THE TOPICS IN COMMON OWNERSHIP

AN ABSTRACT

SUBMITTED ON THE TENTH DAY OF APRIL 2020

TO THE DEPARTMENT OF ECONOMICS

IN PARTIAL FULFILLMENT OF THE REQUIREMENTS

OF THE SCHOOL OF LIBERAL ARTS

OF TULANE UNIVERSITY

FOR THE DEGREE

OF

DOCTOR OF PHILOSOPHY

BY

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Abstract

In this dissertation, I study the topics in common ownership. My dissertation includes three chapters. First chapter studies the effect of common ownership on hospital prices; Second paper studies the effect of common ownership hospital product-mix strategies; Third paper studies the effect of common ownership on gasoline prices. The definition of common ownership is: In one industry, a few large institutional investors commonly own large amount of stock shares in many publicly traded firms. I collect datasets from Medicare and Medicaid cost report, 13-F statement from Wharton Research Data Services, American Hospital Association, and Energy Information Administration. Then, I apply multiple empirical methods to analyze the impact of common ownership on market competition and market prices. My empirical results show three conclusions. First, the rise of common ownership has caused higher hospital prices; Second, hospitals react to common ownership by reconfiguring their services towards high profit services; Third, common ownership among oil refinery firms has caused higher gasoline prices. My results support the theory of common ownership and suggest anti-trust policy makers to pay attention to the common ownership issues.

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Chapter 1

Players Behind the Scenes: Common Ownership in the Hospital Industry

1.1 Introduction

1.1.1 Institutional investors

Since 2000, investors have been purchasing large portions of publicly traded firms' outstanding shares of stocks, especially for the "big three" (BlackRock, Vanguard, and State Street). According to Backus et al. (2019), the "big three" owned an average of 6% of the $S\&P$ 500 in 2000, and the percentage increased to 21% in 2017. These investors are called "institutional investors" in general. Specifically, they include mutual fund managers such as Fidelity, index funds such as Vanguard, and exchange-trade funds such as BlackRock and StateStreet. This phenomenon raises severe concerns of anticompetitive behaviors by publicly traded firms. In traditional industrial organization theories, we measure the market concentration by measuring the number of firms and their market shares. However, the rise of institutional investors makes scholars and lawyers worry about a new antitrust phenomenon: If fewer investors own larger portions of stock shares of publically traded firms, especially firms from the same industry, the market may become more concentrated, because these investors become common owners of the competing firms. This could lead to anti-competitive structure, conduct and performance, including raising product prices. This topic has recently been related back to the common ownership theory introduced by Bresnahan and Salop (1986).

The concept of common ownership is very simple. In traditional industrial organization theories, we know firms' goals are to maximize their own profits. When firms offer public shares to institutional investors who own these publicly traded firms, these new owners have new goals, which are to maximize their diversified portfolio profits. This portfolio not only includes one firm, but also includes the other competing firms. Although these institutional investors are adopting passive investment strategies, literature such as Brav et al. (2018) provides evidence that institutional investors have active roles in corporate governance. Hartzell (2003) also provides evidence that the involvement of large institutional investors may affect the relationship between owners and managers. This provides further evidence that institutional investors are "actively" involved in corporate governance.

1.1.2 Oligopolies in Antitrust law

In the U.S. market, highly competitive markets are very difficult to organize into cartels because of the number of competing producers. At the same time, highly concentrated markets are hard to cheat because cheating can be detected through a drop in sales or by discovering price cutting behavior by a competitor. Either action can be punished by reciprocal action. However, competitive oligopoly is widespread. According to Horizontal Merger Guidelines reference "parallel accommodating behavior" section 7, firms in an oligopoly manage to achieve a noncompetitive outcome through legal parallel interdependent behavior: "tacit collusion" or "conscious parallelism". On the other hand, under the Clayton Act section 7, if they achieve the noncompetitive outcome through an agreement, tacit or otherwise, they have violated section 1. The difference between "tacit collusion" and "tacit agreement" is subtle, much litigated, and the subject of continuing debate.

Under common ownership, firms are sufficiently informed and conscious of their competitor's behavior (and recognize that hard competition will be met with a hard response and affect all parties) that they manage successfully to achieve a "soft competition" equilibrium. Since Azar et al. (2018) found that common ownership raises airline prices, scholars and law makers began to call for antitrust laws that clarify the difference between "tacit collusion" and "tacit agreement."

1.1.3 Literature review on common ownership

Azar (2011) first relates the institutional investors' ownerships to the common ownership theory. In his paper, he develops an oligopoly model with shareholding voting: "Instead of assuming that firms maximize profits, the objective function of the firms is decided by majority voting." His model proposes an extreme condition in which all shareholders are diversified, the firms act as if they were owned by a single monopolist. This creates anti-competitive actions at the shareholders' level. In this scenario, although firms are competing at the firm level, their shareholders (owners) become more concentrated. This paper promped many researchers to test this theory.

Most of the literature tests the effects of common ownership on firms' pricing behaviors. Azar et al. (2018) is the most well-known paper on this topic. They test the common ownership theory in the U.S. airline industry: The major U.S. airlines are owned by very few institutional investors, and this concentration at the shareholder level creates market concentration much larger than traditional market power defined by antitrust authorities. This results in higher ticket prices. Specifically, the authors use the combination of two large asset managers as the exogenous shock, and look at the relationship between within-route changes in common ownership concentration and within-route changes in ticket prices. They define a flight route (for example, Boston to Chicago) as a local market, and define different carriers (for example, United Airlines, American Airlines, etc.) as competing firms. They find strong evidence that higher common ownership concentration increases ticket prices at the route (market) level. These results lead me to study common ownership in the hospital industry.

Other literature also finds evidence in the relationship between common ownership and product prices. Azar et al. (2016) uses the growth of index funds as an arguably exogenous source of cross-sectional variation of county-level common ownership growth to suggest a causal link between common ownership and higher prices for banking products. Gramlich et al. (2017) examine the impacts of common ownership on bank rates and fees for various financial products and quantity of bank deposits.

Scholars have also studied the common ownership effects on other outcomes. Anton et al. (2018) find positive effects of common ownership on firms' innovation. Specifically, they find that common ownership of within-industry competitors can increase incentives to innovate when technological spillovers are relatively larger than the distances of firms to the product market. Therefore, technological spillovers to competitors under the common ownership make it easier and less expensive to innovate. Cici et al. (2015) find that "borrowers and lenders that are commonly held by an institutional blockholder tended to do more business together going forward than those that are not commonly held." He et al. (2017) find that commonly held firms experience significantly higher market share growth than non-commonly-held firms. Their evidence indicates that common ownership by institutional blockholders offers strategic benefits by fostering product market coordination, such as within-industry joint ventures, strategic alliances, or within-industry acquisitions. Kwon (2016) finds that institutional investors with common ownership exert a strong influence on executive compensation in a positive way. Specifically, executives receive more rewards for outperforming peer firms if common ownership concentration increases.

Institutional investors affect product prices is through three channels: votes, managers' incentives, and doing nothing. Of course, institutional investors do not directly affect product prices; they affect firms' competitive strategies through these channels, and prices are in turn affected by firms' competitive strategies. The competitive strategies include expanding a firm's market share, developing $R\&D$, etc. More specifically, institutional investors affect firms' competitive strategies by affecting firms' directors.

Common ownership could affect product prices through institutional investors' voting power on firms' competitive strategies. Aggarwal, Dahiya and Prabhala (2013) used an event study of an uncontested director election to show that shareholders' votes can bring about changes in corporate governance and firm policy. More specifically, shareholders do not directly vote on competitive strategies; rather, they vote on director candidates. According to Charan, Useem, and Carey (2015), "boards now routinely vet director candidates with major shareholders before their names are placed on the proxy." Furthermore, Fos and Tsoutsoura (2014) showed empirically that director elections matter because of directors' career concerns.

Institutional investors also affect corporate strategic product market competition through top management incentives. Anton, Ederer, Gine, and Schmalz (2016) found that "Institutional investors aim to maximize the value of their entire stock portfolio, rather than the performance of individual firms within that portfolio. Because fierce competition between portfolio firms reduces the value of the entire portfolio, it is in the asset managers' interest to structure executive pay in such a way that managers have weakened incentives to compete aggressively against their industry rivals." Specifically, they showed that executives are paid less for their own firm's performance and more for their rival's performance if an industry's firms are more commonly owned by the same set of investors. Meanwhile, Melby and Ritcey (2016) and Melin (2016) found that "institutional investors claim to address the structure of management pay in 45% of engagement meetings, and this results in incentives that are often much less sensitive to relative performance than other investors' demand." In conclusion, a lack of relative performance incentives gives managers reduced incentives to compete.

Doing nothing can also be a mechanism by which common ownership causes higher prices. Once firms decide to increase market shares, costly managerial efforts are required. For example, attracting new customers might require $R\&D$, and entering new markets may require unpleasant price wars with incumbents. If investors are passive and lazy, they may not insist on implementing such expansion strategies. Therefore, Azar et al. (2018) describes firm managers under common ownership as "the omission on behalf of large diversified mutual fund families to push portfolio firms to compete aggressively against each other." Elhauge (2015) also found that antitrust law explicitly recognizes that taking no action is a sufficient mechanism to implement anticompetitive outcomes.

At the same time, some literature shows evidence against the common ownership theory. After Azar, Schamlz and Tecu's paper (AST) started the debate of common ownership, some following literature proposed conflicting evidence. For example, Kennedy, O'Brien, Song, and Waehrer (2017) replicated the AST paper but replaced the measure of common ownership with common ownership incentive terms, and they found no evidence that common ownership raises prices. Edmans, Levit, and Reilly (2018) showed that governance through both voice (monitoring) and exit (the sale of assets) can strengthen rather than weaken corporate governance. This refutes the mechanism that institutional investors affect product prices by affecting firms' competitive strategies.

There are two further concerns toward the common ownership theory. First, how powerful are common owners (COs) compared to non-common owners (NCOs)? Second, what level of ownership is required for owners to be influential? Rock and Rubinfeld (2018) discussed this issue by using legal analysis. First, COs will have access to management of each firm in the industry through earnings calls, investor meetings, etc. Second, COs will have better incentives in influencing decision-making with respect to the determination of both overall price/output and individual firm price/output than the NCOs, and in monitoring that determination. Third, Because of the COs' knowledge and incentives, the firms are more likely to accept the COs' determination of price and output. Lastly, COs will be better able to punish uncooperative managers directly, by voting no on say on pay, or by voting no in director elections.

Common ownership at low levels is pervasive. Institutional investors such as BlackRock, Vanguard, and State Street each owns 5-7% of most public companies. However, Rock and Rubinfeld (2018) used legal analysis and found that although common ownership level is low, common owners still have incentives to raise prices than non-common owners.

1.1.4 Why the hospital industry?

There are two types of hospitals in the United States: for-profit hospitals and non-profit hospitals. According to the American Hospital Association (AHA), there are currently $6,210$ hospitals in the U.S. $1,322$ of which are for-profit hospitals. In this paper, I focus only on for-profit hospitals. The for-profit hospitals are owned by companies called health systems. Some large health systems such as HCA, Health South, and others, offer public stocks. Some large institutional investors invest in these health systems and thus become common owners of some health systems. Since these health systems own many for-profit hospitals in the U.S., the institutional investors become the indirect owners of these hospitals. This institutional investor-health system-hospital channel constitutes my hypothesis: The increase of market concentration caused by common ownership at the health system level will cause hospital prices to rise. Tables 3.20 and 3.21 show the statistics of publicly traded health systems owned by some large institutional investors. Table 3.20 shows the top six blockholders for six large health systems. We can see that BlackRock, Vanguard, and Fidelity are top blockholders in most of these health systems. In Table 3.21, I pick five large institutional investors in the hospital industry and divide their investments in the hospital industry into percentage holdings for each health system. For example, BlackRock invests 27% of their total hospital industry investments into THC and 9% into SEM. This table shows that THC, SEM, HLS and UHS are BlackRock's preferred stocks in the hospital industry. In my analysis, I will study 12 publicly traded health systems: HCA, Health South (now called Encompass Health), Community Health Systems, Kindred Healthcare, Lifepoint Health Inc., Select Medical, Tenet Healthcare, Universal Health Service, Health Management Associates, Psychiatric Solutions, RehabCare Group, and Vanguard Health System.

There are more nonprofit hospitals than for-profit hospitals. In this paper, I examine the effects of common ownership concentration on for-profit hospitals prices. I consider the behavior of nonprofit hospitals and patient flows across the two types of hospitals when there is an increase in price among the for-profit hospitals. In other words, if for-profit hospitals raise their prices because of common ownership, how do nonprofit hospitals in the same region respond? Ultimately, their behaviors lead to potential patient flows either across different types of hospitals, or across regions. In this paper, I solve this concern by citing previous literature and providing empirical strategies.

A paper by Melnick et. al. (1999) reviews empirical evidence suggesting that mergers of hospitals that reduce competition will lead to price increases at both merging hospitals and their competitors, regardless of ownership status. It illustrates that anticompetitive behaviors of some hospitals in the market would affect the market equilibrium price of the whole market. In my paper, the anticompetitive behaviors are caused by the common ownership among for-profit hospitals in the market. According to the Melnick et. al. (1999), this will result in a price increase in the whole market, which consists of both for-profit hospitals and non-profit hospitals. Thus, there is no need to worry that patients flow from for-profit hospitals to nonprofit hospitals in the context of common ownership market concentration.

The next concern is whether patients flow to other regions if the market price increases. According to Tenn (2011), "based on patient flow data, one might conclude that consumers could turn to many other hospitals for care." However, the author analyzes the hospital mergers in the Oakland-Berkeley region of the San Francisco Bay Area and finds that travel costs are high enough to prevent patient flow to other regions. As a result, the presence of other hospitals does not prevent an anticompetitive price increase.

Empirically, I include the region fixed effect in my regressions, which can capture the variations of hospital prices caused by patient flow to other regions. Moreover, I calculate the ratio of non-profit hospital discharges divided by for-profit hospital discharges in each region and in each year from 2005 to 2015, then include this ratio as a control variable in my regressions. This variable will control the variations of hospital prices caused by patient flow from for-profit hospitals to nonprofit hospitals in the same region. In summary, the mean of this ratio is 33.04, and the standard deviation is 103.72.

Therefore, previous literature in hospital consolidations and my empirical strategies solve the concerns that patients flow out of hospital types or out of regions when prices increase. If I can find any impact of common ownership concentration on hospital prices among for-profit hospitals; at the same time, non-profit hospitals also respond to this price change and the whole market is affected. My findings could proxy for the impacts of common ownership concentration on hospital prices in the whole market.

In the broad literature of common ownership, previous empirical studies have looked at common ownership in the bank industry and the airline industry (Azar et al. 2016; Azar et al. 2018). These studies examined the impact of common ownership on county-level banks' financial product fees and within-route airline ticket prices, respectively. When measuring common ownership at the local market level, they use county level and within-route level as local markets respectively. Following their methodologies, I study the impact of common ownership on hospital prices, and I use the hospital referral regions (HRR) as local markets. The HRR code was invented by the Dartmouth Atlas Project. They define HRR as:

> *Hospital referral regions (HRRs) represent regional health care markets for tertiary medical care. Each HRR contains at least one hospital that performs major cardiovascular procedures and neurosurgery. HRRs were defined by assigning local hospital care markets to the region where the greatest proportion of major cardiovascular procedures were performed, with minor modifications to achieve geographic contiguity, a minimum population size of 120,000, and a high localization index.*
>
> *It is also a collection of ZIP codes whose residents receive most of their hospitalizations from the hospitals in that area. They were defined by assigning ZIP codes to the hospital area where the greatest proportion of their Medicare residents were hospitalized. Minor adjustments were made to ensure geographic contiguity.*

According to the Dartmouth Atlas Project, I divide my total sampled hospitals into 170 hospital referral regions (HRR) in the U.S. I treat the HRRs as local hospital markets, and look at how the market concentration caused by common ownership in a specific market affects the hospital prices in that market.

1.1.5 How to measure traditional market concentration?

Market concentration is a key factor in studies on industrial organization. In early industrial organization literature, Bain (1951) asserted that market concentration is a measure of competition, and it is a function of the number of firms and their market shares. Meanwhile, Bain also related the firms' profit rates to the market concentration, which provides further evidence that market concentration could influence industry structure, conduct, and performance.

In the 1940s, Albert O. Hirschman and Orris C. Herfindahl invented the Hirfindahl-Hirschman Index (HHI), an index to measure market concentration, calculated as the sum of the squares of the market shares of each firm in a market. It ranges from 0 to $10,000$, where 0 means no competition and $10,000$ means there is a one-firm monopoly in the market, whose market share is 100%. There are many ways to calculate market shares using revenues or sales; in this paper, I use the number of hospital beds to calculate the hospital's market share.

1.1.6 Market concentration in hospital industry

An increase in market concentration may lead to decreasing competition, and the hospital industry is no exception. Dafny et al. (2016), Connor et al. (1998), and Dranove et al. (2003) have provided evidence showing that hospital mergers lead to decreasing costs and decreasing competition. This ultimately results in raised hospital charges, and thus patients are paying more. Gaynor and Vogt (2003) find that the hospital industry in San Luis Obispo County, "where the merger creates a near monopoly, prices rise by up to 58%." Gowrisankaran et al. (2015) also supports this conclusion.

Mergers and acquisitions are different for the hospital industry compared to other industries because many for-profit hospitals belong to large health systems (HCA, Community Health Systems, Health South, etc.) Some hospital mergers involve two hospitals that belong to the same health system, and some involve different health systems. Dranove et al. (2003) explained these two scenarios specifically in their paper. When two hospitals belonging to the same health system merge, "two or more hospitals in the same geographic market have common ownership, but maintain separate physical facilities, do business under separate licenses, and keep separate financial records." On the other hand, for some mergers: "two or more hospitals in the same local market have common ownership, do business under a single license, report unified financial records, and may or may not consolidate some physical facilities."

Mergers can also occur at the health system level, which may affect hospital costs and behaviors. There are 12 health systems in my dataset in 2005; however, during my analysis period from 2005 to 2015, three systems were acquired by others. Health Management Associates was acquired by Community Health Systems in 2014. According to Dafny et. al. (2016), "the $3.9 billion acquisition of Health Management (71 hospitals) by Community Health Systems (135 hospitals) in 2014." Psychiatric Solutions was acquired by the Universal Health Service in 2009. In a news release from May 17, 2010, UHS states "PSI is the largest standalone operator of owned or leased freestanding psychiatric inpatient facilities with 94 facilities in 32 states, Puerto Rico, and the U.S. Virgin Islands. Today, UHS owns or operates 25 acute care hospitals and 102 behavioral health care facilities and schools located across 32 states, as well as in Washington, D.C. and Puerto Rico." RehabCare Group was acquired by Kindred Healthcare in 2011. According to a news release by Kindred Healthcare on June 1, 2011, "as a result of the Merger, Kindred is the largest and most diversified post-acute healthcare services company in the United States based upon revenues with operations in 46 states. On June 1, 2011, the combined company operated 121 long-term acute care (LTAC) hospitals, 118 inpatient rehabilitation facilities (IRFs) (primarily hospital-based units), 224 nursing and rehabilitation centers and is the largest provider of rehabilitation therapy contract services with approximately 1,870 rehabilitation therapy contracts."

Since health systems own many for-profit hospitals across the U.S., these system-level mergers have larger impacts on hospital costs and behaviors than mergers at the hospital level. Dafny et al. (2016) concluded that "the mechanism operates within state boundaries: cross-market, within-state hospital mergers yield price increases of 7-9 percent for acquiring hospitals." Meanwhile, a recent paper by Lewis and Pflum (2017) finds that "independent hospitals acquired by out of market systems raise prices by about 18%, and the effects are larger when the acquiring system is larger or when the acquired hospital is smaller (by number of beds)."

1.1.7 How to measure financial market concentration?

In traditional markets, HHI is a key standard to measure the market concentration. However, the HHI only concerns market concentration at the firm level. Reynolds and Snapp (1986) modified the Cournot model to allow firms to own shares in their competitors. In terms of the econometric measure of financial market concentration, Bresnahan and Salop (1986) introduced the modified Herfindahl-Hirschman Index (MHHI) to quantify the competitive effects of horizontal joint ventures. Later, O'Brien and Salop (2000) separate the $MHHI$ into two parts: HHI and $MHHIdelta$.

In traditional literature on market concentration, scholars always use HHI to represent the market concentration and analyze its impacts on firms' anti-competitive behaviors. In common ownership literature, scholars use $MHHIdelta$ to represent the common ownership concentration (market concentration at the firms' shareholders' level) and analyze its impacts on firms' anti-competitive behaviors. Therefore, $MHHI$ represents the summation of market concentration at the firm level and market concentration at the shareholder level. In this paper, I follow the previous common ownership literature and use $MHHIdelta$ to represent the common ownership concentration, and include the HHI to capture the traditional market concentration effects.

The equation of $MHHI$ is:

$$MHHI = HHI + MHHIdelta \tag{1.1}$$

In this equation, HHI is well known to measure traditional market concentration. However, once the firms' shareholders get involved in the industry, the market might become more concentrated if shareholders hold stock shares in both firms themselves and their competitors. Therefore, O'Brien and Salop (2000) allow shareholders to hold stock shares in competitors and measure this concentration by $MHHI$. The difference between $MHHI$ and HHI is $MHHIdelta$, which represents the market concentration at the shareholders' level. Therefore, Bresnahan and Salop (1986) were the first to introduce the idea of common ownership ("joint ownership"). O'Brien and Salop (2000) was the first paper introducing the measure of common ownership ("joint ownership"), which is $MHHIdelta$. Recently, Azar et al. (2018) related the idea of common ownership to the empirical world with financial acquisitions and institutional investors.

The formula of MHHI is:

$$\sum_j \sum_k s_j s_k \frac{\sum_i \gamma_{ij} \beta_{ik}}{\sum_i \gamma_{ij} \beta_{ij}} \tag{1.2}$$

In this formula, s_j and s_k represent market shares of companies j and k. β_{ij} represents holding shares from institutional investor i in health system j, and γ_{ij} represents control shares by institutional investor i in health system j. The holding shares is the total shares held by investors, and it equals to the sum of control shares and non-control shares. Control share means that investors have proportional control rights to vote on firms' operational and managerial decisions, such as anti-competitive strategies or replacing managers such as chief executive officers.

In this formula, the numerator and the denominator of the fraction term are differentiated by second terms. They are holding shares by shareholders i invested in systems k and j. In this formula, notations k and j could represent either the same system or different systems. If k and j represent the same system, the numerator and the denominator in this fraction will be cancelled out, and the MHHI will equal to the HHI. If k and j represent two systems, this results in market concentration caused by common ownership:

$$\sum_j \sum_{k \neq j} s_j s_k \frac{\gamma_{ij} \beta_{ik}}{\gamma_{ij} \beta_{ij}} \tag{1.3}$$

Therefore, the equation of calculating these indices is:

$$\sum_j \sum_k s_j s_k \frac{\sum_i \gamma_{ij}\beta_{ik}}{\sum_i \gamma_{ij}\beta_{ij}} = \sum_j s_j^2 + \sum_j \sum_{k\neq j} s_j s_k \frac{\gamma_{ij}\beta_{ik}}{\gamma_{ij}\beta_{ij}} \tag{1.4}$$

In this equation, the left hand side is the MHHI. The first term of right hand side is the HHI, and the second term on the right hand side is the MHHI delta. Both MHHI and HHI range from 0 to 10,000, where 0 indicates a perfectly competitive market, and $10,000$ indicates a monopoly. MHHI is always greater or equal to HHI, which means that $MHHIdelta$ is always a non-negative number. Table 3.18 shows the summary statistics of $MHHIdelta$ and HHI.

