Group Hospitals by Share of Local Market Beds

	No. Health IT Solutions		**No. Health IT Vendors**	
	Below Median %Beds	Above Median %Beds	Below Median %Beds	Above Median %Beds
	(1)	(2)	(3)	(4)
Treated x Post	–0.38	–1.75**	2.38***	0.93***
	(0.82)	(0.72)	(0.42)	(0.35)
Hospital FE	Yes	Yes	Yes	Yes
Unique Hospitals	883	883	883	883
Observations (N)	11,479	11,479	11,479	11,479
Pre-Period Treated Mean	43.5	44.9	9.7	10.0

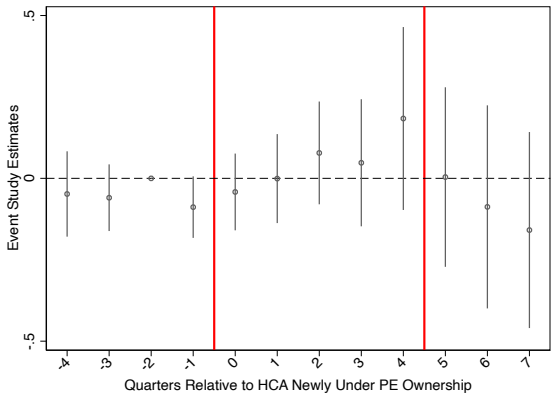
PANEL B: Stratifying Treatment Group Hospitals by Share of Local Market Hospitals

	No. Health IT Solutions		**No. Health IT Vendors**	
	Below Median % Hospitals	Above Median % Hospitals	Below Median % Hospitals	Above Median % Hospitals
	(1)	(2)	(3)	(4)
Treated x Post	0.77	–2.90***	2.75***	0.56*
	(0.81)	(0.66)	(0.43)	(0.31)
Hospital FE	Yes	Yes	Yes	Yes
Unique Hospitals	883	883	883	883
Observations (N)	11,479	11,479	11,479	11,479
Pre-Period Treated Mean	43.7	44.8	9.7	9.9

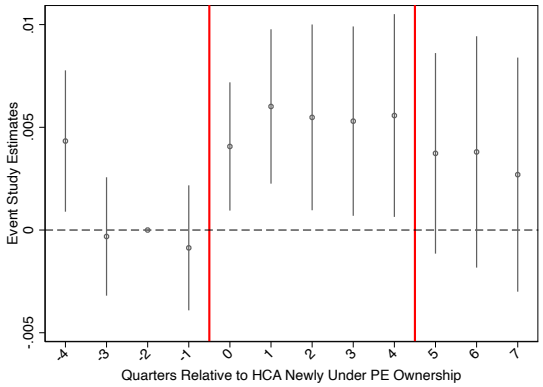
Notes: 'Post' takes the value of 1 in the year 2007 and beyond, which subsequently pools the PE investment and divestment periods. Standard errors clustered at the hospital level. *** P value at 0.01 ** P value at 0.05 * P value at 0.10.

Appendix

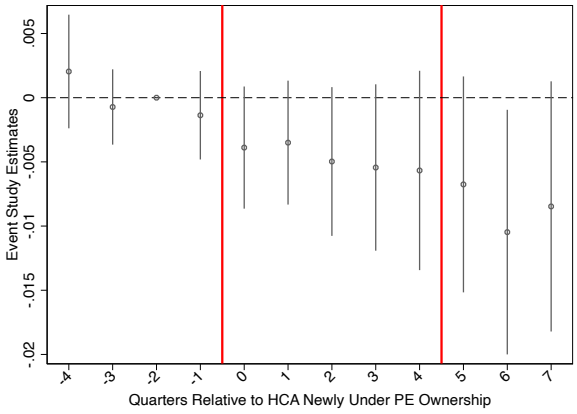
Appendix Figure 1: PE Effects on Medicare Patient Mix