In order to better interpret the idea of common ownership, Table 3.19 shows an intuitive example of common ownership. In the first scenario, suppose there is only one health system in the market, so the market share of the system is 100%, and the HHI equals to $10,000$. Meanwhile, there is no market concentration caused by common ownership, so the $MHHIdelta$ equals to 0. Therefore, $MHHI$ equals to $10,000$. In the second scenario, suppose there are two systems in the market, and each of them owns 50% of market share and their shareholders are independent from each other (i.e., they do not own two systems at the same time.) so, the HHI equals to $5,000$. This traditional market concentration measure decreases because the market is more competitive after another player gets involved. Since firms' shareholders are independent, there is no common ownership, so the $MHHIdelta$ is still 0, and the $MHHI$ equals to $5,000$. In the third scenario, suppose these two systems' shareholders swap 50% of their ownerships with each other. Now, shareholder A owns 50% of firm 1 and also owns 50% of firm 2, and shareholder B has the same portfolio. When calculating the traditional market concentration, the HHI still equals to $5,000$. However, since these two systems have common ownership now, $MHHIdelta$ equals to $5,000$. Therefore, $MHHI$ equals to $10,000$. This scenario tells us that the market becomes less competitive again because systems' shareholders are common owners of both systems, which enhances the market concentration caused by common ownership.

1.1.8 Hospitals' pricing behavior measures

In this paper, I test this hypothesis: The increase of market concentration caused by common ownership at the hospital referral region level would result in higher hospital prices in the region. According to Lewis and Pflum (2017), "prices are negotiated between health systems and insurers." Brooks et al. (1997) find that "greater hospital concentration improves hospitals' bargaining position." As a hospital improves its bargaining position, hospital prices rise. Therefore, I measure the hospitals' pricing behaviors using hospital charges. In order to scale the size of hospitals, I divide hospital charges by patient discharges. Thus, hospital charges divided by discharges is the outcome variable in my empirical analysis.

In the robustness check section, I will also show results obtained using other measures of hospital size, such as number of beds, total payroll expenses, total inpatient days, and number of full time personnel.

1.1.9 Theoretical models

In the traditional theoretical model, scholars usually assume that a firms objective function is to maximize its profit. When firms offer public stock shares, their objective functions change slightly. Hart (1979) supports this hypothesis by saying that, "when large shareholders hold stocks in more than one firms, their objective functions may change." When firms maximize their profits, managers such as chief executive officers play key roles to achieve their goals. Previous literature has studied the delicate relationship between managers and shareholders (Dewatripont et al. (1994), Bertrand et al. (2003), Cornett et al. (2003), etc.) and all indicate that the congruence between managers and shareholders is important in corporate finance (Dewatripont et al. (1994)), and once managers pursue goals that are not in shareholders' interests, "overall productivity and profitability decline" (Bertrand et al. (2003)). Thus, managers now become the "employees" of shareholders instead of employees of firms. At the same time, managers' goals are to maximize their shareholders' profits instead of the firms' profits. So, what is the difference between shareholders' profits and firms' profits? Currently, large shareholders and especially blockholders own stock shares in many firms. For some local markets, a few competitors in a specific industry are owned by the same blockholder. In this case, the blockholder has a portfolio of ownerships in these competing firms. Managers of each firm maximize their blockholder's profit so that they need to enhance their own profits, but they do not want to harm their competing firms' benefits since their competitors are also in the portfolio of their blockholder. Therefore, it is reasonable to say that managers not only value their own profit, but also value their competitors' profits as long as their competitors are in the portfolio of their shareholders. This logic constitutes the following common ownership theory.

In this paper, I follow the common ownership model introduced by Backus et al. (2018) and apply it to the hospital industry. Specifically, following firm behaviors in Rotemburg (1984), common ownership profit weights in Bresnahan and Salop (1986), and the notation of OBrien and Salop (2000), Backus et al. (2018) generate a theoretical model to illustrate common ownership in the context of the Bertrand and Courtnot competition.

Suppose there are many institutional investors, and I index them by i. Their portfolios include shares of many hospital systems, which I index by s. Now, let β_{is} be investor i's ownership share in hospital system s. Note that the total profit of a hospital system is π, so the fraction of profits owned by investor i is $\beta_{is}\pi_s$. Therefore, the value of the investor's portfolio is:

$$\sum_s \beta_{is}\pi_s \tag{1.5}$$

As I said at beginning of this section, managers intend to maximize their investors' portfolio under common ownership. According to the proportional control assumption, firms' managers value their investors differently in terms of the amount of stock shares held by investors, since investors holding more stock shares have more votes to determine corporate executives, and thus have more power on a firm's corporate governance. Although most institutional investors claim that they are passive investors, broad literature has found evidence that they are "active" in corporate governance (see McCahery et al. (2016), Aggarwal et al. (2013), and Brav et al. (2015)). In this scenario, Backus et al. (2018) find that firms' managers place weights on investors. Here, I denote these weights as γ_{is}, which means the weights that manager of system s place on institutional investor i.

Therefore, systems' objective functions (executed by managers in reality) are maximizing:

$$\sum_i \gamma_{is} \sum_r \beta_{ir}\pi_r \tag{1.6}$$

Where both s and r both represent systems included in the portfolio of investor i. In order to interpret this objective function, we can think of $\beta_{ir}\pi_r$ as the value of the investor's real portfolio profits, and when I multiply γ_{is} with its real portfolio profits, I find the proportional value of firms' managers on the real portfolio profits of investors. After I make the double summation of these values, I find that the proportional value of firms' managers on all real portfolio profits by all of their investors. Separating this double summation formula into two parts so that managers of system s maximize:

$$\sum_s \gamma_{is}\beta_{is}\pi_s + \sum_r \gamma_{is}\beta_{ir}\pi_r$$

Where s denotes the manager's system, and r denotes other systems included in investor i's financial portfolio. Re-arrange this formula so that systems are maximizing:

$$\pi_s + \sum_r K_{sr}\pi_r \qquad \text{where } K_{sr} \equiv \frac{\sum_i \gamma_{is}\beta_{ir}}{\sum_i \gamma_{is}\beta_{is}}$$

This objective function is different from the traditional model where a system only aims to maximize its own profit, which is π_s alone. Instead, under the common ownership background, Backus et al. (2018) conclude "K_{sr} represents the value to hospital system s of a dollar of profit generated for a competing system r." They also state that "back in the 19th century, it was unbelievable that firms generate profits for their competitors. It is believable now, because of common ownership." Firms generate profits for their competing firms because they have the common owners and they want to maximize their owners' portfolio profits.

I will relate this common ownership hypothesis to economic outcomes, which in my paper is hospital price. According to Backus et al. (2018), "the canonical case of differentiated Bertrand price competition with single product firms where firms compete by setting prices, as in O'Brien and Salop (2000)." In the hospital industry, suppose hospital systems set a price p_s, and demand for hospital services is given by the function D_s that maps all hospital prices into services sold, i.e. $q_s = D_s(p_1, ..., p_f)$. Denoting the marginal costs as c_s, I have:

$$\pi_s = (p_s - c_s)D_s(p_1, ..., p_f), \tag{1.7}$$

In a traditional market without common ownership, hospital systems choose p_s to maximize π_s. In case of common ownership, hospitals solve:

$$\text{Choose } p_s \text{ to max } \pi_s + \sum_r K_{sr}\pi_r$$

To characterize the prices hospital system s will set in equilibrium, following the mathematics in Backus et al. (2018), I use the first order condition of hospital system s's optimization problem. Plugging equation 1.7 into this new objective function and taking the derivative with respect to p_s yields

$$0 = D_s(p_1, ..., p_s) + (p_s - c_s)\frac{\partial D_s(p_1, ..., p_s)}{\partial p_s} + \sum_r K_{sr}(p_r - c_r)\frac{\partial D_r(p1, ..., p_s)}{\partial p_s} \tag{1.8}$$

According to Backus et al. (2018), the first two terms on the right hand side of this equation are inframarginal and marginal effects of raising prices. Inframarginal customers always buy the products, so when price increases, profits rise. For marginal customers, when price increases they no longer buy the products, so profits decline. Therefore, these two terms are usually countervailing. The third term is a new term. According to Backus et al. (2018), "it captures the profits generated by sales that are diverted to hospital system s's competitors when they raise their price." If products are net substitutes, then this third term in the first-order condition is always positive, and the first order condition of this objective function is greater than zero, which indicates that prices under common ownership will be strictly higher than they would be in a market in which firms maximize only their own profit.

This conclusion is the key concept of common ownership theory. It encourages scholars to test this hypothesis in the empirical world; that is whether consumers face higher product prices if the common ownership exists in the market.

1.1.10 Empirical methods

The straightforward way to test the impacts of common ownership on hospital prices is using the ordinary least squares panel regression. The outcome variable will be hospital prices scaled by hospital size. The main independent variables will be market concentration caused by common ownership, measured by the MHHI, and traditional market concentration, measured by HHI, on the right hand side of regressions to capture the effect of traditional market concentration on price variations. In order to control for the variation in hospital prices caused by other factors, I include the year fixed effects, HRR (region) fixed effects, and a set of control variables. The summary statistics of control variables are presented in Table 3.18.

Although a large number of potential omitted variables are captured via fixed effects in panel regressions, there is one concern named reverse causality; that is, if hospitals raise prices, institutional investors may be enticed to start investing in them, resulting in an increase in market concentration caused by common ownership.

I provide two robustness tests to examine the empirical validity of concerns regarding reverse causality and functional form. In my linear regressions, I take the lags of $MHHIdelta$ to solve the reverse causality. I also use a difference-in-differences identification strategy base on the financial acquisition of BlackRock and Barclays Global Investors in 2009. This identification strategy uses only variation in common ownership across regions that is implied by the hypothetical combination of the two parties' portfolios as of the year before the announcement of the acquisition. Since hospital stocks constituted only a small fraction of the merging parties' portfolios, it is unlikely that this variation is driven by expected changes in hospital prices. Comparing these two empirical strategies, the difference-in-differences approach uses much less variation than the panel regressions, but the estimates from this strategy are arguably less affected by endogeneity of market shares.

1.2 Data

In this paper, I create a unique dataset by merging three datasets: American Hospital Association (AHA) data, healthcare cost report from the Centers for Medicare & Medicaid Services' (CMS) Healthcare Cost Report Information System (HCRIS), and data from the 13-F statement of Thompson Reuters in Wharton Research Data Services (WRDS).

The American Hospital Association (AHA) data includes many hospital characteristics for over 6,000 hospitals across the United States. These include whether hospitals and their systems provide obstetric care or not, whether they provide rehab care or not, whether they provide ultrasound care or not, total admissions, total inpatient days, total births, total surgical operations, total payroll expenses, and total full-time personnel. In my paper, these hospital characteristics are very useful. I can treat them as control variables in my regressions, and I can also scale the hospital size by some of these variables. More importantly, the AHA dataset gives me the code to distinguish for-profit hospitals and non-profit hospitals, and it also gives me the HRR code to divide over 6,000 hospitals into 170 local markets across the U.S.

The healthcare cost report comes from the Centers for Medicare & Medicaid Services' (CMS) Healthcare Cost Report Information System (HCRIS) dataset. It includes many cost variables as well as hospital characteristics for almost the same number of hospitals as the AHA dataset; for example, whether hospitals are rural or urban, whether hospitals are teaching hospitals or not, whether hospitals are critical access hospitals or not, and total number of beds in hospitals. I can use these hospital characteristics to study the heterogeneous effects of common ownership concentration on various interesting outcomes. More importantly, this dataset gives me my main outcome variable of empirical analysis. It gives me the total chargers and total discharges of each hospital to scale the hospital prices by hospital size.

Both of these datasets have the hospital ID number, which allows me to merge them. After merging , I have about 5,800 hospitals.

The 13-F statement of Wharton Research Data Services (WRDS) includes financial variables of health systems and their institutional investors including institutional investor ID, total shares held by each institutional investor, sole voting shares held by each institutional investor, no voting shares held by each institutional investor, shared voting shares held by each institutional investor, and total shares outstanding for each health system. I use these statistics to calculate the index of MHHIdelta (common ownership concentration measure).

1.3 Empirical results

1.3.1 Panel Regressions

In this section, I will apply panel regressions to test the correlation between the common ownership concentration index (MHHIdelta) and hospital charges per patient discharge by using the ordinary least squares (OLS) panel regressions. The regression is:

$$Log((Charges/discharges)_{iht}) = \alpha + \beta * Log(MHHIdelta_{ht}) + \gamma_1 * Log(HHI_{ht}) + \gamma_2 * Log(HHIstar_{ht}) + \delta_t + \lambda_h + \eta_{it} * X_{it} + \epsilon_{iht} \quad (1.9)$$

In this regression, my outcome variable is the hospital charges scaled by hospital discharges in hospital i in region h in year t. The independent variables of interests are $MHHIdelta$ and HHI in region h in year t. Specifically, the coefficient of $MHHIdelta$ captures the effects of market concentration caused by common ownership on hospital charges, the coefficient of HHI captures the effects of market concentration caused by traditional firms' mergers and acquisitions on hospital charges, and the coefficient of HHIstar captures the effects of market concentration caused by traditional firms' mergers and acquisitions on hospital charges considering both for-profit and non-profit hospitals. I include the year fixed effects, region fixed effects, and a set of hospital characteristic control variables in this regression. The year fixed effects capture the variations of hospital charges over the years, and the region fixed effects capture the variations in hospital charges across regions. If patients flow out of regions because of price increases, the region fixed effects also captures this variation. Further, hospital characteristics include the number of beds, urban dummy variable, teaching hospital dummy variable, critical access hospital dummy variable, whether hospital provides obstetrics services, whether hospital provides rehab services, whether hospital provides ultrasound services, total number of births, total surgical operations, total inpatient days, total payroll expenses, total full time personnels, total part time personnels, and the ratio of total numbers of non-profit hospitals' discharges over total numbers of for-profit hospitals' discharges. Table 3.18 shows the summary statistics of all variables in my regression. The number of observations is at the hospital-HRR(region)-year level. In all linear regressions, I cluster standard errors three ways at HRR(region) level in order to solve the potential serial correlation problems among samples. Meanwhile, I take logs of my outcome variable and independent variables in order to better interpret the results.

Table 3.5 shows the results of linear regressions. In the first specification, I include the year fixed effects and region fixed effects without hospital characteristic control variables. The coefficient of MHHIdelta is positive and statistically significant at the one percent level. The coefficient is 0.10, which means that every one percent increase of MHHIdelta will result in a rise of hospital charges per discharge by 0.10 percent. Considering the mean value and the standard deviation of MHHIdelta and charges per discharge in Table 3.18, the economic significance also seems large. From the summary statistics, the mean value of MHHIdelta is about $4,500$, and the standard deviation is $2,460$. The mean value of charges per discharge is 100,000. Therefore, economically speaking, for every increase of MHHIdelta by one standard deviation, hospital charges per discharge will likely increase by \$160. In order to have a better way to gauge the magnitude of panel results, I calculate the average changes of average MHHIdelta from one year to the next. The statistics show that average change of MHHIdelta is about 400, which is 15% of one standard deviation change of MHHIdelta. Therefore, according to the changes of MHHIdelta from one year to the next, hospital average prices change is in average about \$25, which is a very small economic effect. The coefficient of HHI is positive and statistically significant at the one percent level in this specification, and the coefficient of HHIstar is negative and statistically significant at 1 percent level.

In the second specification, I include the year fixed effects, region fixed effects, and hospital characteristic control variables, and find that the coefficients of MHHIdelta, HHI, and HHIstar are all statistically significant and have similar magnitudes to the first specification. In general, both specifications of linear regressions show a positive relationship between common ownership concentration and hospital prices.

Of course, I do not infer a causal effect from this raw correlation. Many factors could impact the level of hospital prices across regions that may also be correlated with common ownership in a given region. In my baseline result I address various of such omitted variable concerns with explicit controls and a large number of fixed effects. For example, I include

HHI to capture the effect of traditional market concentration on hospital prices; I also include various hospital characteristics that HHI fails to capture: whether hospital is in urban or rural, whether it is a teaching hospital or not, whether the hospital has a critical access, the number of beds, total admissions, total inpatient days, total surgical operations, total payroll expenses, and total full-time personnel.

1.3.2 Limitations of the baseline analysis

An attractive feature of the baseline analysis so far is that a large number of potentially omitted variables are differenced out via fixed effects. Nevertheless, two other significant limitations remain at this stage, driven by the potential endogeneity of market shares, as well as the misspecification of functional form of MHHIdelta. I first address reverse causality, specifically the idea that ownership changes could be driven by price changes, rather than the other way around. Second, I consider variations in how I compute $MHHIdelta$. Therefore, I perform two robustness tests to solve these two concerns: distributed-lag regressions and difference-in-differences regressions.

1.3.3 Panel regressions with lags and leads of MHHIdelta and HHI

If common ownership causes higher prices, but higher prices do not cause common ownership, one would expect higher prices to follow increases in common ownership, but not vice versa. To test these hypotheses against each other, I implement dynamic panel regressions that include leads and lags of MHHI deltas.

Table 3.6 shows the results of panel regressions with lags and leads. In the first specification, I include the region fixed effects and year fixed effects into my regression. The coefficients of MHHIdelta, the lag of MHHIdelta, and HHI are positive and statistically significant. In the second regression, I add hospital characteristic control variables in my regression. The coefficients of MHHIdelta, the lag of MHHIdelta, and HHI are still positive and statistically significant. These results indicate that there are two main effects of common ownership concentration: timely common ownership concentration effects and delayed common ownership effects (lag of MHHIdelta). In other words, my results show that common ownership concentration causes higher hospital prices, and some of these causal effects result from the timely emergence of common ownership, while the others result from delayed emergence of common ownership. However, the statistically insignificant coefficients of leads of MHHIdelta indicate that managers cannot foresee the emergence of common ownership. This conclusion is supported by the results from Table 3.6. Both specifications show that the coefficients of MHHIdelta and the lag of MHHIdelta are positive and statistically significant. The economic significance is also large among these coefficients. Specifically, every one percent increase in common ownership concentration results in a 0.1 percent increase in hospital charges per discharge. To use more meaningful numbers for this context, every one standard deviation increase in MHHIdelta will result in $550 in hospital charges per discharge. The coefficients of HHI are positive and statistically significant in both specifications, but the lags and leads of HHI are not statistically significant.

The results of panel regressions with lags and leads yield two important conclusions. First, the statistically significant coefficients of lags of common ownership concentration show that common ownership concentration has delayed effects on hospital prices, helping to eliminate the suspicion of reverse causality. Second, the statistically insignificant coefficients of leads of common ownership concentration could be a good placebo test indicating that there are no effects of expectations of common ownership on hospital prices. In other words, managers will not act strategically to raise prices until the emergence of common ownership.

1.3.4 Difference-in-differences

Background on BlackRock's acquisition of Barclays Global Investors

According to Azar et al. (2018), following the financial crisis that began in 2007, Barclays tried for several months to strengthen its balance sheet. On March 16, 2009, Barclays had received a $4 billion bid by CVC Capital Partners for its iShares family of exchange-traded funds, along with an option to solicit competing offers. BlackRock announced a bid to acquire iShares parent division Barclays Global Investors (BGI) for $13.5 billion on June 11, 2009. The bid was successful and the acquisition was formally completed in December 2009.

The history of Barclays attempt to sell iShares to investors other than BlackRock suggests the divestment decision was not primarily driven by considerations regarding how the iShares portfolio would combine with BlackRocks in terms of potential product market effects. Moreover, health system stocks comprised only a small share of BGIs portfolio. This fact makes it unlikely that hospitals were pivotal in BlackRocks decision to acquire BGI, much less regional variation in expected hospital price changes, thus alleviating reverse causality concerns. More formally, the exclusion restriction is that the cross-sectional distribution across hospital referral regions in the implied increase in common ownership from a hypothetical, pre-merger combination of BLK and BGIs equity portfolios is uncorrelated with errors of the hospital price regression, conditional on controls.

Table 3.26 presents all the large acquisitions among institutional investors from 2005 to 2015. In 2009, there were two acquisitions in the financial industry, both of which involved large institutional investors: Bank of America acquired Merrill Lynch in January, and BlackRock acquired Barclays Global Investors in December. Table 3.8 presents the summary statistics of these institutional investors before the acquisitions. Specifically, these numbers represent the percentages that investors own in the health systems. For example, before the acquisition of Barclays Global Investors and BlackRock, Barclays owned 7.5% of total shares outstanding of UHS, and BlackRock owned 0.34% of total shares outstanding of UHS. In summary, Table 3.8 shows that both Bank of America and Merrill Lynch had similar top holding stocks in the hospital industry before the acquisition: LPNT, CYH and PSYS. At the same time, Bank of America held a large portion of shares in these stocks. Table 3.8 also shows that both BlackRock and Barclays Global Investors had similar top holding stocks before the acquisition: LPNT, UHS, and CYH. Meanwhile, Barclays held a large portion of shares in these stocks. From the statistics, we know that both financial mergers affected ownership stakes in the hospital industry, resulting in an increase of market concentration caused by common ownership. The stock shares involved were large because either the acquiring firm or the target firm held a large portion of stock shares in these health systems.

Difference-in-differences design

Although panel regressions with lags and leads solve the concern of reverse causality and find significant effects, I introduce a case study to corroborate my findings. I apply a difference-in-differences strategy to strengthen a causal interpretation of the results, and a combination of panel with lags and difference-in-differences results may be most informative.

I exploit the variation in ownership generated by BlackRocks acquisition of Barclays BGI as follows. I start by calculating the MHHI delta in the year before the acquisition was announced, 2009, for each hospital referral region. I then calculate a counterfactual MHHI delta for the same year and region, but I treat the holdings of BlackRock and Barclays as if they had already been held by a single entity. I call the difference between the latter and former MHHI delta the implied change in MHHI delta. The null hypothesis is that the acquisition, as with any other ownership change, had no effect on portfolio firms product market behavior. The alternative hypothesis is that markets more affected by the acquisition those with a higher implied change in MHHI delta experience higher price changes compared to less affected markets.

The reason for doing this is that between the pre- and post-periods, many changes can occur in portfolios and market shares, some of which might be endogenous, such as hospital systems may merge or increase prices corresponding to the acquisition between BlackRock and Barclays BGI. The sum of these changes constitutes the actual change in the MHHI delta. I intend to use the only variation that is not endogenous. If the BlackRock-Barclays acquisition were the only change, the actual change in the MHHI delta would be exactly the same as the implied change. If other changes are small relative to the BlackRock-Barclays acquisition, it will not be exactly the same, but the correlation between the two will be high, resulting in a strong instrument. Thus, we can think of the implied change in the MHHI delta as a treatment variable, which measures a given firms level of exposure to the acquisition event.

The DiD regression is:

$$\begin{aligned} Log((Charges/discharges_{iht})) &= \alpha + \beta * Post_t * Treat_h + \gamma_1 * Log(HHI)_{ht} \\ &+ \gamma_2 * Log(HHIstar_{ht}) + \delta_t + \lambda_H + \eta_{it} * X_{it} + \epsilon_{iht} \end{aligned} \tag{1.10}$$

In this regression, the outcome is hospital charges per discharge for hospital i in region h in year t. I take the log of outcome variable for two reasons: Hospital charges are usually large numerical values, and the percentage change of hospital charges is easier to interpret. The DiD term is the interaction of Post dummy variable and Treat dummy variable. The Post dummy equals to one if the year is 2009 or later and zero if it is before 2009. The Treat dummy equals to one for the top ten regions with the highest increases of implied change of MHHIdelta, and it equals to zero otherwise.

Table 3.9 and 3.10 show the summary statistics of the treated group and control group. The summary statistics show that the treated group has similar hospital characteristics compared to the control group.

The other regressors include the HHI in region h in year t, which captures the effect of traditional market concentration on hospital prices; the HHIstar in region h in year t, which captures the effect of traditional market concentration on hospital prices when including both for-profit hospitals and non-profit hospitals; the year fixed effects, the region fixed effects, and hospital characteristic control variables. ϵ_{iht} is the error term, and I cluster standard errors at the regional levels in order to solve the potential serial correlation problem in samples.

Results

The results of DiD regression are presented in Table 3.27. In the first specification, I include the year fixed effects and region fixed effects but not a set of hospital characteristic control variables. The coefficient of $Post * Treat$ dummy is positive and statistically significant. The coefficient of HHI is positive, the coefficient of HHIstar is negative, and they are all statistically significant. The economic significance is a little larger than linear regressions. This indicates that for treated regions after the financial acquisitions in 2009, hospital charges per discharge increased by 12% compared to control regions. The second specification adds hospital characteristic controls into my DiD regression, and the results are similar to the first specification. One way to interpret the magnitude of the difference-in-differences coefficient: Starting with the MHHIdelta and hospital prices in 2008, as a result of the acquisition of BlackRock and Barclays Global Investors in 2009, the average MHHIdelta increased about 10% of one standard deviation in 2009, and hospital prices for treated group increased about \$7000. On the other hand, hospital prices for control group increased about \$4000.

In summary, the results of last two specifications are reasonable and economically sizable. Specifically, applying the difference-in-differences design improves my empirical efficiency and accuracy. This method solves two stubborn endogeneity issues and provides a comprehensible causal inference: The financial acquisition of 2009 caused hospital prices for treated regions to increase by 16% compared to the control regions.

Event Study

In the event study, I explore the dynamic change of the effect of common ownership on hospital prices:

$$Log((Charges/discharges_{iht})) = \alpha + \sum_{t=-3}^{t=7} \beta_{DiD}^{t} * Treat_h^t + \gamma_1 * Log(HHI)_{ht}$$
$$+\gamma_2 * Log(HHIstar_{ht}) + \delta_t + \lambda_H + \eta_{it} * X_{it} + \epsilon_{iht} \tag{1.11}$$

where $Treat_h^t$ is an interaction of the treatment dummy with year fixed effects; that is, it is equal to one for treated regions in period t, and zero otherwise. I drop the year of 2008, so that year serves as the base period, with the estimated β_{DiD}^t coefficients representing the change in the difference between treatment and control regions between 2008 and the given year.

The results are shown in Figure 3.1. In this figure, the x-axis shows the year relative to 2008. The y-axis shows the change in the difference between treatment and control regions between 2008 and the given year. For example, the first observation in this figure is the 2005 dummy * Treat dummy, and it captures the effect of 2005 relative to 2008 interacting with the treatment group relative to the control group on hospital prices. In the graph, the bar around the dot indicates the 95% of confidence interval. The difference between treatment and control fluctuates around zero to some extent during the pre-period; the overall trend before the acquisition is flat. The trend changes after the acquisition, and the cofficients are significantly positive for some periods after the completion of the acquisition. Thus, the sign of the effect, based on variation in common ownership generated by the BGI acquisition is consistent with our previous results.

1.3.5 Comparing the coefficients among three identification strategies

So far, I have used three identification strategies: ordinary least squares linear regressions, panel regressions with leads and lags, and difference-in-differences. As I explained above, the linear regression provides a basic positive correlation between common ownership concentration and hospital prices. Further, panel regressions with leads and lags solve the reverse causality problem. Lastly, the difference-in-differences method solves the reverse causality and endogeneity problems caused by the measure of common ownership. Now, I summarize and compare the magnitudes of these coefficients of interest.

Results indicate that the signs of major coefficients are all positive for all methodologies. Moreover, the coefficients of MHHIdelta are all statistically significant. In the OLS linear regressions and distributed-lag regressions, every increase of one standard deviation of MHHIdelta results in an increase of about$550 in hospital price. In the difference-in-differences strategy, treated regions after the 2009 acquisitions experienced an increase of 12% compared to control regions, which represents about $\$10,000$.

In summary, the difference-in-differences approach uses much less variation than the panel regressions, but the estimates from this strategy are arguably less affected by endogeneity of market shares, even though both strategies solve the reverse causality problem. All three strategies show consistent results and prove the empirical validity of common ownership theory. Next, I will offer some robustness tests to further confirm my hypothesis.

1.3.6 Multiple exogenous shocks

Table 3.26 presents all financial acquisitions from the year of 2005 to 2015. In my main analysis of the difference-in-differences method, I use the two financial acquisitions of 2009 because they involve four large institutional investors, which may affect more health systems and cause larger impacts on hospital prices. However, there were five other financial acquisitions from 2006 to 2008. I use these three exogenous years to analyze the effects of market concentration caused by common ownership on hospital prices.

Empirically, I use the same design applied in my difference-in-differences methodology. The main independent variable of interest is the interaction term of two dummy variables. The first dummy variable is the $Post$ dummy, where I set it equal to one if the year is the exogenous year or after, depending on which exogenous year I use, and set it equal to zero if before the exogenous years. The other dummy variable is the $Treat$ dummy, which equals to one if the regions are in in the treated group, and zero if in the control group. I choose the regions that experienced the top ten highest increases of implied change of common ownership as my treated group, and the rest of regions as my control group. The regressions are:

$$\sum_{j=2006}^{2008} Log(Charges/discharges_{iht}) = \alpha + \beta * Post_t * Treat_h + \gamma_1 * Log(HHI)_{ht} + \gamma_2 * Log(HHIstar_{ht}) + \delta_t + \lambda_H + \eta_{it} * X_{it} + \epsilon_{iht} \tag{1.12}$$

In this design, there are three separate regressions by applying three different exogenous years. They are 2006, 2007, and 2008 according to the Table 3.26. Because of the different exogenous years, the values of *Post* dummy and *Treat* dummy are different in every regression.

Table 3.12 shows the results of these exogenous shocks. Using financial acquisitions in 2006 as the exogenous shock, the coefficient of $Post * Treat$ is positive and statistically significant at the 5 percent level. The economic significance is also large. This indicates that after the financial acquisitions in 2006, the hospitals charges per discharge increased by 9% in treated regions compared to control regions. The coefficient of HHI is positive and statistically significant. Using financial acquisitions in 2007 as the exogenous shock, the coefficient of $Post * Treat$ is positive but becomes statistically insignificant. The coefficient of HHI is still positive and statistically significant. Using financial acquisitions in 2008 as the exogenous shock, the coefficient of $Post * Treat$ is positive and becomes statistically significant again. This indicates that after the financial acquisitions in 2008, hospital charges per discharge increased by 20% in treated regions compared to control regions. The coefficient of HHI is still positive and statistically significant.

From Table 3.12, results show that the exogenous years of 2008 and 2006 have significant impacts of common ownership concentration on hospital prices while the exogenous year of

2007 does not. Table 3.13 could explain this result. From the table, the total stock shares involved by acquisitions are huge for 2008 and 2009, and relatively smaller for 2006 and 2007. Especially for 2007, total stock shares involved by the acquiring firm is especially small, which indicates that the change of market concentration caused by common ownership for treated regions is very small. Therefore, the coefficient of $Post * Treat$ is statistically insignificant when using the financial acquisitions in 2007 as the exogenous shock. In summary, when applying these exogenous shocks, there are two important factors. First, the total stock shares involved by financial acquisitions must be large. Secondly, the total stock shares involved by both acquiring firms and target firms should not be too small. By satisfying these two factors, the change in market concentration caused by common ownership can be captured by the difference-in-differences methodology.

In these difference-in-differences regressions, my non-tabulated results also show that the hospital characteristics are similar for the treated group and control group in each of these regressions.

Robustness check

In addition to using hospital discharges, I also try some other measures to represent the scale of hospitals, such as the number of beds, total payroll expenses, total inpatient days, the number of full time personnel, and total admissions. Table 3.15 shows the results of replacing these measures in my difference-in-differences method.

From the table, all five specifications indicate similar results. The coefficients of $Post * Treat$ are all positive and statistically significant. The economic significance is large as well. No matter what measures of hospital size I apply, they indicate that after the financial acquisitions of 2009, there was approximately a 15% increase in hospital charges for treated regions compared to control regions. The coefficients of HHI are still not statistically significant. In summary, my difference-in-differences analysis is robust when using different measures of hospital sizes.

Falsification tests

After the financial acquisitions of 2009, some hospital referral regions experienced declines of $MHHIdelta$, which means that these regions have lower market concentration caused by the common ownership after 2009; some hospital referral regions retained the same MHHI before and after the exogenous financial shocks in 2009. Therefore, I propose two false hypothesis and test their validity.

The first false hypothesis is that the lower market concentration caused by common ownership would result in higher hospital prices. The empirical method is to change the treated group in my main difference-in-differences analysis by selecting bottom ten regions which experienced lowest increases of the implied change of common ownership from 2008 to 2009, while other settings remain the same. Therefore, the null hypothesis is still $\beta = 0$, but I expect to see statistically insignificant coefficients of DiD dummy and thus not reject my null hypothesis.

Results are presented in the left panel of Table 3.16. In the first specification, the coefficient of $Post{*}Treat$ is not statistically significant, so I cannot reject the null hypothesis. It further indicates that after financial acquisitions in 2009, for regions experiencing bottom changes of implied changes of common ownership, there were no impacts on hospital prices for treated regions compared to control regions. I also test this false hypothesis by using the other three exogenous years and find consistent results. The coefficients of HHI are all positive and not statistically significant.

My second false hypothesis is that the unchanged market concentration caused by common ownership would result in higher hospital prices. The empirical method is to change the treated group in my main difference-in-differences analysis by selecting the middle ten regions that experienced the middle increases of implied change of common ownership from 2008 to 2009, while other settings remain the same. Therefore, the null hypothesis is still $\beta = 0$, but I expect to see statistically insignificant coefficients of DiD dummy and thus do not reject my null hypothesis.

Results of my second false hypothesis test are presented in the right panel of Table 3.16. In the first specification, the coefficient of $Post * Treat$ is not statistically significant. This indicates that after the financial acquisitions of 2009, for regions that experienced middle increases of implied changes of common ownership, there were no impacts on hospital prices for treated regions compared to control regions. I test this second false hypothesis by using the other three exogenous years and find consistent results. The coefficients of HHI are all positive and not statistically significant.

Other interesting outcomes

It is also worth studying the effects of common ownership concentration on different types of for-profit hospitals. In this section, I include four pairs of different types of hospitals to study the effects of common ownership concentration on their pricing behaviors: 1) whether common ownership concentration affects urban hospitals' prices compared to rural hospitals', 2) whether common ownership concentration affects teaching hospitals' prices compared to non-teaching hospitals', 3) whether common ownership concentration affects larger hospitals' prices compared to small hospitals, I define large hospitals as having more than 100 beds and small hospitals as having less than 100 beds, and 4) whether the common ownership concentration affects critical access hospitals' prices (CAH) compared to non-CAH hospitals'. These four indicators are all dummy variables. Table 3.17 shows the results.

In the first panel of this table, results show that the common ownership concentration has a positive and statistically significant effects on rural hospitals. The economic significance is large. Specifically, it indicates that after the financial acquisitions in 2009, rural hospitals' prices increased by 19% for treated regions compared to control regions. The coefficient of HHI is also positive and statistically significant. However, the coefficient of $Post * Treat*$ is positive but not statistically significant. The coefficient of HHI is also not statistically significant. On the other hand, I find no impacts of common ownership concentration on urban hospitals' prices.

The second panel of this table shows that the common ownership concentration has positive and statistically significant impacts on both teaching hospitals' prices and non-teaching hospitals' prices. The economic significance is also large. This indicates that after the financial acquisitions in 2009, prices rose by about 16% for both teaching hospitals and non-teaching hospitals in treated regions compared to control regions. The third panel shows that the common ownership concentration has positive and statistically significant impacts on large hospitals but positive and not statistically significant impacts on small hospitals. The fourth panel shows that the common ownership concentration has positive and statistically significant impacts on non-CAH hospitals but no impacts on CAH hospitals.

In general, most coefficients show that market concentration caused by common ownership results in higher hospital prices. Although some coefficients are not statistically significant, the signs are all positive. The only exception is the coefficient for CAH hospitals. One reason may be that the unit of observations is very small, which can lead to unexpected results. These interesting outcomes further confirm the positive effects of common ownership on hospital prices, and suggests further research into how common ownership concentration affects hospital behaviors depending on different hospital characteristics.

1.4 Conclusions and policy implications

In this paper, I test the common ownership theory raised by Backus et al. (2018) and Azar (2011) and further confirm the validity of this theory. Most importantly, I test this theory in an empirical way in the hospital industry, which is novel and contributes to the broad literature in both the field of common ownership and the field of market competition in the hospital industry. My results show that common ownership concentration causes higher hospital prices. Specifically, I use OLS linear regressions to find a positive relationship between common ownership concentration and hospital prices. However, two limitations of this method require me to apply better empirical designs: the question of reverse causality, and the fact that the measure of common ownership involves market shares. Then, I run the panel regressions with lags and leads and find that the lags of common ownership concentration have significant impacts on hospital prices, but the leads of common ownership concentration do not. This indicates that common ownership concentration has both timely and delayed impacts on hospital prices, but hospital managers cannot foresee the common ownership benefits to take precautionary actions. Thus, panel regressions solve the reserve causality issue but the second limitation remains. Later, I use the difference-in-differences strategy and this design takes care of both limitations. I use the financial acquisitions of 2009 as the exogenous shock and I find both statistically significant and economically significant results by running the DiD regressions. Specifically, I find that after the financial acquisitions in 2009, hospital prices increased by 12% in treated regions compared to control regions. In order to corroborate my results, I run difference-in-differences regressions using three other exogenous shocks in 2006, 2007 and 2008 and find consistent results when large stock shares are involved in financial acquisitions. I also find robust results when I measure hospital size by hospital characteristics other than hospital total discharges. The falsification tests of common ownership theory also passed in my analysis. Last but not least, I find some interesting and consistent results when I compare rural versus urban hospitals, teaching hospitals versus non-teaching hospitals, large hospitals versus small hospitals, and CAH hospitals versus non-CAH hospitals.

The findings in this paper are novel in both common ownership literature and hospital competition literature. Anti-competitive conduct at the institutional investor's level is underway in the hospital industry, but this paper finds common ownership concentration effects on hospital prices, while the mechanism of this behavioral change is not tested here. This paper encourages me to study how common owners influence hospital managers to increase hospital prices; for example, hospitals may convert to profitable service lines under the emergence of common ownership.

In this paper, I find that common ownership has statistically significant effect on hospital prices. The mechanism could be that common institutional investors affect corporate decisions through influencing top managers. Literature mentioned that institutional investors can influence top managers through votes, managers incentives, and doing nothing (Aggarwal et al. (2013); Charan et al. (2015); Fos and Tsoutsoura (2014)). Under common ownership, firms are sufficiently informed and conscious of their competitors behavior (and recognize that hard competition will be met with a hard response and affect all parties) that they manage successfully to achieve a soft competition equilibrium.

Interlocking directorates has the similar mechanism of common ownership, and Clayton Act prohibited interlocking directorates in 1914. Nowadays, scholars find evidence that common ownership could raise product prices in many industries (Azar et al. (2018); Azar et al. (2016)), one plausible explanation is: the linking of profits reduce firms incentives to compete (Reynolds and Snapp (1986)); meanwhile, there might exist a tacit collusion among these common shareholders. Given the scarcity of information on the contents of private engagement meetings, Azar et al. (2018) showed an anecdotal evidence that investors and managers are discussing product market strategies. There have been no anti-trust laws against the common ownership so far, but this anti-trust issue at the shareholders level should call attentions from anti-trust policy makers.

Chapter 2

Hospital Product-Mix Strategies under Common Ownership

2.1 Introduction

2.1.1 Common ownership effects on hospital behaviors

In the hospital industry, hospitals are owned by hospital systems. In recent years, hospital systems started offering stocks publicly, and institutional investors became blockholders of hospital systems. When one investor owns large portions of stock shares in two or more competing hospital systems, it creates higher market concentration caused by common ownership in some local hospital markets. The emergence of common ownership by institutional investors has had impacts on hospital behavior. In my job market paper Players Behind the Scenes: Common Ownership in the Hospital Industry (2019), I show the effect of common ownership concentration on hospital pricing behaviors. I find evidence that an increase in common ownership concentration causes higher hospital prices. Specifically, after the financial acquisitions of Barclays Global Investors by BlackRock in 2009, hospital prices for treated regions increased by 16% compared to control regions. I define treated regions as hospital referral regions that experienced a top 25 percentile increase of market concentration caused by common ownership right after the acquisitions. The ultimate goal of raising hospital prices is to maximize profits, but there are other ways to accomplish this, including deploying hospital services.

2.1.2 Hospital service lines

Compared to other industries, the hospital industry consists of diversified products. There are many kinds of care and services, some of which are relatively profitable and others relatively unprofitable.

Horwitz (2005) divides up hospital services into relatively profitable and relatively unprofitable by collecting medical reports and interviews with doctors and experts. Relatively unprofitable services include HIV-AIDS services, trauma services, emergency department, geriatric adult day care programs, burn care, psychiatric care, and alcohol/drug abuse care.

Relatively profitable services include cardiac intensive care, neonatal intensive care, neonatal intermediate care, pediatric intensive care, birthing rooms, fitness centers, sports medicine services, computed-assisted tomography scanner (CT), and women's health centers.

In this paper, I expect to see that hospitals under common ownership will expand their relatively profitable services. Meanwhile, hospitals are expected to cut back their relatively unprofitable services.

2.1.3 Market power and product-mix

Previous literature has studied the effect of traditional market concentration on firms' product-mix behaviors. Capron et al. (1998) and Karim and Mitchell (2000) argue that firms use acquisitions to reconfigure the acquiring firm or target firm's business and change the mix of products and services offered. Several empirical studies have analyzed such resource redeployment following mergers (Capron et al., 1998; Helfat, 1997; Karim and Mitchell, 2000). Specifically, Capron et al. (1998) find evidence in the manufacturing industry of redeployment of resources following horizontal acquisitions: The redeployment process both successful businesses expand and preserves valuable portions of unsuccessful businesses . Helfat (1997) empirically investigates the role of know-how and other assets in the context of changing conditions in the U.S. petroleum industry during the 1970s and early 1980s. She finds that in response to rising oil prices, firms with larger amounts of complementary technological knowledge and physical assets also undertook larger amounts of $R\&D$ on coal conversion (a synthetic fuels process)." Karim and Mitchell (2000) study the reconfiguration of business resources following acquisitions in the U.S. medical sector from 1978 to 1995 and find that acquisitions play a major role in business reconfiguration, offering opportunities for firms to both build on existing resources and obtain substantially different resources.

Hospitals have increased their merger activities since the 1990s (Jaspen, 1998). The merger and acquisition activities are in response to changes in the hospital industry environment, which constrains hospitals profitability and brings more costs to hospitals. For example, the uninsured population is higher, and improved technology decreases the length of inpatient stays. Therefore, mergers could give hospitals competitive advantages compared to non-merged hospitals, including price increases made by rising market power, cost reduction through economies of scale, and favorable adjustments in the product mix (Krishnan et al., 2004). Krishnan et al. (2004) also study the effect of hospital mergers on hospitals' adjustment of their product mixes and find that mergers facilitate reconfiguring the product mix toward high-profit services. They argue that the effects of hospital mergers are caused by resource interaction between two merged hospitals.

Priem and Butler (2001) assert that resources are antecedents to products and a firm can exploit opportunities, combat threats, and ultimately realize value, through appropriate and timely changes in its product portfolio. Hence, Krishnan et. al. (2004) conclude that mergers and associated resource acquisitions are aimed at product-mix reconfiguration by entering and/or dominating attractive product markets and reducing the presence in unattractive product markets. In other words, the success or failure of a merger and the associated resource redeployment can be assessed by observable changes in the product-mix.

On the other hand, hospitals need market power to enhance their profit-maximizing activities, such as expanding profitable services. Specifically, merged hospitals have competitive advantages for three reasons. First, the federal anti-trust regulations against collusive pricing and exercise of market power become less relevant to a merged firm. Second, merged organizations can reduce costs by reducing the duplication of these structural elements across two merging entities; for example, hospitals might eliminate duplicate services in order to avoid unnecessary competition and costs. Third, mergers accelerate changes toward cost efficiency, technical process control, and market discipline.

2.1.4 Hospital product-mix behaviors

Hospitals can expand their relatively profitable services in two ways: the extensive margins when hospitals start a profitable service, and the intensive margins when hospitals expand their profitable services such as adding more beds dedicated to profitable services.

Krishnan et al. (2004) study the extensive margins of hospital product-mix strategies post mergers. Specifically, through empirical analysis of mergers in the state of Ohio, Krishnan et al. (2004) find that merging hospitals shifted their product-mix and market shares towards high-profit services to a greater extent relative to non-merging hospitals. Meanwhile, they find that hospital mergers have not resulted in product-mix adjustments away from the low-profit services used by poor and uninsured. Karim and Mitchell (2000) also study the extensive margins of hospital product mix strategies after hospital acquisitions and find that acquirers and targets tend both to add more new lines and drop more old lines than nonacquirers, resulting in major differences in business reconfiguration.

One theory supports the intensive margins of hospital product-mix strategies post mergers. Wernerfelt (1984) and Salter and Weinhold (1979) draw on the resource-based view (RBV) of the firm and discuss acquisition strategies that involve obtaining more of the firms existing valuable resources (related supplementary), and resources that combine effectively with the firms existing resources (related complementary). Specifically, the RBV considers a broader set of resources, capabilities, and competencies, including intangible resources such as brand names, in-house knowledge, technical and marketing capability, reputation, customer loyalty, and management skills (Mahoney and Pandian, 1992; Penrose, 1959; Wernerfelt, 1984). Obviously, merged hospitals have more of these resources than non-merged hospitals. Furthermore, hospitals under common ownership also have more of these resources than hospitals without common ownership. For example, previous literature shows that firms under common ownership share technical information (Asker and Ljungqvist (2010)). Therefore, hospitals could acquire more patients in profitable areas after a change of common ownership through obtaining more resources.

2.1.5 The measure of traditional market concentration

Hospital mergers are defined as traditional market concentration, a key factor in studies on industrial organization. In early industrial organization literature, Bain (1951) says that market concentration is a measure of competition, and it is a function of the number of firms and their market shares. Meanwhile, Bain also relates firms' profit rates to market concentration, providing further evidence that market concentration could influence industry structure, conduct, and performance.

In the 1940s, Albert O. Hirschman and Orris C. Herfindahl invented a market index to measure market concentration, the Hirfindahl-Hirschman Index (HHI), calculated as the sum of the squares of the market shares of each firm in a market. Krishnan et al. (2004) measures the market concentration using the HHI, which ranges from 0 to $10,000$, where 0 means no competition and $10,000$ means there is a one-firm monopoly in the market, whose market share is 100%. There are many ways to calculate market shares using revenues or sales; in this paper, I use the number of hospital beds to calculate the hospital's market share.

2.1.6 The measure of common ownership concentration

In traditional markets, HHI is a key standard to measure market concentration. However, the HHI only concerns market concentration at the firm level. Reynolds and Snapp (1986) modified the Cournot model to allow firms to own shares in their competitors. In terms of the econometric measure of financial market concentration, Bresnahan and Salop (1986) introduced the modified Herfindahl-Hirschman Index (MHHI) to quantify the competitive effects of horizontal joint ventures. Later, O'Brien and Salop (2000) separate the $MHHI$ into two parts: HHI and $MHHIdelta$.

In traditional literature on market concentration, scholars always use HHI to represent the market concentration and analyze its impacts on firms' anti-competitive behaviors. In common ownership literature, scholars use $MHHIdelta$ to represent the common ownership concentration (market concentration at the firms' shareholders' level) and analyze its impacts on firms' anti-competitive behaviors. Therefore, $MHHI$ represents the summation of market concentration at the firm level and market concentration at the shareholder level. In this paper, I follow the previous common ownership literature and use $MHHIdelta$ to represent the common ownership concentration, and include the HHI to capture the traditional market concentration effects.

The equation of $MHHI$ is:

$$MHHI = HHI + MHHIdelta \tag{2.1}$$

In this equation, HHI is well known to measure the traditional market concentration. However, once the firms' shareholders get involved in the industry, the market might become more concentrated if shareholders hold stock shares in the firms themselves and in their competitors. Therefore, O'Brien and Salop (2000) allow shareholders to hold stock shares in competitors and measure this concentration by $MHHI$. The difference between $MHHI$ and HHI is $MHHIdelta$, which represents the market concentration at the shareholder level. Therefore, Bresnahan and Salop (1986) were the first to introduce the idea of common ownership (joint ownership). O'Brien and Salop (2000) was the first paper introducing the measure of common ownership (joint ownership), which is $MHHIdelta$. Recently, Azar et al. (2018) related the idea of common ownership to the empirical world with financial acquisitions and institutional investors.

The formula of MHHI is:

$$\sum_j \sum_k s_j s_k \frac{\sum_i \gamma_{ij}\beta_{ik}}{\sum_i \gamma_{ij}\beta_{ij}} \tag{2.2}$$

In this formula, s_j and s_k represent market shares of companies j and k. β_{ij} represents holding shares from institutional investor i in health system j, and γ_{ij} represents control shares by institutional investor i in health system j. The holding shares is the total shares held by investors, and it equals to the sum of control shares and non-control shares. A control share is when investors have proportional control rights to vote on firms operational and managerial decisions, such as anti-competitive strategies or replacing managers like chief executive officers.