(a) Average Age

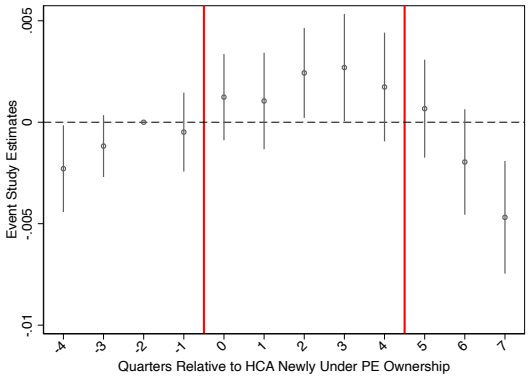


(b) Percent Female

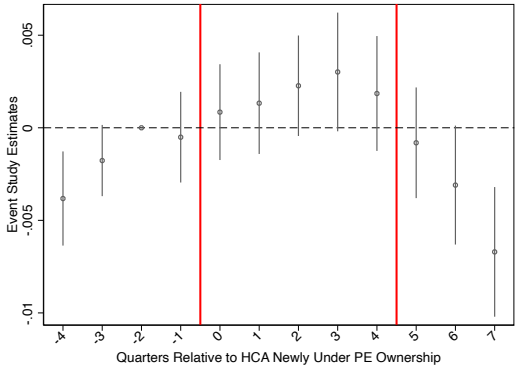


(c) Percent White

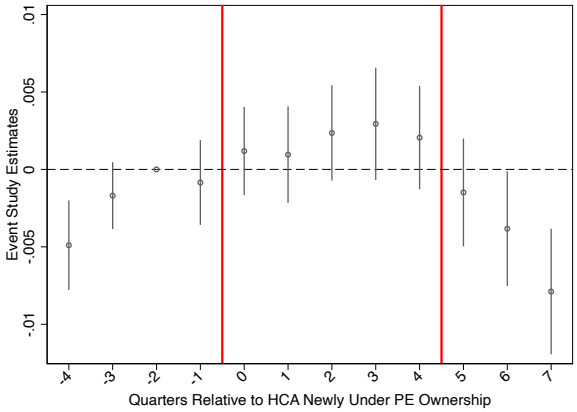
Appendix Figure 2: PE Effects on Hospitalized Medicare Beneficiary Mortality



(a) 30-day Mortality

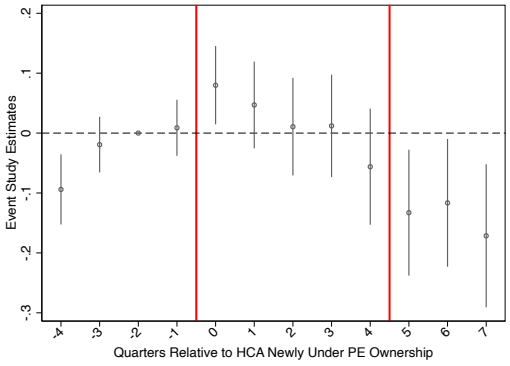


(b) 60-day Mortality

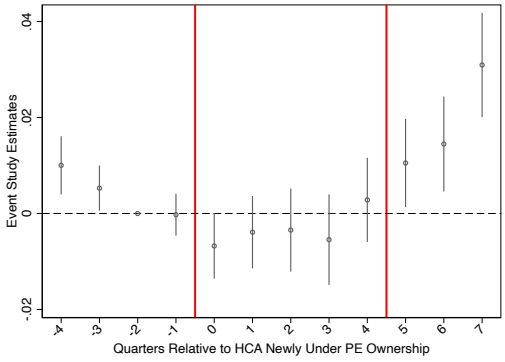


(c) 90-day Mortality

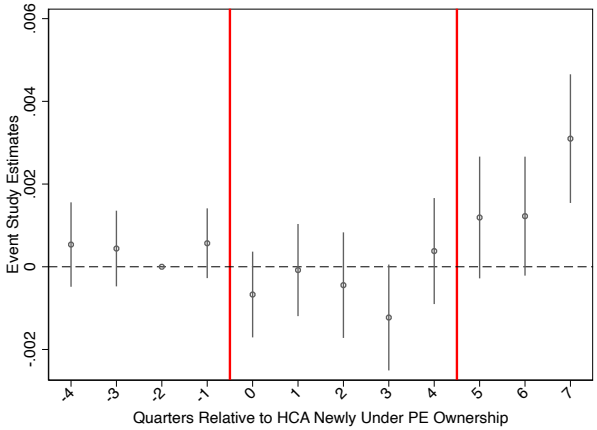
Appendix Figure 3: PE Effects on Length of Stay Outcomes



(a) Average Length of Stay (LOS)

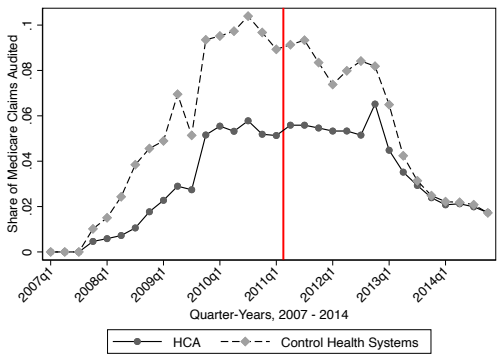


(b) Share Short Stays (<=2 days)