In this formula, the numerator and the denominator of the fraction term are differentiated by second terms. They are holding shares by shareholders i invested in systems k and j. In this formula, notations k and j could represent either the same system or different systems. If k and j represent the same system, the numerator and the denominator in this fraction will be cancelled out, and the MHHI will equal to the HHI. If k and j represent two systems, this results in market concentration caused by common ownership:

$$\sum_j \sum_{k \neq j} s_j s_k \frac{\gamma_{ij}\beta_{ik}}{\gamma_{ij}\beta_{ij}} \tag{2.3}$$

Therefore, the equation of calculating these indexes is:

$$\sum_j \sum_k s_j s_k \frac{\sum_i \gamma_{ij}\beta_{ik}}{\sum_i \gamma_{ij}\beta_{ij}} = \sum_j s_j^2 + \sum_j \sum_{k \neq j} s_j s_k \frac{\gamma_{ij}\beta_{ik}}{\gamma_{ij}\beta_{ij}} \tag{2.4}$$

In this equation, the left side is the MHHI. The first term of the right side is the HHI, and the second term on the right side is the MHHI delta. Both MHHI and HHI range from 0 to 10,000, where 0 indicates a perfectly competitive market, and $10,000$ indicates a monopoly. MHHI is always greater or equal to HHI, which means that $MHHIdelta$ is always a non-negative number. Table 3.18 shows the summary statistics of $MHHIdelta$ and HHI.

In order to better interpret the idea of common ownership, table 3.19 shows an intuitive example of common ownership. In the first scenario, suppose there is only one health system in the market, so the market share of the system is 100%, and the HHI equals to $10,000$. Meanwhile, there is no market concentration caused by common ownership, so the $MHHIdelta$ equals to 0. Therefore, $MHHI$ equals to $10,000$. In the second scenario, suppose there are two systems in the market, and each of them owns 50% of market share and their shareholders are independent from each other (i.e., they do not own two systems at the same time). So, the HHI equals to $5,000$. This traditional market concentration measure decreases because the market is more competitive after another player gets involved. Since firms' shareholders are independent, there is no common ownership, so the $MHHIdelta$ is still 0, and the $MHHI$ equals to $5,000$. In the third scenario, suppose these two systems' shareholders swap 50% of their ownerships with each other. Now, shareholder A owns 50% of firm 1 and also owns 50% of firm 2, and shareholder B has the same portfolio. When calculating the traditional market concentration, the HHI still equals to $5,000$. However, since these two systems have common ownership now, $MHHIdelta$ equals to $5,000$. Therefore, $MHHI$ equals to $10,000$. This scenario tells us that the market becomes less competitive again because systems' shareholders are common owners of both systems, which enhances the market concentration caused by common ownership.

2.1.7 Common ownership and hospital product-mix

Common ownership concentration has played an important role in the hospital industry over the past 20 years. Scholars have researched this topic in many industries; however, most literature studies the effect of common ownership on firms' pricing behaviors. Azar et al. (2018) use the combination of two large asset managers as the exogenous shock, and look at the relationship between within-route changes in common ownership concentration and within-route changes in ticket prices. Azar et al. (2016) uses the growth of index funds as an arguably exogenous source of cross-sectional variation of county-level common ownership growth to suggest a causal link from the common ownership to higher prices for banking products. Gramlich et al. (2017) find the impacts of common ownership on bank rates and fees for various financial products and quantity of bank deposits.

To the best of my knowledge, no one has yet studied the effect of common ownership concentration on hospitals' product mix. There are several obstacles inhibiting scholarly work on this issue. First, common ownership concentration is completely different from traditional market concentration such as mergers and acquisitions. Under common ownership, the common owner holds shares of stocks in competing firms. The common owner holds partial interest in both firms, so the owner does not have as much power as the owner of two merged firms does. For instance, after an acquisition happens between two firms, the owner (or owners) has the absolute power to managerially perform the strategies of the firm. However, under common ownership, the indirect owners of firms (which are often the institutional investors) have less power to affect the managerial decisions of the firms, although there is literature showing that these institutional investors have impacts on firms' managerial decisions by affecting executive compensation (Brav, Jiang, Partnoy, and Thomas (2008); Brav, Jiang, and Kim (2011)). Second, many industries have homogeneous products and not enough product diversity. Only few industries have a mix of products and are worth studying. For example, anecdotal evidence reveals that Exxon and Mobil used their merger as an opportunity to shed some of their low-profit retailing and refining operations in order to create a stronger competitor for oil exploration, the most profitable section of the business (Howe, 1999). However, the hospital industry has various products, both profitable and unprofitable. Third, firms reconfigure their services and products for a reason, usually to achieve larger profits. In many industries, firms have many ways of raising profits, such as gaining market power and then raising prices, or enhancing the economies of scale and then lowering costs. Thus, they do not need to alter their product deployment, which is more complicated.

I will analyze the effect of common ownership concentration on hospitals' product mix redeployment in this paper. The hospital industry has various products, and previous literature shows that hospitals can gain profits by providing profitable services while eliminating duplicate services (Krishnan et al. (2004). The hospital industry can also be easily connected to the common ownership concentration. For-profit hospitals are owned by companies called health systems. Some large health systems offer public stocks, such as HCA, Health South, and others. Some large institutional investors invest in these health systems. The result is that some institutional investors become common owners of some health systems; since these health systems own many for-profit hospitals in the U.S., the institutional investors become the indirect owners of these hospitals. This institutional investor-health system-hospital channel constitutes my hypothesis: The increase of market concentration caused by common ownership at the health system level will cause hospital prices to rise. Table 3.20 and table 3.21 show the statistics of publicly traded health systems owned by some large institutional investors. Table 3.20 shows the top six blockholders for six large health systems. We can see that BlackRock, Vanguard, and Fidelity are top blockholders in most of these health systems. In table 3.21, I pick five large institutional investors in the hospital industry and divide up their investments in the hospital industry into percentage holdings for each health system. For example, BlackRock invests 27% of their total investments in the hospital industry into THC, and 9% of their total investments in the hospital industry into SEM. In conclusion, this table shows that THC, SEM, HLS and UHS are their favorite stocks in the hospital industry. In my analysis, I will study 12 publicly traded health systems: HCA, Health South (now called Encompass Health), Community Health Systems, Kindred Healthcare, Lifepoint Health Inc., Select Medical, Tenet Healthcare, Universal Health Service, Health Management Associates, Psychiatric Solutions, RehabCare Group, and Vanguard Health System.

2.1.8 Empirical strategies

I will study the effect of common ownership concentration on hospital product mix strategies by analyzing both the extensive margins and intensive margins. Intensive margins include binary variables such as whether a hospital provides certain services like cardiac intensive care and neonatal intensive care. Extensive margins include continuous variables such as the number of cardiac intensive care beds and the number of neonatal intensive care beds. In both intensive margin analysis and extensive margin analysis, I will compare the effect of common ownership concentration on relatively profitable services and relatively unprofitable services.

First, I study the basic linear effect of common ownership concentration on extensive margins of hospital product mix strategies. I use the Logit model to analyze the effect of common ownership concentration on the probability of a hospital to open a service. Then, I use the Poisson model to analyze the effect of common ownership concentration on the number of beds provided by hospitals. Poisson regression is also known as a log-linear model. It is used when the outcome variable is a count (the number of beds in my analysis). A least-squares normal model does not work here because count variables cannot be below zero, but a normal model has no bounds, so any value is possible.

In linear regressions, a large number of potential omitted variables are captured via fixed effects. However, according to Azar et al. (2018), one concern is reverse causality, which means that if hospitals raise prices, investors may be attracted to the potential for profit, which could result in an increase of market concentration caused by common ownership.

I follow the methodology applied by Azar et al. (2018), which is a difference-in-differences methodology using the financial acquisition of BlackRock and Barclays Global Investors in 2009 as the exogenous shock. Since this financial acquisition is unrelated to the hospital industry, and the change of financial industry structure also affects the common ownership concentration in each hospital referral region, the change of financial concentration is also natural to each region. This helps me to select natural treated groups and natural control groups. Specifically, I choose regions that experienced top 25 percentile increase of common ownership measured by $MHHIdelta$ as my treated group, and the bottom 25 percentile as my control group. I choose 25 percentile because Azar et al. (2018) also used this threshold. I will also try thresholds of 10 percentile and 5 percentile as robustness checks in my study.

2.2 Data

In this paper, I create a unique dataset by merging three datasets: American Hospital Association (AHA) data, healthcare cost report from the Centers for Medicare & Medicaid

Services' (CMS) Healthcare Cost Report Information System (HCRIS), and data from the 13-F statement of Thompson Reuters in Wharton Research Data Services (WRDS). The American Hospital Association (AHA) data includes hospital characteristics for over 6,000 hospitals across the United States. These include whether hospitals and their systems provide obstetric care or not, whether they provide rehab care or not, whether they provide ultrasound care or not, total admissions, total inpatient days, total births, total surgical operations, total payroll expenses, and total full-time personnel. In my paper, these hospital characteristics are very useful. I can treat them as control variables in my regressions, and I can also scale the hospital size by some of these variables. More importantly, the AHA dataset gives me the code to distinguish for-profit hospitals and non-profit hospitals, and it also gives me the HRR code to divide over 6,000 hospitals into 170 local markets across the U.S.

The healthcare cost report comes from the Centers for Medicare & Medicaid Services' (CMS) Healthcare Cost Report Information System (HCRIS) dataset. It includes many cost variables as well as hospital characteristics for almost the same amount of hospitals as the AHA dataset. For example, it has hospital characteristics such as whether hospitals are rural or urban, whether hospitals are teaching hospitals or not, whether hospitals are critical access hospitals or not, and total number of beds in hospitals. I can use these hospital characteristics to study the heterogeneous effects of common ownership concentration on various interesting outcomes. More importantly, this dataset gives me my main outcome variable of empirical analysis. It gives me the total charges and total discharges of each hospital to scale the hospital prices by hospital size.

Both of these datasets have the same hospital ID, which allows me to merge them. After merging, I have about 5,800 hospitals.

The 13-F statement of Wharton Research Data Services (WRDS) includes financial variables of health systems and their institutional investors. For example, it has variables such as institutional investor ID, total shares held by each institutional investor, sole voting shares held by each institutional investor, no voting shares held by each institutional investor, shared voting shares held by each institutional investor, and total shares outstanding for each health system. I use these statistics to calculate the index of MHHIdelta (common ownership concentration measure).

2.3 Empirical methodology and results

2.3.1 Logit regressions

First of all, I use the logit regressions to test the relationship between the common ownership concentration and the extensive margins of hospitals' product-mix. The regression is:

$$Pr(Y=1)_{iht} = \alpha + \beta * Log(MHHIdelta_{ht}) + \gamma * Log(HHI_{ht}) + \delta_t + \lambda_h + X_{it} + \epsilon_{iht} \quad (2.5)$$

Where the Y_{iht} is the binary outcome in hospital i in region h in year t. I divide my binary outcome into relatively profitable services and relatively unprofitable services. Profitable services include cardiac intensive care, neonatal intensive care, neonatal intermediate care, pediatric intensive care, birthing room service, fitness center service, sports medicine service, Computed Tomography scanner service, and women's health center service. Relatively unprofitable services include AIDS-HIV service, trauma service, emergency department service, and geriatric adult day care service. Main independent variables include MHHIdelta and HHI. MHHIdelta captures the effect of common ownership concentration, and HHI captures the effect of traditional market concentration. I include year fixed effects and region fixed effects as well as other control variables, such as urban indicator, teaching hospital indicator, critical access indicator, total surgeries and operations, total inpatient days, total payroll expenses, full time total personnel and part time personnel. ϵ_{iht} is the error term. I cluster the standard errors in three levels: hospital level, hospital system level, and region level. Doing this will solve the serial correlation issue among hospital observations.

The results are shown in table 3.22. The left panel includes outcomes of relatively profitable services. When the outcome is the probability of opening Computed Tomography scanner service, the coefficient is statistically significant. The magnitude indicates that for every one standard deviation change of Log(MHHIdelta), the event is about 176 times as likely to occur, which is economically significant as well. The right panel includes outcomes of relatively unprofitable services. When the outcome is the probability of opening HIV-AIDS service, the coefficient is statistically significant. The magnitude indicates that one standard deviation change of Log(MHHIdelta) will make the event about six times less likely to occur, which is economically significant as well. The remaining outcomes are not significantly affected by the common ownership concentration.

By summarizing the CT variable, I find that only 74 observations (hospital, region and year) out of 3502 observations (hospital, region and year) have CT services, which could bias my results. Thus, I decide to leave the results in my table and conclude that I find no significant effects from the logit model on extensive margins because effects are inconsistent and are estimated with few observations.

The change of common ownership concentration may have delayed effects on hospital behaviors relating to product mix. Therefore, I take one-year lag of MHHIdelta and run logit regressions again. The results in table 3.23 shows that no outcomes are significantly affected by the one-year lag of common ownership concentration, and the signs of these coefficients are not expected in either profitable services or unprofitable services.

Poisson regressions

I test the effect of common ownership concentration on the intensive margins of hospitals product mix by running Poisson regressions. I use the Poisson model to study the common ownership concentration effects on the number of hospital beds. Poisson regression is also known as a log-linear model. It is used when the outcome variable is a count variable (number of beds in my analysis). A least-squares normal model does not work here, because count variables cannot be below zero, but a normal model has no bounds, so any value is possible. The regression is:

$$Log(E(Y|X))_{iht} = \alpha + \beta * Log(MHHIdelta_{ht}) + \gamma * Log(HHI_{ht}) + \delta_t + \lambda_h + X_{it} + \epsilon_{iht} \quad (2.6)$$

Where the $Log(E(Y|X))_{iht}$ is the number of beds in hospital i in region h in year t, where Y is the outcome, including profitable services such as the number of beds in cardiac intensive care, the number of beds in neonatal intensive care, the number of beds in neonatal intermediate care, and the number of beds in pediatric intensive care; and unprofitable care such as the number of beds in psychiatric care, the number of beds in alcohol/drug abuse care, and the number of beds in burn care. X is a set of explanatory variables. Main independent variables include MHHIdelta and HHI. MHHIdelta captures the effect of common ownership concentration, and HHI captures the effect of traditional market concentration. I include year fixed effects and region fixed effects as well as other control variables, such as an urban indicator, teaching hospital indicator, critical access indicator, total surgeries and operations, total inpatient days, total payroll expenses, total full time personnel, and total part time personnel. ϵ_{iht} is the error term. I cluster the standard errors in three levels: hospital level, hospital system level, and region level. This will solve the serial correlation issue among hospital observations.

The results are presented in table 3.24. The left panel includes outcomes of the number of beds in profitable services. The coefficients of MHHIdelta in the left panel are all positive and statistically significant for all four specifications. Column (1) indicates that every change of Log(MHHIdelta) in one standard deviation, the number of beds in cardiac intensive care will increase by 3 (mean of CICBD is 12.8) units. In column (2), the coefficient indicates that for every change of Log(MHHIdelta) in one standard deviation, the number of beds in neonatal intensive care will increase by 3 (mean of NICBD is 23.9) units. In column (3), the coefficient indicates that for every change of Log(MHHIdelta) in one standard deviation, the number of beds in neonatal intermediate care will increase by 6 (mean of NINTBD is 12.2) units. In column (4), the coefficient indicates that for every change of Log(MHHIdelta) in one standard deviation, the number of beds in pediatric intensive care will increase by 4 (mean of NINTBD is 14.3) units.

The right panel includes outcomes of the number of beds for unprofitable services. Only the coefficient of the number of beds in psychiatric care is negative and statistically significant. Column (5) indicates that for every change of Log(MHHIdelta) in one unit, the number of beds in psychiatric care decreases by 3 (mean of PSYBD is 51.1) units. The coefficients of alcohol/drug abuse care and burn care are not statistically significant.

The change of common ownership concentration may have delayed effects on hospital behaviors regarding product mix. Therefore, I take a one-year lag of MHHIdelta and run Poisson regressions again. The results in table 3.25show that there is not much relationship between delayed common ownership concentration and the number of beds.

2.3.2 Difference-in-differences method

A logit model and a Poisson model provide a basic relationship between common ownership concentration and hospital product mix strategies. However, one endogenous concern remains in these two models: the reverse causality problem. Therefore, a difference-in-differences model is introduced to obtain the causal impacts of common ownership concentration on hospital product mix strategies. The DiD method can also solve the two endogenous concerns in logit and Poisson models.

I use the financial acquisitions of 2009 as exogenous shocks and apply the difference-in-differences method. The list of financial acquisitions is presented in table 3.26. Two acquisitions include Bank of America Corp.s acquisition of Merrill Lynch, and BlackRocks acquisition of Barclays Global Investors. The stocks previously held by two owners are now held by the one owner. Thus, the ownership is more concentrated, and the change in ownership concentration may affect hospital product mix strategies.

According to Azar et al. (2018), following the financial crisis that began in 2007, Barclays tried for several months to strengthen its balance sheet. On March 16, 2009, Barclays received a $4 billion bid by CVC Capital Partners for its iShares family of exchange-traded funds, along with an option to solicit competing offers. BlackRock announced a bid to acquire iShares parent division Barclays Global Investors (BGI) for $13.5 billion on June 11, 2009. The bid was successful and the acquisition was formally completed in December 2009.

The history of Barclays attempt to sell iShares to investors other than BlackRock suggests the divestment decision was not primarily driven by considerations regarding how the iShares portfolio would combine with BlackRocks in terms of potential product market effects. Moreover, health system stocks comprised only a small share of BGIs portfolio. This fact makes it unlikely that hospitals were pivotal in BlackRocks decision to acquire BGI, much less regional variation in expected hospital product mix changes, thus alleviating reverse causality concerns. More formally, the exclusion restriction is that the cross-sectional distribution across hospital referral regions in the implied increase in common ownership from a hypothetical, pre-merger combination of BLK and BGIs equity portfolios is uncorrelated with errors of the hospital price regression, conditional on controls.

I apply a difference-in-differences strategy to strengthen a causal interpretation of the results, and a combination of panel with lags and difference-in-differences results may be most informative.

I exploit the variation in ownership generated by BlackRocks acquisition of Barclays BGI as follows. I start by calculating the MHHI delta in 2009, the year before the acquisition was announced, for each hospital referral region. I then calculate a counterfactual MHHI delta for the same year and region, but I treat the holdings of BlackRock and Barclays as if they had already been held by a single entity. I call the difference between the latter and former

MHHI delta the implied change in MHHI delta. The null hypothesis is that the acquisition, as with any other ownership change, had no effect on portfolio firms product market behavior. The alternative hypothesis is that markets more affected by the acquisition (i.e., those with a higher implied change in MHHI delta) experience higher price changes compared to less affected markets.

Between the pre- and post-periods, many changes can occur in portfolios and market shares, some of which might be endogenous. For example, hospital systems may merge or increase prices corresponding to the acquisition between BlackRock and Barclays BGI. The sum of these changes constitutes the actual change in the MHHI delta. I intend to use the only variation that is not endogenous. If the BlackRock-Barclays acquisition were the only change, the actual change in the MHHI delta would be exactly the same as the implied change. If other changes are small relative to the BlackRock-Barclays acquisition, it will not be exactly the same, but the correlation between the two will be high, resulting in a strong instrument. Thus, we can think of the implied change in the MHHI delta as a treatment variable, which measures a given firms level of exposure to the acquisition event.

The DiD regression is:

$$Log(E(Y|X))_{iht} = \alpha + \beta * Post_t * Treat_h + \gamma * Log(HHI)_{ht} + \delta_t + \lambda_H + X_{iht} + \epsilon_{iht} \quad (2.7)$$

In this regression, the outcomes are intensive margins of hospital product-mix strategies, represented by profitable services such as the number of beds in cardiac intensive care, the number of beds in neonatal intensive care, the number of beds in neonatal intermediate care, and the number of beds in pediatric intensive care; and unprofitable services such as the number of beds in psychiatric care, the number of beds in alcohol/drug abuse care, and the number of beds in burn care. In order to compare the results in the DiD model with the results in the Poisson model, I also apply the Poisson regression here. The independent variable of interest is the interaction of *Post* dummy and *Treat* dummy. The *Post* dummy equals to one if the year is 2009 or after and zero if it is before 2009. The *Treat* dummy equals to one if the hospital referral regions experience a top 25 percentile increase of implied MHHIdelta from 2008 to 2009, and equals to zero otherwise. The other independent variable of interest is the log of HHI, which captures the effect of traditional market concentrations on the number of beds. I also include year fixed effects and region fixed effects in this regression, as well as a set of control variables at the hospital level. ϵ_{iht} is the error term. Further, I cluster the standard errors two ways, at the hospital level and the region level.

The results are presented in table 3.27. The left panel includes relatively profitable services. Three of four profitable services are positively and significantly affected by changes of common ownership concentration. In column (1), the coefficient indicates that after the financial acquisitions of 2009, hospitals in treated regions have 1.9 more beds in cardiac intensive care on average compared to control regions. Considering the average number of beds in cardiac intensive care is around 12.8 in table 3.18, this effect is economically large and is about 15 percent of the average. In column (2), the coefficient indicates that after the financial acquisitions of 2009, hospitals in treated regions have 1.9 more beds in neonatal intensive care on average compared to control regions. Considering the average number of beds in neonatal intensive care is around 23.9 in table 3.18, this effect is also economically large and is about 8 percent of the average. In column (3), the coefficient indicates that after the financial acquisitions of 2009, hospitals in treated regions have about 1.4 more beds in neonatal intermediate care on average compared to control regions. Considering the average number of beds in neonatal intermediate care is around 12.2 in table 3.18, this effect is also economically large and is about 11 percent of the average. In column (4), the coefficient indicates that common ownership concentration does not have significant impacts on the number of beds in pediatric intensive care.

The right panel includes relatively unprofitable services. Two of three unprofitable services are negatively and significantly affected by changes of common ownership concentration. In column (5), the coefficient indicates that after the financial acquisitions of 2009, hospitals in treated regions have about 1.1 fewer beds in psychiatric care on average compared to control regions. Considering the average number of beds in psychiatric care is around 51.1 in table 3.18, this effect is small and is about 2 percent of the average. In column (6), the coefficient indicates that after the financial acquisitions of 2009, hospitals in treated regions have about 1.2 fewer beds in alcohol/drug abuse care on average compared to control regions. Considering the average number of beds in alcohol/drug abuse care is around 16.9 in table 3.18, this effect is economically large and is about 7 percent of the average. In column (7), the coefficient indicates that common ownership concentration does not have significant impacts on the number of beds in burn care.

Compared to logit regressions and Poisson regressions, the difference-in-differences method provides the causal impacts of common ownership concentration on hospital intensive margins of product mix strategies. In summary, when common ownership concentration increases, hospitals tend to invest more in beds for profitable services (cardiac intensive care, neonatal intensive care, and neonatal intermediate care) and less on unprofitable services (psychiatric care and alcohol/drug abuse care). This analysis finds no statistically significant impacts of common ownership concentration on services such as pediatric intensive care and burn care.

2.4 Parallel path assumption

In the DiD model, it is necessary to check the parallel path assumption for each outcome. In figure 3.2, the top left figure illustrates the parallel path of the number of beds in cardiac intensive care; the top right figure illustrates the parallel path of the number of beds in neonatal intensive care; the bottom left figure illustrates the parallel path of the number of beds in neonatal intermediate care; the bottom right figure illustrates the number of beds in pediatric intensive care. All figures show that the trends pre-2009 between treated regions and control regions are similar. After 2009, the number of beds in these profitable services rise in treated regions compared to control regions. More interestingly, this gap is converging in the long run.

In figure 3.3, the top left figure illustrates the parallel path of the number of beds in psychiatric care, the top right figure illustrates the parallel path of the number of beds in alcohol/drug abuse care, and the bottom left figure illustrates the parallel path of the number of beds in burn care. All figures show that these unprofitable services have similar pre-2009 trends. Unlike profitable services, the gap between treated regions and control regions is diverging in the long run.

2.5 Conclusion

In this paper, I test the effect of common ownership concentration on hospital product mix strategies. Hospital product mix strategies include both extensive margins and intensive margins. Extensive margins are measured by starting new hospital services such as cardiac intensive care. Intensive margins are measured by investing in hospitals beds for services such as cardiac intensive care.

By using the logit model, I find very little evidence for a relationship between common ownership concentration and hospital product mix strategies in extensive margins. However, by using the Poisson model, I find a significant relationship between common ownership concentration and hospital product mix strategies in intensive margins, especially in relatively profitable services. Specifically, there are positive and significant relationships between common ownership concentration and hospital investment in profitable services (measured by the number of beds). For example, higher common ownership concentration relates to a rise of 1.1 bed units in cardiac intensive care (mean of CICBD is 12.8), a rise of 1.1 beds in neonatal intensive care (mean of NICBD is 23.9), a rise of 2.2 beds in neonatal intermediate care (mean of NINTBD is 12.2), and a rise of 1.4 beds in pediatric intensive care (mean of

NINTBD is 14.3). The effects of common ownership concentration on unprofitable services are not so obvious. The only interesting result is a negative relationship between common ownership concentration and the number of beds in psychiatric care. Specifically, higher common ownership concentration relates to a decline of 1.1 beds in psychiatric care (mean of PSYBD is 51.1).

Further, I use a difference-in-differences model and find causal impacts of common ownership concentration on hospital product mix strategies in intensive margins. The exogenous shock is the financial acquisitions of 2009. Specifically, I find three positive causal impacts on profitable services, and two negative causal impacts on unprofitable services. The economic significances are as large as in the Poisson model.

In conclusion, common ownership concentration leads to hospital behavioral changes. In this paper, I find behavioral changes of product mix strategies in intensive margins. In my job market paper Players Behind the Scenes: Common Ownership in the Hospital Industry (2019), I find behavioral changes of pricing strategies. Both of these behavioral changes are motivated by one goal: maximizing profit.

Unlike hospital mergers, hospital managers partly serve their common owners. As I mentioned in my job market paper, evidence indicates that hospital managers maximize their own profits as well as their competing hospitals profits, as long as the competing hospital is also owned by their common owners. Unlike mergers, the common ownership concentration is new and has not been targeted by anti-trust agencies, resulting in consumer burdens (hospital pricing strategy) and social welfare loss (hospital product mix strategies).

These two chapters of common ownership concentration on hospital behaviors only solve the empirical conundrums. Although some mechanisms are discussed through these two studies, a rigorous study of the mechanisms of common ownership concentration on firm behaviors is needed in future research.

Chapter 3

Market concentration on gasoline prices: in the context of common ownership

3.1 Introduction

A concentrated oil refinery industry may lead to an increase of gasoline prices of the competitive level. Since 1990s, mergers among large oil firms happened in the U.S. For example, Exxon acquired Mobil forming ExxonMobil. According to a report by the U.S. Government Accountability Office on 2004, there are two problems caused by this increase of market concentration. First, the availability of generic gasoline has decreased substantially. Second, refiners prefer to deal with large distributors and retailers, which further motivate consolidation in distributor and retail markets. This paper tests the hypothesis that the impact of market concentration in the oil refinery markets on gasoline prices. Specifically, I measure the market concentration by the change of common ownership, and test its effects on gasoline prices.

Common ownership means one or a few large institutional investors own large stock shares on competing firms in the same market at the same time. American households have vastly increased their participation in equity markets since the early 1980s, primarily through the purchase of shares in mutual funds. The resulting growth in assets managed by the mutual fund industry has been concentrated in a few fund complexes (Davis, 2008). The increasing prevalence of institutional ownership of corporate equity creates many cases where two firms are owned by the same institutional investors (Freeman, 2017). According to Freeman's paper on 2017, if these two firms have the ability to influence each others' profits, the presence of common owners can affect how the firms interact, since these two firms share the goal of maximizing the wealth of the same owners. Common ownership is prevelant in many industries such as airline industry (Azar et. al. 2017) or banking industry (Azar et. al. 2016). Table 3.30 also illustrates that the common ownership exists in the oil refinery industry. Vanguard group and Blackrock almost own large stock shares in all big oil firms on 2016.

The mechanism of common ownership affecting product prices is through owners' voting power on firms managerial decisions. Once an institutional investor has large amount of stock shares in firms, they have the power to make firms operational decisions. Aggarwal, Dahiya and Prabhala (2015) used an event study of uncontested director election to show that shareholders' votes can bring about changes in corporate governance and firm policy. When they have the voting power among a few competing firms, hypothetically they could influence these competing firms by voting for a collusive outcome. For example, if Vanguard group owns large stock shares among a few competing oil refinery firms, the Vanguard group could manipulate managers in these firms to increase the prices of their refined oil products, acting as a monopoly in the oil refinery market.

There are literature discussed about the impact of market concentration on prices. Joe Bain is one of the pioneers in exploring market concentration, monopoly power and price theory. In his paper on, he says that an excess profit arises from a discrepancy between price and average cost, whereas a monopoly is conventionally defined as a situation involving a discrepancy between price and marginal cost. Therefore, a less competitive market could increase the discrepancy between price and marginal cost, and thus maximize profits. There are also empirical studies showing the effect of market concentration on product prices. For example, Hastings and Gilbert (2005) examined the effect of market concentration on wholesale gasoline prices. They used the mergers in West Coast gasoline refining and retailing markets to test this relationship, and they found evidence that "this acquisition can have a significant impact on wholesale prices." However, another paper by Sen (2003) approached an opposite result, showing that the movements of gasoline prices in Canada "are largely the results of input price fluctuations rather than local market structure". In other words, he indicates that crude oil prices affect gasoline prices more than the effects coming from market concentration.

There are some literature about the effect of market concentration on product prices due to common ownership. Azar (2011) showed that the density of the network, of common ownership of publicly traded US corporations generated by institutional investors, more than tripled between 2000 and 2010. Under common ownership, firm managerial policies are significantly affected by institutional investors, see McCahery et al. (2016). Also, common ownership reduces the marginal cost of information, see Asker and Ljungqvist (2010). Because under common ownership, same-industry rival firms would benefit from each others' information about the industry. With these two mechanisms, common ownership influences firms profitability and markups through influencing product prices. For example, Azar, Schmalz, and Tecu (2017) found a robust correlation between within-route changes in common ownership concentration and route-level changes in ticket prices; also, Azar, Raina, and Schmalz (2016) used the growth of index funds as an arguably exogenous event of cross-ownership variation of county-level common ownership growth to suggest a causal link from the standard measure of concentration to higher prices for banking products.

There are three contributions of this paper. First, I have a good measure of market concentration, which is the common ownership. This is a good measure because it not only considers competing firms' market shares, but also takes investors' ownerships in these competing firms into account. Second, I use an acquisition in the asset management industry that causes the change of ownership in the oil refinery industry and changes in market concentration, which is exogenous. Third, this is an empirical test of a traditional model about the impact of market concentration on product prices.

My data comes from two sources. The first source is the Wharton Research Data Services (WRDS), and the second source is the Energy Information Administration (EIA). WRDS includes data of institutional stock shares and oil firms' revenues. The firms' revenues are from the Compustat, and institutional stock shares are from the 13-f statement. EIA has the data about gasoline prices and refined oil quantities at the firm level.

In this paper, I first run a panel regression to test the correlation between common ownership and gasoline prices at the regional level. In order to solve the reverse causality issue, I introduce the acquisition of Lehman Brothers by Barclays Bank PLC on June of 2009 as an exogenous shock, and I apply a difference-in-differences methodology.

The panel regression shows statistically significant results that the increasing common ownership will cause higher regional gasoline prices. In the difference-in-differences method, I find statistically significant results that after acquisition the treated regions have 4 cents per gallon higher gasoline price than the control regions. The results suggest that market concentration due to common ownership would cause the increase of regional gasoline prices.

The rest of this paper is structured as following: section 2 introduces previous literature about the common ownership; section 3 gives the background of my identification strategies; section 4 describes the data and summary statistics; section 5 shows the methodologies and their results; section 6 concludes; section 7 provides future studies for this topic.

3.2 Literature Review

To my knowledge, this paper is the first paper to study the effect of common ownership on gasoline prices. The mechanism of this effect is through the institutional stockholders voting power on firms' managerial decisions. There are some theoretical literature arguing that shareholders with diversed portfolios have interests in maximize their joint portfolio profits rather than individual firm profit, and they predict that the diversification can increase concentration in product markets. For example, Gordon (1990) and Rubin (2006) both modelled the corporate behavior normally assume shareholders not only care about the effects of a manager's decisions on the shares they own in that firm, but also care about the effects of a manager's decisions on the value of the firm's bonds they own in other firms.

Reynolds and Snapp (1986) modified the Cournot model to allow firms own shares in competitors. Bresnahan and Salop (1986) introduced the modified Herfindahl-Hirschman Index (MHHI) to quantify the competitive effects of horizontal joint ventures. I use O'Brien and Salop (2000)'s version of the MHHI for my reduced-form empirical tests.

On the empirical side, Azar, Schmalz, and Tecu (2017) found a robust correlation between within-route changes in common ownership concentration and route-level changes in ticket prices. In their paper, they used the acquisition of Barclays Global Investors by BlackRock as an exogenous shock, and they showed the relationship between the common ownership in the airline industry and tickets prices is causal. In this paper, I apply a different exogenous shock in the asset management industry to analyze the effect of common ownership in the oil refinery industry on gasoline prices.

In terms of both methodology and setting, my analysis mirrors that of Hastings and Gilbert (2005); Sen (2003), who studied the price effect of oil firms mergers on gasoline prices. By contrast, I investigate the effects of changes in the market concentration due to the changes in ownership structure of the refinery oil industry.

This paper contributes to the broad literature on institutional investors involvement in corporate governance. It is well known that active investors implement changes in executive compensation, turnover, and other corporate decisions that may affect product markets, see Brav et. al. (2008); Brav et. al. (2011). I mention that strategic changes can typically be implemented with the support of the firms' large institutional investors. Also, my paper contribute an empirical answer to the question "Do firm boundries matter?" My results suggest that common ownership can have the effect of blurring formal firm boundaries.

3.3 Identification background

In order to calculate the effect of common ownership in the oil refinery industry on gasoline prices, it is necessary to find a measurement to represent common ownership. In this paper, I use some indices to measure the market concentration and common ownership. The first index is called the Hirfindahl-Hirschman index (HHI). This index measures the market concentration. The calculation of HHI is $\sum_j s_j^2$. s_j means the market share of company j in the oil industry. Thus, the HHI of the oil refinery industry at a certain time period is the summation of square of all companies' market shares. The market share is calculated as the company's total revenue divided by the industry's total revenue at the same time period. Therefore, if HHI is larger, the industry is more concentrated.

O'Brien and Salop (2000) used a modified Hirfindahl-Hirschman Index (MHHI) to represent the market concentration allowing firms to hold shares in competitors, and I will use this measure to calculate the common ownership. The formula of MHHI is: $\sum_j \sum_k s_j s_k \frac{\sum_i \gamma_{ij}\beta_{ik}}{\sum_i \gamma_{ij}\beta_{ij}}$. In this formula, s_j and s_k represent market shares of companies j and k in the oil industry. β_{ij} represents holding shares from institutional investor i in oil company j, and γ_{ij} represents control shares by institutional investor i on oil company j. Holding shares mean the shares that are only for financial interests by shareholders, and control shares give shareholders the power to vote on portfolio firms operational decisions.

In this formula, the numerator and the denominator of the fraction term are differentiated by second terms. They are holding shares by institutional investor i invested in companies k and j. In this formula, notations k and j could represent a same company or two companies. If k and j represent a same company, the numerator and the denominator in this fraction will be cancelled out, and the MHHI will equal to the HHI. If k and j represent two companies, this induces a new term: $\sum_j \sum_{k \neq j} s_j s_k \frac{\gamma_{ij}\beta_{ik}}{\gamma_{ij}\beta_{ij}}$. This term is called the MHHI Delta, which represents the market concentration due to common ownership. The equation of calculating these indices is:

$$\sum_j \sum_k s_j s_k \frac{\sum_i \gamma_{ij}\beta_{ik}}{\sum_i \gamma_{ij}\beta_{ij}} = \sum_j s_j^2 + \sum_j \sum_{k \neq j} s_j s_k \frac{\gamma_{ij}\beta_{ik}}{\gamma_{ij}\beta_{ij}} \tag{3.1}$$

In this equation, the left hand side is the MHHI, representing the total market concentration. The first term of right hand side is the HHI, representing the market concentration due to everything but without ownership issue; the second term on the right hand side is the MHHI delta, representing the market concentration due to common ownership. Both MHHI and HHI ranges from 0 to 10,000, and MHHI is always greater or equal to HHI.

In order to interpret the relationship between MHHI, HHI and MHHI delta, I give an intuitive example in table 3.31. In the first scenario, suppose there is only one firm monopoly in the market, the total market concentration MHHI is 10,000, and all of this concentration is only due to HHI because there is no common ownership issue here, so the HHI is also 10,000.

In the second scenario, suppose there are two firms in the market, and each of these firms have 50% of market share and their owners are independent. Now, MHHI becomes 5,000, and this concentration is only due to HHI because there is no common ownership involved yet. However, the entry of a second firm into the market drives market competitive. In the third scenario, suppose these two firm owners swap 50% of their ownership to each other. Common ownership now plays a role in the market concentration. The HHI is still 5,000 like the scenario 2. The MHHI delta now becomes 5,000 because of common ownership. The total market concentration MHHI becomes 10,000 again, which means that although there are two competitors in the market, the market acting like a monopoly again. This also gives the hypothesis of my paper: The common ownership issue increases market concentration.

3.4 Data

My data comes from two sources. The first source is the Wharton Research Data Services (WRDS), and the second source is the Energy Information Administration (EIA). WRDS includes two sub-datasets. The Compustat includes firms income statements. The 13-f statement includes institutional ownerships. EIA gives all information about gasoline prices, crude oil prices and refined oil quantities.

The outcome variable is the average retailing gasoline prices by different grades and forms. The grades include regular, medgrade, and premium. The forms include conventional and reformulated. Gasoline prices varied by every combination of grades and forms. For example, conventional regular, conventional midgrade, or reformulated premium. The independent variable is the MHHI delta. The control variables include HHI, crude oil price and other fixed effects.

Both the price data and MHHI delta varied by regions and quarterly time. The U.S. oil refinery market is divided into five regions by Petroleum Administration for Defense Districts (PADD). The regions map is showed in figure 3.4. PADD1 represents the east coast; PADD2 represents the midwest; PADD3 represents the gulf coast; PADD4 represents the rocky mountains; PADD5 represents the west coast. The sample period is from June of 2006 to June of 2012, and there are in total 25 quarters in my sample period. Table 3.32 and figure 3.5 gives the summary statistics for some key information across different PADDs.

In order to study the common ownership, I drop the observations that financial institutions only hold stock shares in one oil company. I only include oil refinery firms which have refinery locations in the U.S. from June of 2006 to June of 2012. In other words, no matter the nationality or headquarter of the oil refinery firm, they are in my sample as long as they have at least 4 refinery locations in my sample. Nowadays, there are many integrated oil firms, which means they have business in both upstream and downstream. If such an oil firm has the oil refinery business, I will count it in my sample. For example, oil firms such as ExxonMobil and Royal Dutch Shell[1]. There was one spinoff of an oil firm happened during my sample period. ConocoPhillips was an integrated oil firm before 2010. On 2010, Phillips66 becomes a subsidiary of the parent company ConocoPhillips, and Phillips66 now mainly focuses on the oil refinery and ConocoPhillips focuses on upstream business. I treat ConocoPhillips in my sample before 2010, and treat Phillips66 in my sample after 2010. After making these data adjustments, there are in total 4,834 institutional investors and 15 oil refinery companies in my sample.

3.5 Methodology

3.5.1 Assumptions

First, I use a panel regression to test the relationship between common ownership and gasoline prices. In this analysis, the U.S. oil refinery market is divided into 5 regions. According to the EIA, these regions are differend Petroleum Administration for Defense

[1] These integrated oil firms have businesses other than oil refinery, so when calculating the market shares, there is an upward bias for these integrated firms.

Districts (PADD). These PADDs were created during the World War 2, in order to help organize the allocation of fuels. After the war, these PADDs were kept and continue be using nowadays. Figure 3.4 shows the map of these PADDs.

A very important assumption in this analysis is assuming that these PADDs are independent oil refinery market. I assume that in each of these PADDs, local refinery locations will only supply refined products to the regions inside the PADD. Although in reality, the pipelines can ship the refined oil out and into the PADDs. From the facts, I find that PADD1 moved about 15,000 thousand barrels to PADD2, PADD2 shipped in average about 15,000 thousand barrels to all other PADDs. PADD3 shipped mainly to PADD1 and PADD2; PADD4 shipped mainly to PADD2. PADD5 only received. In my difference-in-differences regression, I define PADD1 and PADD2 as control regions, and PADD4 and PADD5 as treated regions. I find that control regions received more refined product from other regions than treated regions did, so treated regions should have more power and influence on local regions gasoline prices. Therefore, if I relax the assumption, the effects should be larger, which means under the assumption my estimate is the lower bound of the effect of common ownership on gasoline prices.

The second assumption is the way to calculate the regional market share. The traditional way of calculating market shares is dividing the firm's total revenue by the market's total revenues. In my analysis, the revenue data is at the national level, but I need to calculate the regional market share. The equation of calculating the regional revenue is:

$$r_i = \frac{q_i}{Q_i} \times R_i \tag{3.2}$$

In this equation, r_i is the regional revenue of firm i; q_i is the regional quantities of refined oil by firm i; Q_i is the national quantities of refined oil by firm i; R_i is the national revenue of firm i. In this equation, I calculate a firm's regional revenue equals to the percentage of regional refined oil over national refined oil multiplies this firm's national revenue. The disadvantage of my data is that q_i and Q_i are collected at the year level, but R_i is collected at the quarter level, and I also need the regional revenue to be at the quarter level. So, I assume that the percentage of regional quantities of refined oil over national quantities of refined oil is constant over four quarters in the same year. After I get the regional revenues for all oil companies, I can get the regional market share and thus get the regional HHI.

3.5.2 Panel regression

Empirical strategy

In the panel regression, I analyze the effect of common ownership on gasoline prices. The regression is:

$$Price_{rgt} = \alpha + \beta MHHIdelta_{rt} + \theta X_{rt} + F_t + F_r + F_g + \epsilon_{rgt} \tag{3.3}$$

Where the outcome variable is gasoline prices in PADD r at time t for grade-form g. The grades include regular, midgrade, and premium. The forms include conventional and reformulated. Gasoline prices varied by every combination of grades and forms. For example, conventional regular, conventional midgrade, or reformulated premium. The independent variable is the $MHHIdelta$ index at PADD r at time t. X_{rt} is a set of control variables, including crude oil prices which captures the variation of gasoline prices caused by crude oil prices and HHI which captures the variation of gasoline prices caused by the change of market concentration due to other activities than due to common ownership, such as mergers or spinoffs of oil firms. F_t is year fixed effects; F_r is PADD fixed effects; F_g is grade-form fixed effects. Following the paper by Azar et. al. (2017), I add a weight into the regression, in order to distinguish the weight of different PADDs. The weight is measured by the average quantities of refined oil in each PADD.

A possible mechanism in this relationship is that once the common ownership becomes more concentrated, while the shareholders have the power on firms voting decisions, so they could make decisions in order to maximize their joint portfolio profits. Therefore, these firms might have a collusive decision to increase the gasoline prices. So, I expect to see that a higher MHHI delta index could cause higher gasoline prices. Thus, the expected sign of the main coefficient β is positive.

The limitation by using this strategy is the reverse causality. The increasing gasoline prices might attract investors to invest on oil refinery firms, and therefore cause the increase of common ownership. So, I need to perform a difference in difference strategy to solve this concern, which will be explained in the next section.

Results

Table 3.33 shows the results of panel regression. The coefficient of $MHHIdelta$ is statistically significant at one percent level. We can see that that every increase of MHHIdelta by 1 point will increase the regional gasoline prices by 4.8 cents per gallon. I adjust the range of MHHI delta by dividing the real value by 1,000 in order to get the range of MHHI delta from 0 to 10. Thus, the MHHI delta over my sample period is ranging from 4.9 to 7.5. Therefore, an one point increase of $MHHIdelta$ causing 4.8 cents per gallon increase of gasoline prices is also economically significant. This result suggests a positive correlation between common ownership and gasoline prices.

3.5.3 Difference-in-Differences

Empirical strategy

The panel regression method gives a basic relationship between common ownership and gasoline prices. However, there is a severe concern in this approach. We are testing the effect of common ownership on gasoline prices. However, the reverse causality might exist. In other words, the increase of gasoline prices could attract institutional investors to invest in oil companies. In order to solve this potential concern, I introduce an exogenous shock and apply the difference-in-differences methodology.

On 2008, Lehman Brothers declared bankruptcy. On the June of 2009, Barclays Bank

PLC claimed the acquisition of Lehman Brothers. After this event, stock shares that were previously held by Lehman Brothers in the oil industry became Barclays'. The oil industry therefore became more concentrated because of this acquisition event in the asset management industry. I use this acquistion as an exogenous shock to study the effect of common ownership on gasoline prices.

In order to divide 5 PADDs into the treated group and the control group. I assume that on March of 2009, which is one quarter before the acquisition happened, the PADDs consisting of oil refinery firms were held by Lehman Brothers and Barclays Bank PLC with more stock shares experienced larger effects by this acquisition. I calculate the amount of stock shares held by Lehman Brothers and Barclays Bank PLC in oil refinery firms in each of these PADDs on the first quarter of 2009 and show the results in table 3.34. The results show that the PADD1 and PADD2 had oil refinery firms with smaller amount of stock shares that belong to Lehman Brothers and Barclays Bank PLC back on March of 2009, so these two PADDs form the control group. On the other hand, PADD5 and PADD4 had oil refinery firms with larger amount of stock shares that belong to Lehman Brothers and Barclays Bank PLC, so they are in the treated group. In order to balance the treated group and control group, I drop the "middle" PADD3. In this table, I also calculate the percentage of stock shares that were held by Lehman Brothers and Barclays over total stock shares in the PADD. I find that these percentages are pretty similar at around 10%.

I exploit the variation in ownership generated by the acquisition as follows. I start by calculating the MHHI delta in the year before the acquisition was announced, 2009, for each hospital referral region. I then calculate a counterfactual MHHI delta for the same year and region, but I treat the holdings of Lehman Brothers and Barclays as if they had already been held by a single entity. I call the difference between the latter and former MHHI delta the implied change in MHHI delta. The null hypothesis is that the acquisition, as with any other ownership change, had no effect on portfolio firms product market behavior. The alternative hypothesis is that markets more affected by the acquisition those with a higher implied change in MHHI delta experience higher price changes compared to less affected markets.

The reason for doing this is that between the pre- and post-periods, many changes can occur in portfolios and market shares, some of which might be endogenous, such as hospital systems may merge or increase prices corresponding to the acquisition between Lehman Brothers and Barclays. The sum of these changes constitutes the actual change in the MHHI delta. I intend to use the only variation that is not endogenous. If the BlackRock-Barclays acquisition were the only change, the actual change in the MHHI delta would be exactly the same as the implied change. If other changes are small relative to the Lehman Brothers-Barclays acquisition, it will not be exactly the same, but the correlation between the two will be high, resulting in a strong instrument. Thus, we can think of the implied change in the MHHI delta as a treatment variable, which measures a given firms level of exposure to the acquisition event.

The difference-in-differences regression is:

$$Price_{rgt} = \alpha + \beta DD_{rt} + F_t + F_r + F_g + \theta X_{rt} + \epsilon_{rgt} \tag{3.4}$$

In this regression, the outcome variable is the gasoline price at PADD r at time t of grade-form g. The independent variable is an interaction of two dummy variables. The first dummy variable is the post dummy variable, which equals to 1 if the time is equal or after the June of 2009, and 0 if before this time. The second dummy variable is the treated dummy variable, which equals to 1 is the PADDs are in the treated group, and 0 if the PADDs are in the control group. In this regression, I include the crude oil price as a control variable to control for the variation of gasoline prices caused by crude oil prices. I also include the year fixed effects, PADDs fixed effects, and grade-form fixed effects into the regression. I add a weight into the regression in order to distinguish the size of different PADDs. The weight is calculated by the average of quantities in each PADD.