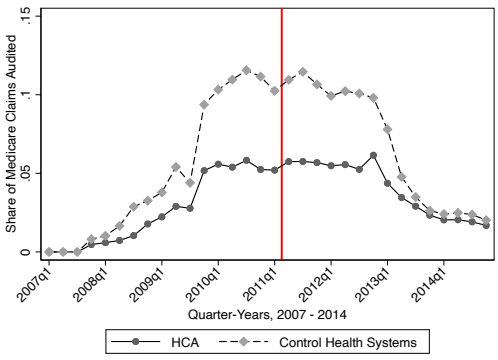


(c) Share Same-Day Discharge

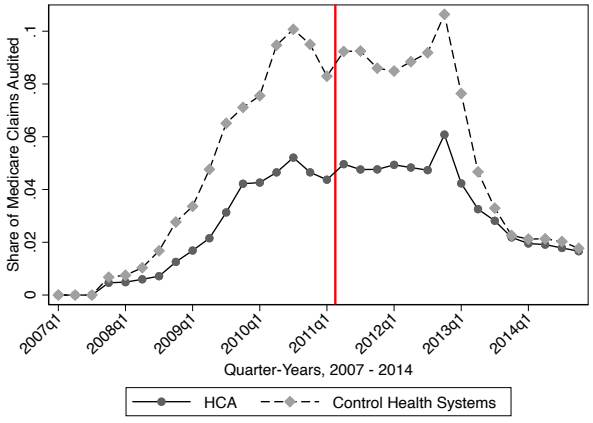
Appendix Figure 4: Trends in CMS Audit Rates for Short Stay Hospitalizations by Treated/Control Status



(a) All Regions

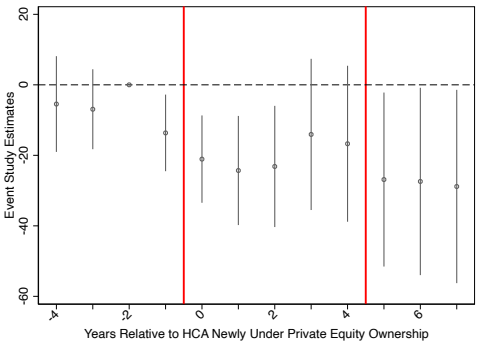


(b) Regions C + D

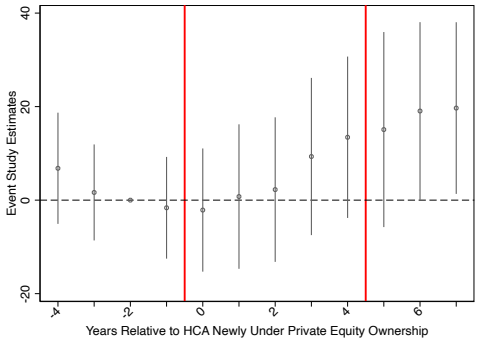


(c) Region C Only

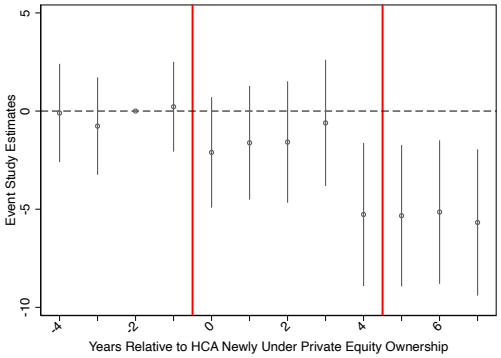
Appendix Figure 5: PE Effects on Hospital Nursing Employment



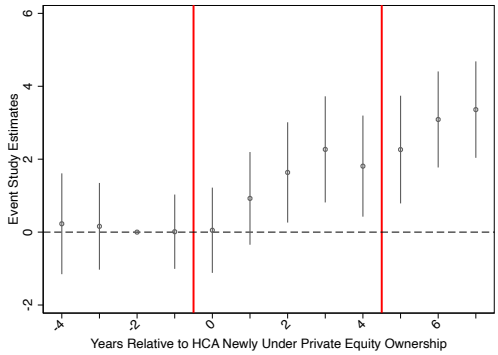
(a) Full-Time RNs



(b) Part-Time RNs



(c) Full-Time LPNs



(d) Part-Time LPNs