A possible mechanism in this approach is that after this acquisition, the market concentration in the refinery oil industry increased due to common ownership, and therefore Barclays could make voting decisions in its portfolio firms in order to maximize the joint portfolio profits. The hypothesis is that for the PADDs that are more affected by the acquisition, which are those have more stocks shares of Barclays' Bank PLC and Lehman Brothers, will experience higher price increases compared to the less affected PADDs.

By performing this difference-in-differences methodology, I also need to prove the satisfaction of the parallel path assumption. Figure 3.6 shows the pre-trends and post-trends of treated group and control group. We can see that the pre-trends between two groups are very similar. Right after the acquisition happened, the treated group deviated from the control group and experience a increasing of gasoline prices.

Results

Table 3.35 shows the results of difference-in-differences methodology. The main coefficient β is positive and statistically significant at 5 percentage level. The value of coefficient means that the acquisition of Lehman Brothers by Barclays' Bank PLC caused the treated PADDs increase the gasoline prices by 4 cents per gallon comparing to the controlled PADDs. This result is also economically significant because 4 cents per gallon for the gasoline is a large increase of price considering that the oil refinary industry plays a relatively small role in pricing the gasoline than crude oil pricing and state gasoline taxes. Figure 3.7 shows the breakdown of regular gasoline prices.

3.5.4 Robustness check

In addition to using the national revenue generated by each oil refinery firm to calculate the market shares of oil refinery firms, I introduce an alternative measure of market shares: In each region, I divide each oil refinery firm's refinery capacities by the total capacities refined by all oil refinery firms in this region.

The advantage of this measure is that I calculate firms' market shares at the regional level, so it would be more accurate to use this measure to calculate the regional market concentration index. The weakness of this measure is that the data of firm's refinery capacity is at the year level, but my outcome variable is at the quarter level. Therefore, the control variable, HHI, is constant over four quarters in the same year, which might bias my results.

When using the new measure of market shares, I re-run my panel regressions, and the results are in table 3.36. Comparing to my results when using the original measure of market shares, the effect of common ownership concentration on gasoline prices is larger: a one standard deviation increase of $MHHIdelta$ causes 10 cents per gallon increase of gasoline prices. The results of difference-in-differences are the same when using both two measures of market shares, because the treatment group and the control group are the same.

The first method is to use the national revenue of oil refinery firms to represent the local revenue of them, and then calculate the local market shares of these firms. The local revenue should be smaller than the national revenue, so the market share of some firms should be smaller, which indicates that the measure of common ownership concentration should be smaller. In my second method, I use the local oil refinery capacities to calculate local market share. However, the capacity data is at the year level, but gasoline price data is at the quarter level. Thus, the market shares of firms are constant through the whole year, and the weakness is that it could miss some market share changes at the quarter level, which could probably contaminate my results.

3.6 Conclusion

In this paper, I test the traditional theory of market concentration on product prices by measuring the market concentration by common ownership. Following the empirical strategy from Azar et. al. (2017), I test the effect of common ownership in the oil refinery industry on gasoline prices. In the panel regression, I find a statistically significant result that every every increase of 1 point of adjusted MHHI delta would increase the regional gasoline prices by 4.8 cents per gallon. Since the panel regression only shows the correlation between common ownership and gasoline prices, and this method has potential reverse causality issue, I run a difference-in-differences methodology by using the acquisition of Lehman Brothers by Barclays Bank PLC on June of 2009 as an exogenous shock, and I find a statistically significant result that the acquistion happened in the asset management industry has an impact on treated regions with 3.9 cents per gallon of higher gasoline prices than control regions. My results suggest a statistically and economically significant causal relationship between the common ownership in the oil refinery industry and gasoline prices.

3.7 Future researches

In this paper, the outcome variable is the average retailing gasoline prices, which includes the state gasoline taxes into the prices. Although I add the regional fixed effects into my regressions to control for the variation caused by state gasoline taxes, exogenous changes of state gasoline taxes could affect my results. For this matter, I check the state motor-fuel tax rates from my sample period, and I find that almost all states didn't change their gasoline taxes at all or little change no larger than 1%, but only California increased gasoline tax from 18% to 35.3% on 2010. Excluding California from my sample would be harmful to my analysis, but this tax shock is something that I can't control in my analysis, which could be studied by future researchers.

Appendices

Table 3.1: Summary statistics 1

Community Health Systems (CYH)	[%]	Health South Corp. (HLS)	[%]	Kindred Healthcare (KND)	[%]
Franklin Resources Inc.	11.63	Fidelity MGMT	9.25	BlackRock Inc.	8.56
T. Rowe Price Associates Inc.	9.54	T. Rowe Price Associates Inc.	8.91	Dimensional Fund Advisors	8.30
Bamco Inc.	8.66	BlackRock Inc.	5.18	Fidelity MGMT & Wellington MGMT Co.	6.53
TPG-AXON Capital MGMT, L.P.	4.97	Amvescap PLC	4.76	Columbia MGMT Inv. Advisors	5.69
BlackRock Inc.	4.74	Vanguard Group Inc.	4.73	Vanguard Group Inc.	4.22
Vanguard Group Inc.	4.04	Osterweis Capital MGMT Inc.	3.56	Acadian Asset MGMT	3.90
Universal Health Service (UHS)	**[%]**	**Selected Medical (SEM)**	**[%]**	**Tenet Healthcare (THC)**	**[%]**
Wellington MGMT Co.	8.05	Amvescap PLC	2.97	Franklin Resources Inc.	10.47
BlackRock Inc.	4.92	T. Rowe Price Associates Inc.	2.91	Fidelity MGMT	8.30
Fidelity MGMT	4.30	Adage Capital MGMT	1.36	Vanguard Group Inc.	5.65
Vanguard Group Inc.	3.76	Vanguard Group Inc.	1.35	BlackRock Inc.	4.02
Viking Global Investors	3.46	Omega Advisors	1.10	Oracle Investment MGMT	3.27
Sirios Capital MGMT	3.29	BlackRock Inc.	1.05	State Street Corp.	3.27

Notes: This table shows the largest six stock shareholders of each publicly traded health care system in the fourth quarter of 2010.

Table 3.2: Summary statistics 2

Adage Capital MGMT	[%]	BlackRock Inc.	[%]	Fidelity MGMT	[%]
THC	58.6	THC	27.1	THC	13.7
SEM	19.4	SEM	9.0	CYH	2.6
HLS	11.2	CYH	5.2	HLS	2.6
UHS	10.8	HLS	5.1	UHS	2.5
T. ROWE PRICE ASSOCIATES, INC.	**[%]**	**Vanguard Group Inc.**	**[%]**		
THC	10.8	THC	8.9		
SEM	3.6	SEM	3.0		
CYH	2.1	CYH	1.6		
HLS	2.1	HLS	1.6		

Notes: This table shows the investment distributions of five large institutional investors in the hospital industry in the fourth quarter of 2010. In each investment distribution, the percentage represents that how much investments that institutional investors invest in each health systems out of investor's total investment in the hospital industry.

Table 3.3: Intuitive example of common ownership

	MHHI	HHI	MHHI delta
formula	$\sum_j \sum_k s_j s_k \frac{\sum_i \gamma_{ij}\beta_{ik}}{\sum_i \gamma_{ij}\beta_{ij}}$	$\sum_j s_j^2$	$\sum_j \sum_{k\neq j} s_j s_k \frac{\gamma_{ij}\beta_{ik}}{\gamma_{ij}\beta_{ij}}$
scenario 1: 1 firm	10,000	10,000	0
scenario 2: 2 firms with independent owners	5,000	5,000	0
scenario 3: 2 owners swap 50% of their ownerships	10,000	5,000	5,000

Table 3.4: Summary statistics of all variables

VARIABLES	(1) N	(2) mean	(3) sd	(4) min	(5) max
charges	17,699	4.168e+08	6.645e+08	2.390e+06	7.765e+09
discharges	17,699	5,910	8,394	1	82,036
charges/discharges	17,699	100,244	378,848	6,394	5.985e+06
MHHIdelta	17,699	5,894	2,460	1	8,555
Log(MHHIdelta)	17,699	8.327	1.569	0	9.054
HHI	17,699	2,804	1,762	1,232	10,000
Log(HHI)	17,699	7.800	0.493	7.116	9.210
HHIstar	17,699	1,332	744.9	471.8	7,909
Log(HHIstar)	17,699	7.054	0.534	6.157	8.976
number of beds	17,699	149.5	122.8	7	1,492
operating expenses	17,699	8.668e+07	1.210e+08	1.634e+06	1.178e+09
urban hospital dummy	17,699	0.826	0.379	0	1
teaching hospital dummy	17,699	0.106	0.308	0	1
critical access hospital dummy	17,699	0.0253	0.157	0	1
admissions	17,699	6,061	8,219	20	79,612
total inpatient days	17,699	33,907	40,180	47	428,809
inpatient surgical operations	17,699	1,679	3,106	0	32,283
outpatient surgical operations	17,699	2,447	3,636	0	39,418
total surgical operations	17,699	4,126	6,518	0	71,477
total payroll expenses	17,699	2.942e+07	3.928e+07	785,319	4.355e+08
full-time personnel	17,699	467.7	601.3	21	5,899
part-time personnel	17,699	119.7	144.4	0	1,800

Notes: The number of observations is at the hospital-HRR(region)-year level. My sample years are from 2005 to 2015. e+08=10,000,000, so 6.07e+08=607,000,000.

Table 3.5: Linear regressions

Dependent variable: hospital charges per discharge		
VARIABLES	(1)	(2)
MHHIdt	0.10***	0.10***
	(0.03)	(0.03)
hhi	0.34***	0.36***
	(0.05)	(0.05)
hhistar	-0.24***	-0.25***
	(0.04)	(0.04)
beds		0.00***
		(0.00)
urban		0.15***
		(0.02)
teach		-0.01
		(0.02)
cah		0.14***
		(0.03)
suroptot		0.00***
		(0.00)
ipdtot		-0.00***
		(0.00)
paytot		0.00***
		(0.00)
fttot		0.00
		(0.00)
pttot		-0.00
		(0.00)
vtot		-0.00***
		(0.00)
ratio		0.00
		(0.00)
Year fixed effects	✓	✓
Region fixed effects	✓	✓
Observations	17,699	17,699
R-squared	0.19	0.24

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

Table 3.6: Linear regressions with leads and lags

Dependent variable: hospital charges per discharge		
VARIABLES	(1)	(2)
MHHIdt - lead	0.05	0.06
	(0.05)	(0.05)
MHHIdt	0.11**	0.09*
	(0.05)	(0.05)
MHHIdt - lag	0.05**	0.04*
	(0.02)	(0.02)
HHI - lead	0.03	0.09
	(0.12)	(0.12)
HHI	0.39**	0.37**
	(0.16)	(0.16)
HHI - lag	-0.04	-0.04
	(0.07)	(0.07)
HHIstar	-0.29**	-0.31**
	(0.13)	(0.13)
beds		0.00
		(0.00)
urban		0.14
		(0.10)
teach		-0.06
		(0.07)
cah		0.14
		(0.10)
suroptot		0.00**
		(0.00)
ipdtot		-0.00***
		(0.00)
paytot		0.00***
		(0.00)
fttot		0.00
		(0.00)
pttot		-0.00
		(0.00)
vtot		-0.00**
		(0.00)
ratio		0.00*
		(0.00)
Year fixed effects	✓	✓
Region fixed effects	✓	✓
Observations	2,047	2,047
R-squared	0.28	0.31

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 3.7: Exogenous shocks

Acquiring firm	Target firm	Effective date
J.P. Morgan Chase & Co.	BNY-Consumer Business	10/2/2006
Morgan Stanley Group Inc.	FrontPoint Partners, L.L.C.	12/4/2006
Bank of NY Trust Co.	Mellon Bank	7/2/2007
Barclays Bank PLC	Lehman Brothers Inc.	9/22/2008
RiverSource Investments	J. & W. Seligman & Co., Inc.	11/7/2008
Bank of America Corporation	Merrill Lynch & Co Inc.	1/1/2009
BlackRock Inc.	Barclays Global Investors	12/1/2009

Table 3.8: Summary statistics of acquired investors before acquisitions

Bank of American Corp.	[%]	Merrill Lynch & Co. Inc.	[%]
LPNT	4.87	PSYS	0.69
KND	3.71	CYH	0.59
CYH	1.72	LPNT	0.30
PSYS	1.71	THC	0.13
BlackRock	[%]	Barclays Global Investors	[%]
KND	1.10	UHS	7.52
LPNT	0.85	PSYS	6.47
UHS	0.34	LPNT	5.35
CYH	0.11	CYH	5.03

Notes: The statistics in the table above were on 2008, which were before the acquisitions occurred. The table shows the top four holding stocks by the four institutional investors that are involved in the acquisitions in 2009.

Table 3.9: Summary statistics of hospital characteristics for treated group

VARIABLES	(1) N	(2) mean	(3) sd	(4) min	(5) max
beds	1,372	144.7	85.32	25	568
op_exp	1,372	9.036e+07	1.013e+08	4.940e+06	5.751e+08
urban	1,372	0.856	0.351	0	1
teach	1,372	0.125	0.331	0	1
cah	1,372	0.0295	0.169	0	1
hospbd	1,372	146.5	123.2	0	668
obhos	1,372	0.368	0.483	0	1
obsys	1,372	0.152	0.359	0	1
rehabhos	1,372	0.281	0.450	0	1
rehabsys	1,372	0.0719	0.258	0	1
pethos	1,372	0.0817	0.274	0	1
petsys	1,372	0.0659	0.248	0	1
ultsnhos	1,372	0.467	0.499	0	1
ultsnsys	1,372	0.0522	0.222	0	1
admtot	1,372	6,144	6,537	179	36,389
ipdtot	1,372	33,947	32,213	1,878	198,167
births	1,372	609.4	1,021	0	6,617
suropip	1,372	1,593	2,374	0	15,548
suropop	1,372	2,317	3,033	0	25,304
suroptot	1,372	3,910	5,182	0	36,804
paytot	1,372	2.956e+07	3.380e+07	1.387e+06	2.233e+08
fttot	1,372	470.4	470.2	42	2,609
pttot	1,372	122.5	137.3	0	1,118
n_f_ratio	1,372	5.301	0.477	4.647	6.333

Table 3.10: Summary statistics of hospital characteristics for control group

VARIABLES	(1) N	(2) mean	(3) sd	(4) min	(5) max
beds	2,118	132.0	116.8	7	1,492
op_exp	2,118	7.447e+07	1.109e+08	1.634e+06	1.178e+09
urban	2,118	0.798	0.401	0	1
teach	2,118	0.103	0.305	0	1
cah	2,118	0.0219	0.147	0	1
hospbd	2,118	134.6	150.6	0	1,604
obhos	2,118	0.293	0.455	0	1
obsys	2,118	0.152	0.359	0	1
rehabhos	2,118	0.247	0.432	0	1
rehabsys	2,118	0.0613	0.240	0	1
pethos	2,118	0.0495	0.217	0	1
petsys	2,118	0.0418	0.200	0	1
ultsnhos	2,118	0.403	0.491	0	1
ultsnsys	2,118	0.0446	0.206	0	1
admtot	2,118	5,065	7,477	20	79,612
ipdtot	2,118	29,552	37,270	47	428,809
births	2,118	559.7	1,275	0	11,324
suropip	2,118	1,405	2,812	0	32,283
suropop	2,118	2,297	3,579	0	39,418
suroptot	2,118	3,702	6,157	0	71,477
paytot	2,118	2.618e+07	3.598e+07	785,319	4.355e+08
fttot	2,118	411.6	550.5	21	5,899
pttot	2,118	123.5	143.6	0	1,800
n_f_ratio	2,118	5.336	0.472	4.647	6.333

Table 3.11: Difference-in-differences regressions

Dependent variable: hospital charges per discharge		
VARIABLES	(1)	(2)
Post*Treat	0.12***	0.12***
	(0.02)	(0.02)
HHI	0.27***	0.30***
	(0.05)	(0.04)
HHIstar	-0.25***	-0.27***
	(0.04)	(0.04)
beds		0.00***
		(0.00)
urban		0.16***
		(0.02)
teach		-0.02
		(0.02)
cah		0.14***
		(0.03)
suroptot		0.00***
		(0.00)
ipdtot		-0.00***
		(0.00)
paytot		0.00***
		(0.00)
fttot		0.00
		(0.00)
pttot		-0.00**
		(0.00)
ratio		0.00
		(0.00)
Year fixed effects	✓	✓
Region fixed effects	✓	✓
Observations	17,699	17,699
R-squared	0.20	0.24

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

Table 3.12: Multiple exogenous shocks

Dependent variable: hospital charges per discharge			
Exogenous year	2006	2007	2008
$Post * Treat$	0.09**	0.13	0.20***
	(0.04)	(0.03)	(0.03)
HHI	0.30***	0.29**	0.27***
	(0.04)	(0.04)	(0.04)
HHIstar	-0.25***	-0.23**	-0.18***
	(0.04)	(0.04)	(0.04)
beds	0.00	0.00*	0.00*
	(0.00)	(0.00)	(0.00)
urban	0.15**	0.11	0.11
	(0.08)	(0.08)	(0.08)
teach	-0.10*	-0.04	-0.04
	(0.06)	(0.06)	(0.06)
cah	0.01	0.13	0.13
	(0.08)	(0.08)	(0.08)
suroptot	0.00**	0.00***	0.00***
	(0.00)	(0.00)	(0.00)
ipdtot	-0.00**	-0.00***	-0.00***
	(0.00)	(0.00)	(0.00)
paytot	0.00***	0.00***	0.00***
	(0.00)	(0.00)	(0.00)
fttot	0.00	0.00	0.00
	(0.00)	(0.00)	(0.00)
pttot	-0.00	-0.00	-0.00
	(0.00)	(0.00)	(0.00)
ratio	-0.59***		
	(0.05)		
Year fixed effects	✓	✓	✓
Region fixed effects	✓	✓	✓
Observations	17,699	17,699	17,699
R-squared	0.24	0.25	0.25

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 3.13: Total stock shares involved by institutional acquisitions

Exogenous year	2009	2008	2007	2006
Total stock shares involved by acquisitions	50,700,000	41,000,000	18,758,000	11,800,000
Total stock shares involved by acquiring firm	10,300,000	38,400,000	2,700	10,700,000

Notes: The units of these numbers are dollars.

Table 3.14: Exogenous shocks

Acquiring firm	Target firm	Effective date
J.P. Morgan Chase & Co.	BNY-Consumer Business	10/2/2006
Morgan Stanley Group Inc.	FrontPoint Partners, L.L.C.	12/4/2006
Bank of NY Trust Co.	Mellon Bank	7/2/2007
Barclays Bank PLC	Lehman Brothers Inc.	9/22/2008
RiverSource Investments	J. & W. Seligman & Co., Inc.	11/7/2008
Bank of America Corporation	Merrill Lynch & Co Inc.	1/1/2009
BlackRock Inc.	Barclays Global Investors	12/1/2009

Notes: I copy the table 3.26 here in order to better interpret the table 3.13.

Table 3.15: Robustness check with similar outcomes

	Outcome variable: Hospital charges / X				
X	number of beds	total payroll expenses	total inpatient days	the number of full time personnel	total admissions
$Post * Treat$	0.12**	0.14***	0.20***	0.15***	0.17***
	(0.05)	(0.04)	(0.05)	(0.04)	(0.05)
HHI	0.09	0.07	0.12	0.07	0.10
	(0.08)	(0.06)	(0.08)	(0.06)	(0.08)
HHIstar	-0.20	-0.12	-0.08	-0.23	-0.13
	(0.17)	(0.11)	(0.14)	(0.15)	(0.11)
urban	0.06	-0.08*	-0.28***	0.08	0.17**
	(0.09)	(0.05)	(0.08)	(0.05)	(0.07)
teach	0.18**	0.10*	0.11	0.04	-0.04
	(0.09)	(0.06)	(0.08)	(0.07)	(0.07)
cah	-1.09***	-0.37***	0.21	-0.39***	-0.03
	(0.23)	(0.12)	(0.19)	(0.12)	(0.18)
obhos	0.50***	0.16***	0.28***	0.19***	-0.08
	(0.09)	(0.05)	(0.08)	(0.06)	(0.06)
rehabhos	-0.30***	-0.28***	-0.44***	-0.31***	-0.30***
	(0.05)	(0.04)	(0.05)	(0.04)	(0.05)
ultsnhos	0.33***	0.29***	0.58***	0.34***	0.31***
	(0.07)	(0.05)	(0.08)	(0.05)	(0.07)
births	-0.00*	-0.00**	-0.00***	-0.00***	-0.00***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
suroptot	0.00	0.00***	0.00***	0.00***	0.00***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
ipdtot	-0.00*	-0.00		-0.00**	-0.00***
	(0.00)	(0.00)		(0.00)	(0.00)
paytot	0.00***		0.00***	0.00***	0.00***
	(0.00)		(0.00)	(0.00)	(0.00)
fttot	-0.00	-0.00	-0.00***		-0.00
	(0.00)	(0.00)	(0.00)		(0.00)
pttot	0.00	-0.00**	-0.00*	-0.00***	-0.00
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
ratio	-0.27***	-0.21***	-0.31***	-0.30***	-0.30***
	(0.03)	(0.02)	(0.03)	(0.02)	(0.03)
beds		0.00***	0.00***	0.00***	0.00***
		(0.00)	(0.00)	(0.00)	(0.00)
Year fixed effects	✓	✓	✓	✓	✓
Region Fixed effects	✓	✓	✓	✓	✓
Observations	17,699	17,699	17,699	17,699	17,699
R-squared	0.63	0.54	0.59	0.55	0.31

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 3.16: Falsification tests

False hypothesis	(1)				(2)			
Exogenous years	2009	2008	2007	2006	2009	2008	2007	2006
$Post * Treat$	0.00	-0.00	-0.07	-0.04	-0.04	0.02	-0.01	-0.04
	(0.06)	(0.05)	(0.06)	(0.06)	(0.05)	(0.06)	(0.04)	(0.04)
HHI	0.12	0.12	0.13	0.13	0.12	0.12	0.12	0.13
	(0.10)	(0.11)	(0.11)	(0.11)	(0.11)	(0.11)	(0.11)	(0.11)
HHIstar	-0.13	-0.21	-0.08	-0.14	-0.12	-0.07	-0.21	-0.14
	(0.14)	(0.11)	(0.13)	(0.12)	(0.11)	(0.11)	(0.11)	(0.11)
beds	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
urban	0.15**	0.15**	0.15**	0.15**	0.15**	0.15**	0.15**	0.15**
	(0.08)	(0.08)	(0.08)	(0.08)	(0.08)	(0.08)	(0.08)	(0.08)
teach	-0.10*	-0.10*	-0.10*	-0.10*	-0.10*	-0.10*	-0.10*	-0.10*
	(0.06)	(0.06)	(0.06)	(0.06)	(0.06)	(0.06)	(0.06)	(0.06)
cah	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
	(0.08)	(0.08)	(0.08)	(0.08)	(0.08)	(0.08)	(0.08)	(0.08)
obhos	-0.09*	-0.09*	-0.09*	-0.09*	-0.09*	-0.09*	-0.09*	-0.09*
	(0.05)	(0.05)	(0.05)	(0.05)	(0.05)	(0.05)	(0.05)	(0.05)
rehabhos	-0.35***	-0.35***	-0.35***	-0.35***	-0.35***	-0.35***	-0.35***	-0.35***
	(0.05)	(0.05)	(0.05)	(0.05)	(0.05)	(0.05)	(0.05)	(0.05)
ultsnhos	0.26***	0.26***	0.26***	0.26***	0.26***	0.26***	0.26***	0.26***
	(0.05)	(0.05)	(0.05)	(0.05)	(0.05)	(0.05)	(0.05)	(0.05)
births	-0.00**	-0.00**	-0.00**	-0.00**	-0.00**	-0.00**	-0.00**	-0.00**
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
suroptot	0.00**	0.00**	0.00**	0.00**	0.00**	0.00**	0.00**	0.00**
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
ipdtot	-0.00**	-0.00**	-0.00**	-0.00**	-0.00**	-0.00**	-0.00**	-0.00**
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
paytot	0.00***	0.00***	0.00***	0.00***	0.00***	0.00***	0.00***	0.00***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
fttot	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
pttot	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
ratio	-0.48***	-0.48***	-0.64***	-0.48***	-0.49***	-0.47***	-0.63***	-0.64***
	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)	(0.05)	(0.05)	(0.05)
Year fixed effects	✓	✓	✓	✓	✓	✓	✓	✓
Region Fixed effects	✓	✓	✓	✓	✓	✓	✓	✓
Observations	3,887	3,887	3,887	3,887	3,887	3,887	3,887	3,887
R-squared	0.36	0.36	0.36	0.36	0.36	0.36	0.36	0.36

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 3.17: Other interesting outcomes

	(1)		(2)		(3)		(4)	
Outcomes	Urban	Rural	Teach	Non-teach	Large	Small	CAH	non-CAH
$Post * Treat$	0.06	0.19***	0.17*	0.16**	0.14**	0.16	-0.08	0.17***
	(0.06)	(0.07)	(0.09)	(0.06)	(0.07)	(0.10)	(0.14)	(0.06)
HHI	-0.17	0.23*	0.01	0.17	0.19	0.13	-0.18	0.16
	(0.09)	(0.13)	(0.19)	(0.13)	(0.16)	(0.17)	(0.27)	(0.11)
HHIstar	-0.14	-0.23	-0.05	-0.16	-0.11	-0.07	-0.20	-0.14
	(0.10)	(0.10)	(0.13)	(0.12)	(0.13)	(0.11)	(0.12)	(0.11)
beds	0.00	0.00	0.00	0.00			0.00	0.00
	(0.00)	(0.00)	(0.00)	(0.00)			(0.00)	(0.00)
urban			-0.31*	0.16**	-0.04	0.23*	0.20	0.15*
			(0.16)	(0.08)	(0.09)	(0.13)	(0.17)	(0.08)
teach	-0.01	-0.08			-0.03	0.10		-0.10*
	(0.06)	(0.06)			(0.05)	(0.27)		(0.06)
cah	0.13*	-0.04		0.02	0.18	-0.02		
	(0.07)	(0.16)		(0.09)	(0.13)	(0.12)		
obhos	-0.06	-0.12**	-0.09	-0.10	-0.14**	-0.07	-0.55***	-0.09*
	(0.06)	(0.06)	(0.08)	(0.06)	(0.06)	(0.09)	(0.15)	(0.05)
rehabhos	-0.13**	-0.36***	-0.13**	-0.37***	-0.12**	-0.51***	-0.22	-0.35***
	(0.07)	(0.06)	(0.06)	(0.05)	(0.05)	(0.07)	(0.24)	(0.05)
ultsnhos	0.09	0.27***	0.16*	0.26***	0.31***	0.11*	0.37**	0.26***
	(0.07)	(0.06)	(0.08)	(0.06)	(0.07)	(0.07)	(0.15)	(0.05)
births	0.00	-0.00*	-0.00	-0.00**	-0.00	-0.00	0.00	-0.00**
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
suroptot	0.00	0.00*	0.00	0.00**	0.00	0.00	-0.00	0.00**
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
ipdtot	-0.00	-0.00**	-0.00	-0.00**	-0.00	-0.00	-0.00	-0.00**
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
paytot	0.00	0.00***	0.00	0.00***	0.00	0.00***	-0.00*	0.00***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
fttot	-0.00	0.00	0.00	0.00	0.00	-0.00	0.00	0.00
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
pttot	0.00	-0.00**	-0.00	-0.00	0.00	-0.00*	-0.00**	-0.00*
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
ratio	-0.43***	-0.43***	-0.38***	-0.19**	-0.33***	-0.14*	-1.25***	-0.20***
	(0.06)	(0.05)	(0.11)	(0.08)	(0.11)	(0.08)	(0.14)	(0.08)
Year fixed effects	✓	✓	✓	✓	✓	✓	✓	✓
Region Fixed effects	✓	✓	✓	✓	✓	✓	✓	✓
Observations	725	3,162	424	3,463	1,859	2,028	93	3,794
R-squared	0.81	0.37	0.73	0.36	0.41	0.45	0.90	0.36

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 3.18: Summary statistics of variables

	VARIABLES	N	mean	sd	min	max
Concentration	Log(MHHIdelta)	3,502	7.231	2.883	0	9.054
	Log(HHI)	3,502	8.116	0.611	7.116	9.210
profitable binary	Cardiac Intensive Care	3,502	0.140	0.347	0	1
	Neonatal Intensive Care	3,502	0.144	0.351	0	1
	Neonatal Intermidiate Care	3,502	0.0965	0.295	0	1
	Pediatric Intensive Care	3,502	0.202	0.402	0	1
	Birthing Rooms	3,502	0.306	0.461	0	1
	Fitness Center	3,502	0.0971	0.296	0	1
	Sports Medicine	3,502	0.186	0.389	0	1
	Electron Beam Computed Tomography	3,502	0.0214	0.145	0	1
	Womens Health Center	3,502	0.292	0.455	0	1
unprofitable binary	HIV/AIDS Service	3,502	0.0671	0.250	0	1
	Trauma Center	3,502	0.156	0.363	0	1
	Emergency Department	3,502	0.419	0.494	0	1
	Geriatric Services	3,502	0.211	0.408	0	1
profitable beds	Cardiac Intensive Care Beds	406	12.8	9.3	1	69
	Neonatal Intensive Care Beds	468	23.9	22.7	2	112
	Neonatal Intermediate Care Beds	242	12.2	16.2	1	105
	Pediatric Intensive Care Beds	114	14.3	8.3	3	59
unprofitable beds	Psychiatric Care Beds	659	51.1	38.3	5	208
	Alcohol/Chemical Dependency Care Beds	177	16.9	12.1	2	94
	Burn Care Beds	13	9.8	2.5	6	12

Table 3.19: Intuitive example of common ownership

	MHHI	HHI	MHHI delta
formula	$\sum_j \sum_k s_j s_k \frac{\sum_i \gamma_{ij}\beta_{ik}}{\sum_i \gamma_{ij}\beta_{ij}}$	$\sum_j s_j^2$	$\sum_j \sum_{k\neq j} s_j s_k \frac{\gamma_{ij}\beta_{ik}}{\gamma_{ij}\beta_{ij}}$
scenario 1: 1 system	10,000	10,000	0
scenario 2: 2 systems with independent shareholders	5,000	5,000	0
scenario 3: 2 shareholders swap 50% of their ownerships	10,000	5,000	5,000

Table 3.20: Summary statistics 1

Community Health Systems (CYH)	[%]	Health South Corp. (HLS)	[%]	Kindred Healthcare (KND)	[%]
Franklin Resources Inc.	11.63	Fidelity MGMT	9.25	BlackRock Inc.	8.56
T. Rowe Price Associates Inc.	9.54	T. Rowe Price Associates Inc.	8.91	Dimensional Fund Advisors	8.30
Bamco Inc.	8.66	BlackRock Inc.	5.18	Fidelity MGMT & Wellington MGMT Co.	6.53
TPG-AXON Capital MGMT, L.P.	4.97	Amvescap PLC	4.76	Columbia MGMT Inv. Advisors	5.69
BlackRock Inc.	4.74	Vanguard Group Inc.	4.73	Vanguard Group Inc.	4.22
Vanguard Group Inc.	4.04	Osterweis Capital MGMT Inc.	3.56	Acadian Asset MGMT	3.90
Universal Health Service (UHS)	[%]	Selected Medical (SEM)	[%]	Tenet Healthcare (THC)	[%]
Wellington MGMT Co.	8.05	Amvescap PLC	2.97	Franklin Resources Inc.	10.47
BlackRock Inc.	4.92	T. Rowe Price Associates Inc.	2.91	Fidelity MGMT	8.30
Fidelity MGMT	4.30	Adage Capital MGMT	1.36	Vanguard Group Inc.	5.65
Vanguard Group Inc.	3.76	Vanguard Group Inc.	1.35	BlackRock Inc.	4.02
Viking Global Investors	3.46	Omega Advisors	1.10	Oracle Investment MGMT	3.27
Sirios Capital MGMT	3.29	BlackRock Inc.	1.05	State Street Corp.	3.27

Notes: This table shows the largest six stock shareholders of each publicly traded health care system in the fourth quarter of 2010.

Table 3.21: Summary statistics 2

Adage Capital MGMT	[%]	BlackRock Inc.	[%]	Fidelity MGMT	[%]
THC	58.6	THC	27.1	THC	13.7
SEM	19.4	SEM	9.0	CYH	2.6
HLS	11.2	CYH	5.2	HLS	2.6
UHS	10.8	HLS	5.1	UHS	2.5
T. ROWE PRICE ASSOCIATES, INC.	[%]	Vanguard Group Inc.	[%]		
THC	10.8	THC	8.9		
SEM	3.6	SEM	3.0		
CYH	2.1	CYH	1.6		
HLS	2.1	HLS	1.6		

Notes: This table shows the investment distributions of five large institutional investors in the hospital industry in the fourth quarter of 2010. In each investment distribution, the percentage represents that how much investments that institutional investors invest in each health systems out of investor's total investment in the hospital industry.

Table 3.22: Extensive margins: Logit model

	Profitable services									Unprofitable services			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
	r1	r2	r3	r4	r5	r6	r7	r8	r9	r10	r11	r12	r13
VARIABLES	cichos	nichos	ninthos	pedhos	broomhos	fitchos	sporthos	ebcthos	womhchos	aidsshos	traumhos	emdephos	gersvhos
MHHIdelta	0.60	-0.77	0.50	-0.13	-0.09	-0.35	-0.12	4.14**	0.11	-0.34***	0.27	-0.00	0.15
	(0.39)	(0.50)	(0.43)	(0.41)	(0.44)	(0.13)	(0.23)	(1.96)	(0.57)	(0.08)	(0.21)	(0.26)	(0.09)
HHI	1.51**	0.35	1.71**	-0.68	0.82	-0.37	-0.15	4.21**	0.78	-0.45	0.30	-0.01	0.23
	(0.77)	(0.88)	(0.84)	(0.67)	(0.54)	(0.79)	(0.63)	(1.87)	(0.59)	(0.37)	(0.37)	(0.34)	(0.29)
HHIstar	-0.35	0.09	0.19	0.47	-1.04**	-0.61	0.01	0.63	-0.72*	0.36	-0.41	-0.01	-0.19
	(0.63)	(0.78)	(0.62)	(0.55)	(0.44)	(0.53)	(0.53)	(1.55)	(0.42)	(0.34)	(0.35)	(0.22)	(0.24)
urban	-0.44	0.37	-0.02	-1.59***	-2.06***	-1.26***	-1.17***	0.60	-1.14***	0.10	-0.68***	-0.75***	0.01
	(0.37)	(0.43)	(0.44)	(0.36)	(0.30)	(0.41)	(0.33)	(0.73)	(0.31)	(0.24)	(0.22)	(0.15)	(0.17)
teach	1.34***	0.09	0.94*	0.11	-0.23	-0.09	-0.14	-0.29	0.36	0.69**	-0.36	0.15	0.44**
	(0.48)	(0.64)	(0.55)	(0.56)	(0.50)	(0.62)	(0.42)	(0.99)	(0.38)	(0.30)	(0.27)	(0.24)	(0.21)
suroptot	0.00***	0.00***	0.00*	0.00***	0.00***	0.00*	0.00**	0.00	0.00***	0.00**	0.00**	0.00***	0.00***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
ipdtot	0.00	-0.00	-0.00**	-0.00***	-0.00	-0.00	-0.00***	0.00	-0.00*	-0.00	-0.00***	-0.00*	0.00***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
paytot	-0.00**	0.00	0.00**	0.00	0.00	-0.00	0.00*	-0.00*	0.00	-0.00	0.00	0.00	-0.00*
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
fttot	0.00***	0.00*	0.00	0.00***	0.00	0.00***	0.00*	0.00*	0.00**	0.00***	0.00***	0.00	-0.00
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
pttot	0.00	0.00**	-0.00	0.00	0.00	0.00	0.00	-0.00	0.00	0.00	0.00	-0.00	0.00
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
ratio	-0.03	-0.12*	-0.05	-0.05	-0.06**	-0.05	-0.07**	-0.12	-0.04	-0.00	-0.01	-0.02	-0.01
	(0.04)	(0.07)	(0.04)	(0.04)	(0.03)	(0.04)	(0.03)	(0.20)	(0.03)	(0.03)	(0.01)	(0.02)	(0.01)
concode	1.55**	-0.96**	-0.38	0.45	-0.25	0.45	-0.52	-0.21	-0.07	-0.56	0.09	-0.03	-0.25
	(0.67)	(0.38)	(0.35)	(0.66)	(0.41)	(0.39)	(0.38)	(0.67)	(0.36)	(0.35)	(0.25)	(0.27)	(0.27)
cah				-0.01	0.08	-1.97**	-2.22***		0.89		-0.76**	0.80**	0.30
				(0.55)	(0.81)	(0.96)	(0.64)		(0.65)		(0.36)	(0.37)	(0.34)
Observations	2,652	2,290	2,284	2,752	2,846	2,435	2,849	1,766	2,905	2,050	2,322	2,889	3,009

Robust standard errors in parentheses: *** p<0.01, ** p<0.05, * p<0.1
The codes of translating variables into services are showed in Appendix 2.

Table 3.23: Extensive margins: Logit model with lags

	Profitable services									Unprofitable services			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
	r1	r2	r3	r4	r5	r6	r7	r8	r9	r10	r11	r12	r13
VARIABLES	cichos	nichos	ninthos	pedhos	broomhos	fitchos	sporthos	ebcthos	womhchos	aidsshos	traumhos	emdephos	gersvhos
L.MHHIdelta	-0.13	-0.04	0.15	-0.03	0.08	0.18	0.03	0.66	0.00	-0.00	0.37	0.00	-0.05
	(0.32)	(0.33)	(0.15)	(0.21)	(0.23)	(0.13)	(0.16)	(0.91)	(0.22)	(0.29)	(0.34)	(0.18)	(0.16)
HHI	0.21	-0.04	0.69*	-0.45	-0.05	-0.26	-0.04	1.05	0.02	-0.03	0.48	-0.50*	0.12
	(0.37)	(0.34)	(0.38)	(0.32)	(0.25)	(0.42)	(0.32)	(0.66)	(0.26)	(0.44)	(0.37)	(0.28)	(0.27)
HHIstar	-0.36	-0.19	-0.01	0.26	-0.01	0.01	-0.12	-0.75	-0.49**	0.42	-0.01	-0.22	-0.23
	(0.41)	(0.41)	(0.37)	(0.32)	(0.26)	(0.32)	(0.35)	(0.53)	(0.25)	(0.38)	(0.35)	(0.29)	(0.28)
urban	-0.34*	0.04	0.04	-0.91***	-1.23***	-0.78***	-0.65***	0.25	-0.67***	0.18	-0.66***	-0.88***	0.01
	(0.19)	(0.13)	(0.26)	(0.20)	(0.18)	(0.23)	(0.20)	(0.36)	(0.19)	(0.27)	(0.24)	(0.18)	(0.18)
teach	0.80***	-0.28*	0.19	-0.07	-0.24	0.11	-0.16	-0.28	0.06	0.54*	-0.41	-0.06	0.31
	(0.24)	(0.17)	(0.28)	(0.28)	(0.28)	(0.28)	(0.25)	(0.37)	(0.22)	(0.30)	(0.28)	(0.28)	(0.22)
suroptot	0.00***	0.00***	0.00**	0.00***	0.00***	0.00*	0.00***	0.00	0.00***	0.00**	0.00**	0.00***	0.00***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
ipdtot	0.00	0.00	-0.00***	-0.00***	-0.00	-0.00	-0.00***	0.00	-0.00*	-0.00	-0.00***	-0.00***	0.00***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
paytot	-0.00**	0.00	0.00**	0.00	-0.00	-0.00	0.00**	-0.00**	0.00	-0.00	0.00	0.00	-0.00*
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
fttot	0.00***	0.00	0.00	0.00***	0.00*	0.00	0.00	0.00	0.00*	0.00**	0.00***	0.00	-0.00
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
pttot	0.00	0.00**	-0.00	-0.00	0.00	0.00	0.00	-0.00	-0.00	0.00	0.00	-0.00	-0.00
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
ratio	-0.02	-0.00	-0.02	-0.02	-0.03	-0.03	-0.04**	0.06	-0.02	-0.00	-0.01	-0.03	-0.01
	(0.02)	(0.01)	(0.01)	(0.02)	(0.02)	(0.03)	(0.02)	(0.06)	(0.02)	(0.03)	(0.01)	(0.02)	(0.01)
concode	0.81***	-0.56***	-0.29	0.28	-0.07	-0.00	-0.42	-0.20	-0.09	-0.63*	-0.04	0.27	-0.25
	(0.31)	(0.10)	(0.24)	(0.36)	(0.22)	(0.25)	(0.27)	(0.31)	(0.22)	(0.38)	(0.25)	(0.27)	(0.30)
Observations	2,028	1,763	1,707	2,180	2,255	1,841	2,238	1,332	2,295	1,584	1,812	2,292	2,389

Robust standard errors in parentheses: *** p<0.01, ** p<0.05, * p<0.1

The codes of translating variables into services are showed in Appendix 2.

Table 3.24: Intensive margins: Poisson regressions

	Profitable services				Unprofitable services		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	r1	r2	r3	r4	r5	r6	r7
VARIABLES	cicbd	nicbd	nintbd	pedicbd	psybd	alchbd	brnbd
MHHIdelta	0.06***	0.10***	0.78**	0.33**	-0.08**	0.04	0.00
	(0.01)	(0.02)	(0.36)	(0.15)	(0.04)	(1.27)	(0.01)
HHI	0.10**	0.14**	0.34	0.09	-0.33**	-0.21	0.02
	(0.04)	(0.07)	(0.46)	(0.34)	(0.15)	(1.52)	(0.05)
HHIstar	-0.21***	-0.51***	0.20	-0.11	0.11	-0.40	0.02
	(0.06)	(0.12)	(0.38)	(0.29)	(0.10)	(0.72)	(0.03)
urban	0.99***	0.29***	0.70**	0.24*	0.79***	-0.49	0.00
	(0.06)	(0.04)	(0.29)	(0.12)	(0.19)	(1.43)	(0.04)
teach	0.05	-0.13***	0.30	1.09***	0.01	-0.30	0.30
	(0.03)	(0.03)	(0.87)	(0.16)	(0.19)	(1.00)	(0.25)
cah	-2.33	-1.68	-0.22	0.52*	-1.53	-4.26***	0.03
	(43.79)	(2.59)	(0.50)	(0.27)	(1.90)	(1.43)	(0.04)
nichos		2.98***					
		(0.04)					
births		0.00***	0.00**	0.00***			
		(0.00)	(0.00)	(0.00)			
suroptot	-0.00***	-0.00***	-0.00**	0.00***	-0.00**	0.00	-0.00
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
ipdtot	0.00***	0.00***	0.00	0.00***	0.00***	0.00***	0.00
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
paytot	0.00	0.00***	-0.00	0.00***	-0.00***	-0.00**	0.00
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
fttot	-0.00**	0.00***	-0.00	-0.00***	0.00	0.00	-0.00
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
pttot	0.00***	-0.00***	0.00	-0.00***	-0.00	0.00	0.00
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
ratio	-0.05***	-0.01	-0.00	0.00	0.01***	0.00	0.00
	(0.01)	(0.01)	(0.00)	(0.00)	(0.00)	(0.02)	(0.00)
concode	0.10***	2.02***	0.56	-0.11	-0.02	0.21	-0.06
	(0.02)	(0.19)	(0.67)	(0.18)	(0.06)	(0.76)	(0.07)
cichos	11.20***						
	(1.88)						
ninthos			5.59***				
			(0.94)				
pedhos				0.71***			
				(0.12)			
psyhos					10.96***		
					(1.86)		
Observations	3,502	3,502	3,502	3,502	3,502	3,502	3,502

Robust standard errors in parentheses: *** p<0.01, ** p<0.05, * p<0.1

The codes of translating variables into services are showed in Appendix 2.

Table 3.25: Intensive margins: Poisson regressions with one year lag

	Profitable services				Unprofitable services		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	r1	r2	r3	r4	r5	r6	r7
VARIABLES	cicbd	nicbd	nintbd	pedicbd	psybd	alchbd	brnbd
L.MHHIdelta	0.05***	-0.12	-0.08	0.10	-0.11***	1.26**	-0.00
	(0.01)	(0.18)	(0.11)	(0.12)	(0.04)	(0.53)	(0.01)
HHI	0.06	0.12	0.16	-0.23	-0.40***	0.65	0.02
	(0.05)	(0.80)	(0.43)	(0.63)	(0.15)	(0.71)	(0.06)
HHIstar	-0.24***	-0.37	0.12	-0.22	0.13	1.05**	0.03
	(0.07)	(0.94)	(0.37)	(0.38)	(0.10)	(0.50)	(0.04)
urban	1.22***	0.13	0.73**	0.29	0.81***	-1.25***	0.00
	(0.08)	(0.46)	(0.30)	(0.25)	(0.20)	(0.48)	(0.04)
teach	0.07*	-0.08	0.05	1.09	0.04	-0.22	0.35
	(0.04)	(0.69)	(0.87)	(0.76)	(0.21)	(0.54)	(0.28)
cah	0.57	-0.61	-0.13	0.47	-1.65	-11.42***	0.04
	(16.39)	(3.02)	(0.49)	(0.35)	(2.41)	(1.34)	(0.05)
nichos		3.17***					
		(0.98)					
births		0.00	0.00**	0.00**			
		(0.00)	(0.00)	(0.00)			
suroptot	-0.00***	-0.00	-0.00**	0.00	-0.00***	0.00	-0.00
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
ipdtot	0.00	0.00**	-0.00	0.00*	0.00***	0.00***	0.00
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
paytot	0.00	0.00**	-0.00	0.00*	-0.00***	-0.00***	0.00
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
fttot	0.00*	0.00	-0.00	-0.00	0.00	-0.00***	-0.00
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
pttot	0.00	-0.00**	0.00	-0.00	-0.00	-0.00	0.00
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
ratio	-0.06***	-0.00	-0.00	0.00	0.01***	-0.01	0.00
	(0.01)	(0.03)	(0.00)	(0.00)	(0.00)	(0.01)	(0.00)
concode	0.08***	-1.41	0.78	-0.03	-0.02	0.12	-0.06
	(0.02)	(42.17)	(0.76)	(0.48)	(0.06)	(0.33)	(0.07)
cichos	11.84***						
	(2.89)						
ninthos			5.63***				
			(1.04)				
pedhos				0.88**			
				(0.42)			
psyhos					12.11***		
					(2.36)		
Observations	2,739	2,739	2,739	2,739	2,739	2,739	2,739

Robust standard errors in parentheses: *** p<0.01, ** p<0.05, * p<0.1
The codes of translating variables into services are showed in Appendix 2.

Table 3.26: Exogenous shocks

Acquiring firm	Target firm	Effective date
J.P. Morgan Chase & Co.	BNY-Consumer Business	10/2/2006
Morgan Stanley Group Inc.	FrontPoint Partners, L.L.C.	12/4/2006
Bank of NY Trust Co.	Mellon Bank	7/2/2007
Barclays Bank PLC	Lehman Brothers Inc.	9/22/2008
RiverSource Investments	J. & W. Seligman & Co., Inc.	11/7/2008
Bank of America Corporation	Merrill Lynch & Co Inc.	1/1/2009
BlackRock Inc.	Barclays Global Investors	12/1/2009

Table 3.27: Difference-in-differences regressions

VARIABLES	(1) cicbd	(2) nicbd	(3) nintbd	(4) pedicbd	(5) psybd	(6) alchbd	(7) brnbd
$Post * Treat$	0.65***	0.64***	0.34*	-0.00	-0.10*	-0.21*	-0.01
	(0.21)	(0.22)	(0.39)	(0.00)	(0.11)	(0.43)	(0.06)
Log(HHI)	0.09	0.01	0.49	0.00**	-0.18	-0.18	0.03
	(0.33)	(0.72)	(0.39)	(0.00)	(0.17)	(0.52)	(0.05)
Log(HHIstar)	0.54	0.43	0.22	0.00***	-0.12	-0.35	-0.00
	(0.56)	(0.42)	(0.37)	(0.00)	(0.12)	(0.46)	(0.03)
urban	0.14	0.27	0.70**	-0.00***	1.07***	-0.41	-0.03
	(0.51)	(0.65)	(0.29)	(0.00)	(0.24)	(0.54)	(0.04)
teach	0.83***	0.07	0.32	0.00	-0.01	-0.32	0.25
	(0.28)	(0.68)	(0.87)	(0.00)	(0.18)	(0.46)	(0.17)
cah	-3.24***	-18.84***	-0.21	0.00	-0.11	-0.28	0.03
	(0.90)	(0.91)	(0.50)	(0.00)	(0.54)	(0.42)	(0.03)
nichos		3.54***					
		(0.92)					
births		0.00	0.00**	-0.00*			
		(0.00)	(0.00)	(0.00)			
suroptot	0.00	-0.00	-0.00**	0.00***	-0.00	0.00	-0.00
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
ipdtot	0.00***	0.00	0.00	0.00***	0.00***	0.00**	0.00
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
paytot	-0.00***	0.00	-0.00	0.00***	-0.00***	-0.00***	0.00
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
fttot	0.00	0.00	-0.00	-0.00***	-0.00	0.00	-0.00
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
pttot	0.00	-0.00	0.00	0.00	0.00	0.00	0.00
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
ratio	0.07***	-0.16	-0.00	0.00*	0.00	0.00	0.00
	(0.01)	(0.11)	(0.00)	(0.00)	(0.01)	(0.00)	(0.00)
concode	-0.18	1.23	0.56	0.00	0.35	0.24	-0.08
	(1.68)	(1.39)	(0.68)	(0.00)	(0.24)	(0.67)	(0.07)
cichos	8.12***						
	(0.52)						
ninthos			5.59***				
			(0.94)				
pedicbd				1.00***			
				(0.00)			
psyhos					7.17***		
					(0.36)		
brnhos							2.26*
							(1.29)
Observations	3,502	3,502	3,502	3,502	3,502	3,502	3,502
R-squared			0.52	1.00		0.16	0.33

Robust standard errors in parentheses: *** p<0.01, ** p<0.05, * p<0.1
The codes of translating variables into services are showed in Appendix 2.

Table 3.28: Summary statistics of control variables

VARIABLES	(1) N	(2) mean	(3) sd	(4) min	(5) max
Urban Hospital	3,502	0.815	0.388	0	1
Teaching Hospital	3,502	0.107	0.309	0	1
Critical Access Hospital	3,502	0.0237	0.152	0	1
Total Admission	3,502	5,325	7,265	20	79,612
Total inpatient days	3,502	30,683	36,241	47	428,809
Total Births	3,502	567.3	1,213	0	11,324
Inpatient Surgical Operations	3,502	1,445	2,713	0	32,283
Outpatient Surgical Operations	3,502	2,282	3,420	0	39,418
Total Surgical Operations	3,502	3,727	5,911	0	71,477
Total Payroll Expenses	3,502	2.690e+07	3.547e+07	785,319	4.355e+08
Total Operating Expenses	3,502	7.827e+07	1.091e+08	1.635e+06	1.178e+09
Full Time Total Personnel	3,502	423.6	530.8	21	5,899
Part Time Total Personnel	3,502	122.9	142.0	0	1,800
Non-profit/For-profit Hospital Ratio	3,502	10.98	29.06	0.117	415.8

Table 3.29: Codes for translating variables to services

(1) VARIABLES	(2) Services
cichos	Cardiac Intensive Care hospital services
nichos	Neonatal Intensive Care hospital services
ninthos	Neonatal Intermediate Care hospital services
pedhos	Pediatric hospital services
broomhos	Birthing Rooms hospital services
fitchos	Fitness Center hospital services
sporthos	Sports Medicine hospital services
ebcthos	Electron Beam Computed Tomography hospital services
womhchos	Women Health Center hospital services
aidsshos	HIV/Aids hospital services
traumhos	Trauma Center hospital services
emdephos	Emergency Department hospital services
gersvhos	Geriatric hospital services
cicbd	Cardiac Intensive Care # of beds
nicbd	Neonatal Intensive Care # of beds
nintbd	Neonatal Intermediate Care # of beds
pedicbd	Pediatric Care # of beds
psybd	Psychiatric Care # of beds
alchbd	Alchohol/Chemical Dependency Care # of beds
brnbd	Burn Care # of beds

Table 3.30: Summary statistics of stock ownerships among oil firms

Exxon Mobile	[%]	Alon	[%]	Chevron	[%]
Vanguard Group	6.96	Dimensional FD Advisors	8.43	Vanguard Group	6.94
State Street Corp.	4.82	Vanguard Group	3.72	State Street Corp.	6.22
Mellon Bank NA	1.33	Goldman Sachs	1.96	Fidelity Management & Research Co.	2.22
Wellington Management CO	1.18	D. E. Shaw & Co.	1.67	Capital World Investors	2.19
Marathon Petroleum Corp.	[%]	Marathon Oil Corp.	[%]	Murphy Oil Corp.	[%]
Vanguard Group	6.85	Vanguard Group	9.68	Capital World Investors	10.39
State Street Corp.	5.29	Hotchkis & Wiley Cap Management	5.70	Vanguard Group	10.13
Boston Partner	2.75	State Street Corp.	5.65	Fidelity Management & Research Co.	6.49
Blackrock Advisors	2.70	Franklin Resources Inc.	4.26	Hotchkis & Wiley Cap Management	6.37
Murphy USA Inc.	[%]	Valero Energy Corp.	[%]	ConocoPhillips	[%]
Vanguard Group	7.32	Vanguard Group	7.20	Vanguard Group	6.89
LSV Asset Management	4.45	State Street Corp.	5.88	State Street Corp.	5.08
Cook Michael W Asset Management Inc.	3.96	Mellon Bank NA	2.62	Fidelity Management & Research Co.	4.64
AQR Capital Management	3.24	JPMorgan Chase	1.82	Capital World Investors	4.30

Notes: This table shows the statistics of top four institutional ownerships in nine big U.S. oil compaies in the December of 2016. These ownership data is from the 13-f statements of WRDS.

Table 3.31: Intuitive example of common ownership

	MHHI	HHI	MHHI delta
formula	$\sum_j \sum_k s_j s_k \frac{\sum_i \gamma_{ij}\beta_{ik}}{\sum_i \gamma_{ij}\beta_{ij}}$	$\sum_j s_j^2$	$\sum_j \sum_{k \neq j} s_j s_k \frac{\gamma_{ij}\beta_{ik}}{\gamma_{ij}\beta_{ij}}$
scenario 1: 1 firm	10,000	10,000	0
scenario 2: 2 firms with independent owners	5,000	5,000	0
scenario 3: 2 owners swap 50% of their ownerships	10,000	5,000	5,000

Table 3.32: Summary Statistics

	PADD1	PADD2	PADD3	PADD4	PADD5
Quantities of refined oil	192,013	166,162	237,321	54,071	130,672
Average gasoline prices	3.01928	2.97016	2.88944	2.98268	3.27208

Notes: The unit of quantities is barrels per stream day; the unit of gasoline prices is dollars per gallon.

Table 3.33: Panel regression

Dependent variable: gasoline price	
MHHI delta	0.0484929***
year fixed effects	Yes
PADD fixed effects	Yes
COP fixed effects	Yes
HHI fixed effects	Yes
Gradeform fixed effects	Yes
No. of observations	1,525

Robust standard errors in parentheses: *** p<0.01, ** p<0.05, * p<0.1

Table 3.34: Treated v.s. Control

2009Q1: shares of Barclays + shares of Lehman Brothers					
	Control group			Treated group	
	padd1	padd2	padd3	padd4	padd5
Total shares (millions)	175.5648	292.6665	355.4648	374.833	358.127
Percentage of total regional shares	9.2%	10.28%	10.18%	10.53%	9.7%

Table 3.35: Difference-in-differences

Dependent variable: gasoline price	
Post*Tre	0.0388229**
year fixed effects	Yes
PADD fixed effects	Yes
grade fixed effects	Yes
COP fixed effects	Yes
HHI fixed effects	Yes
gradeform fixed effects	Yes
No. of observations	1,200

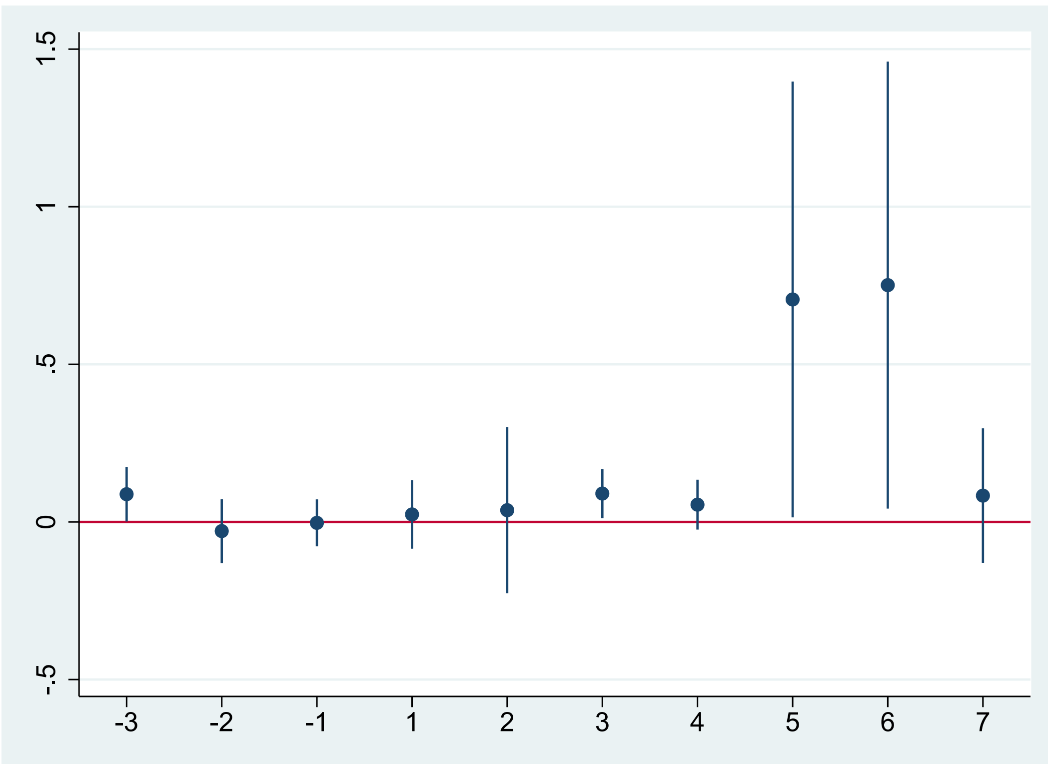
Robust standard errors in parentheses: *** p<0.01, ** p<0.05, * p<0.1

Table 3.36: Panel results using an alternative measure of market shares

Outcome	gasoline price
MHHIdelta	0.17***
	(0.03)
year fixed effects	Yes
region fixed effects	Yes
crude oil price fixed effects	Yes
HHI fixed effects	Yes
gradeform fixed effects	Yes
Observations	1,200
R-squared	0.90

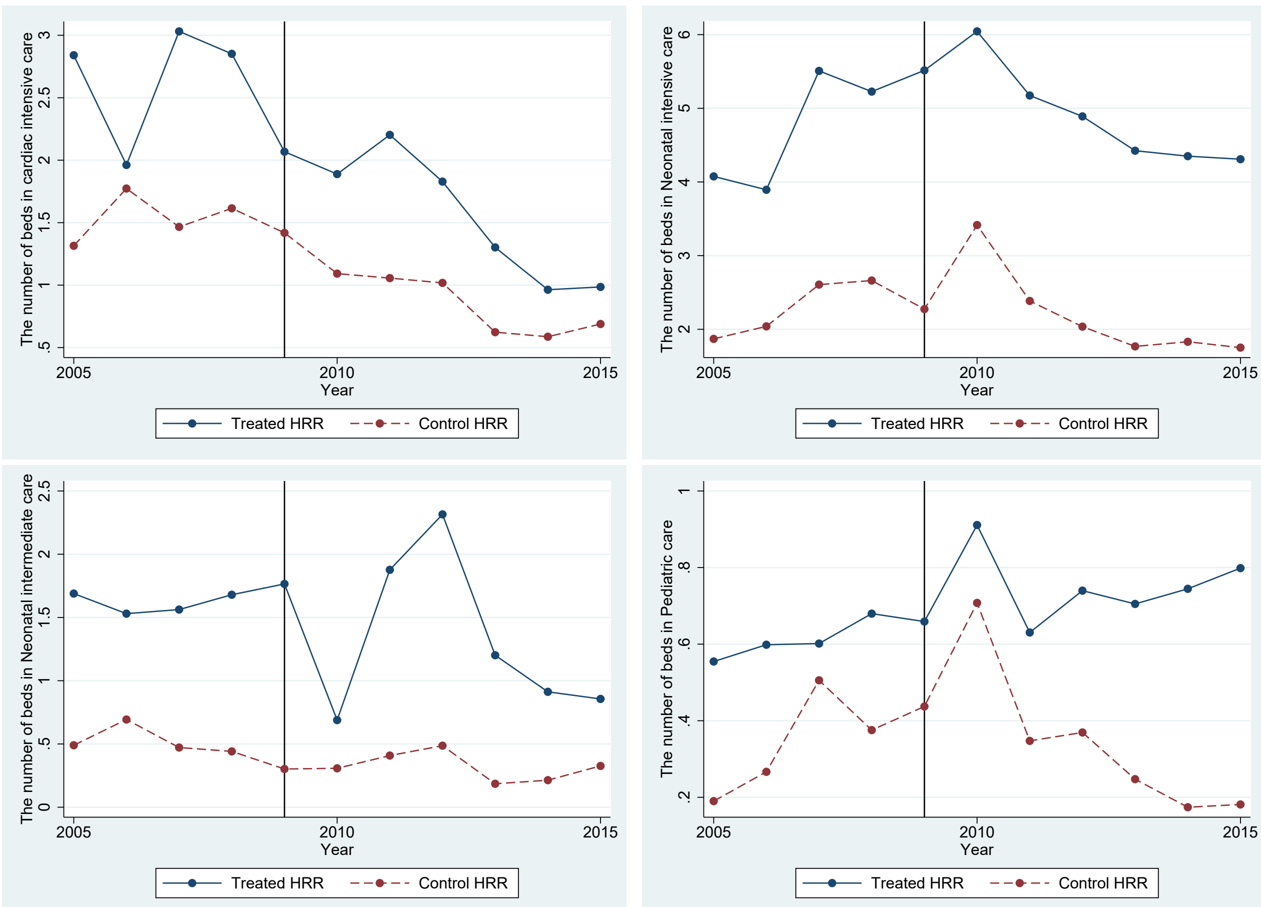
Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Figure 3.1: Event Study



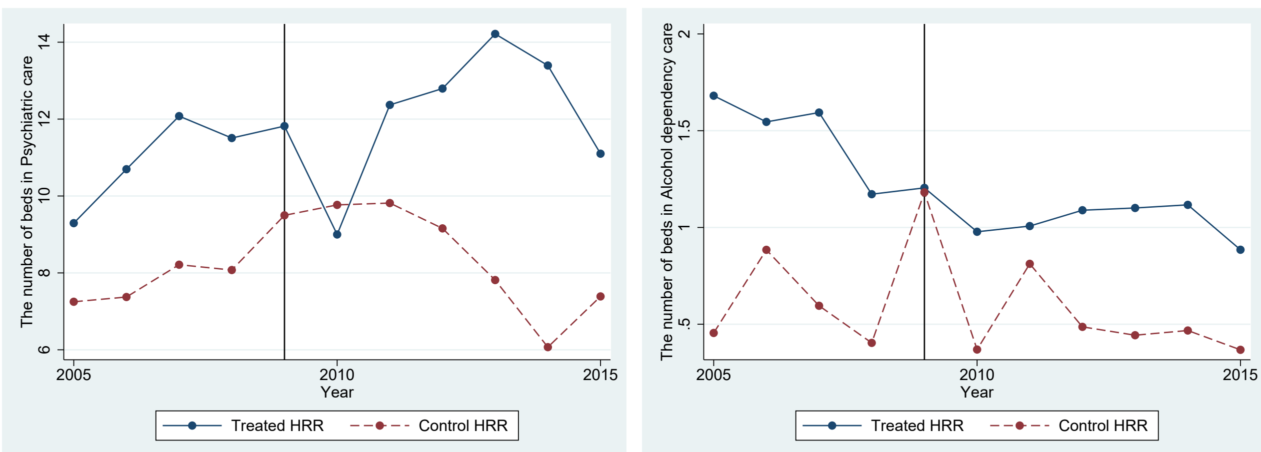
The X-axis shows the relative years of 2008, which is one year before the financial acquisition occurred. For example, −3 indicates the year of 2005, and 1 indicates the year of 2009. The Y-axis shows the coefficient of each diff-in-diff variable. The vertical lines across dots are confidence intervals.

Figure 3.2: Parallel path assumption in profitable services



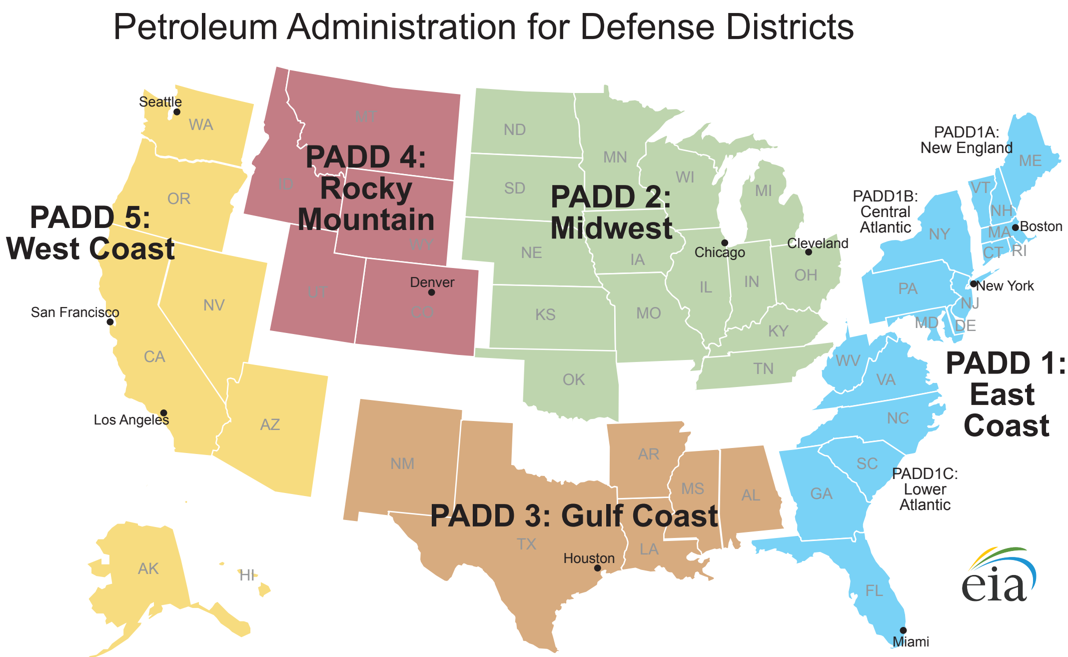
This figure shows the general trends for the number of beds in four profitable services: Cardiac Intensive Care, Neonatal Intensive Care, Neonatal Intermediate Care, and Pediatric Care.

Figure 3.3: Parallel path assumption in unprofitable services



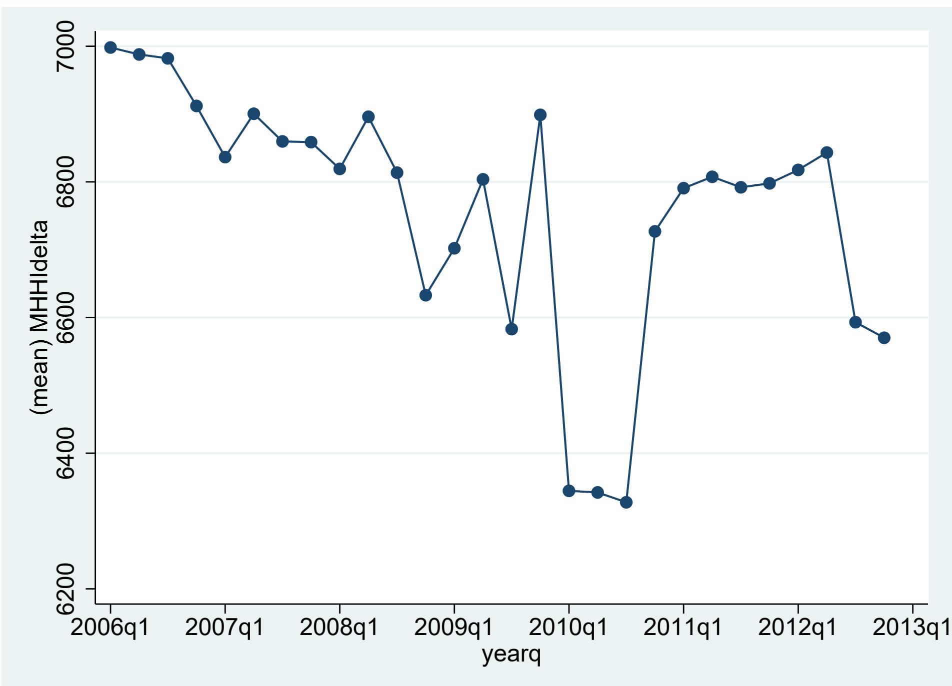
This figure shows the general trends for the number of beds in two unprofitable services: Psychiatric Care and Alchohol/Chemical Dependency Care.

Figure 3.4: The map of PADDs



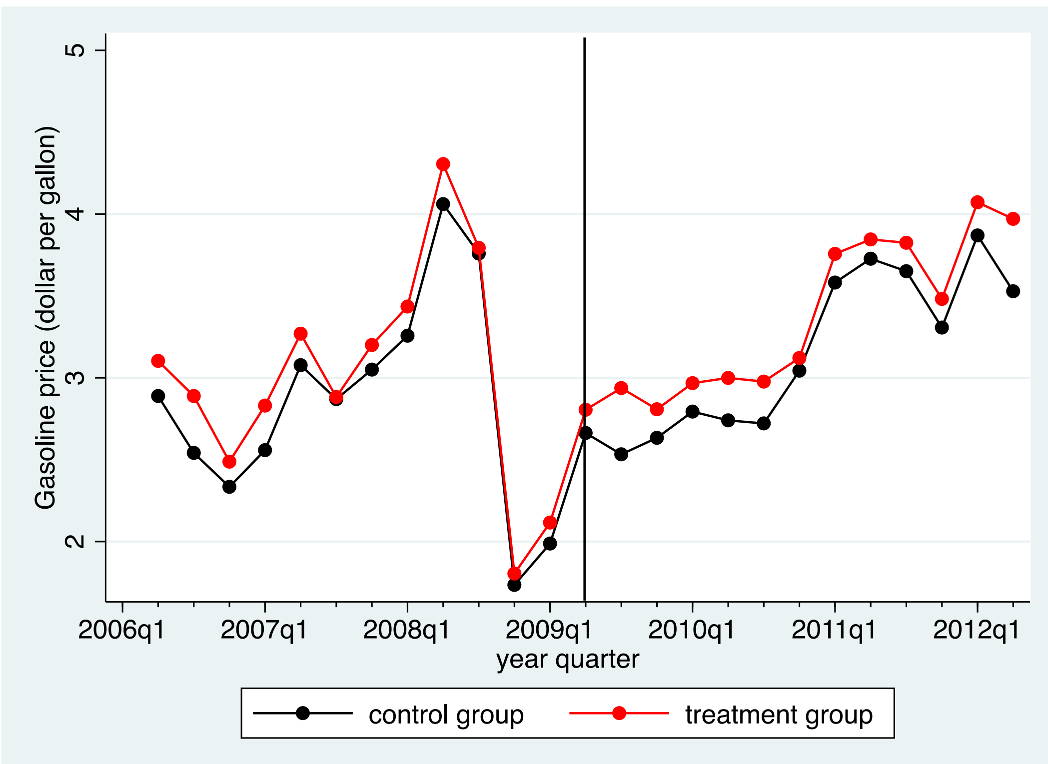
Source: U.S. Energy Information Administration

Figure 3.5: Trend of average MHHI delta



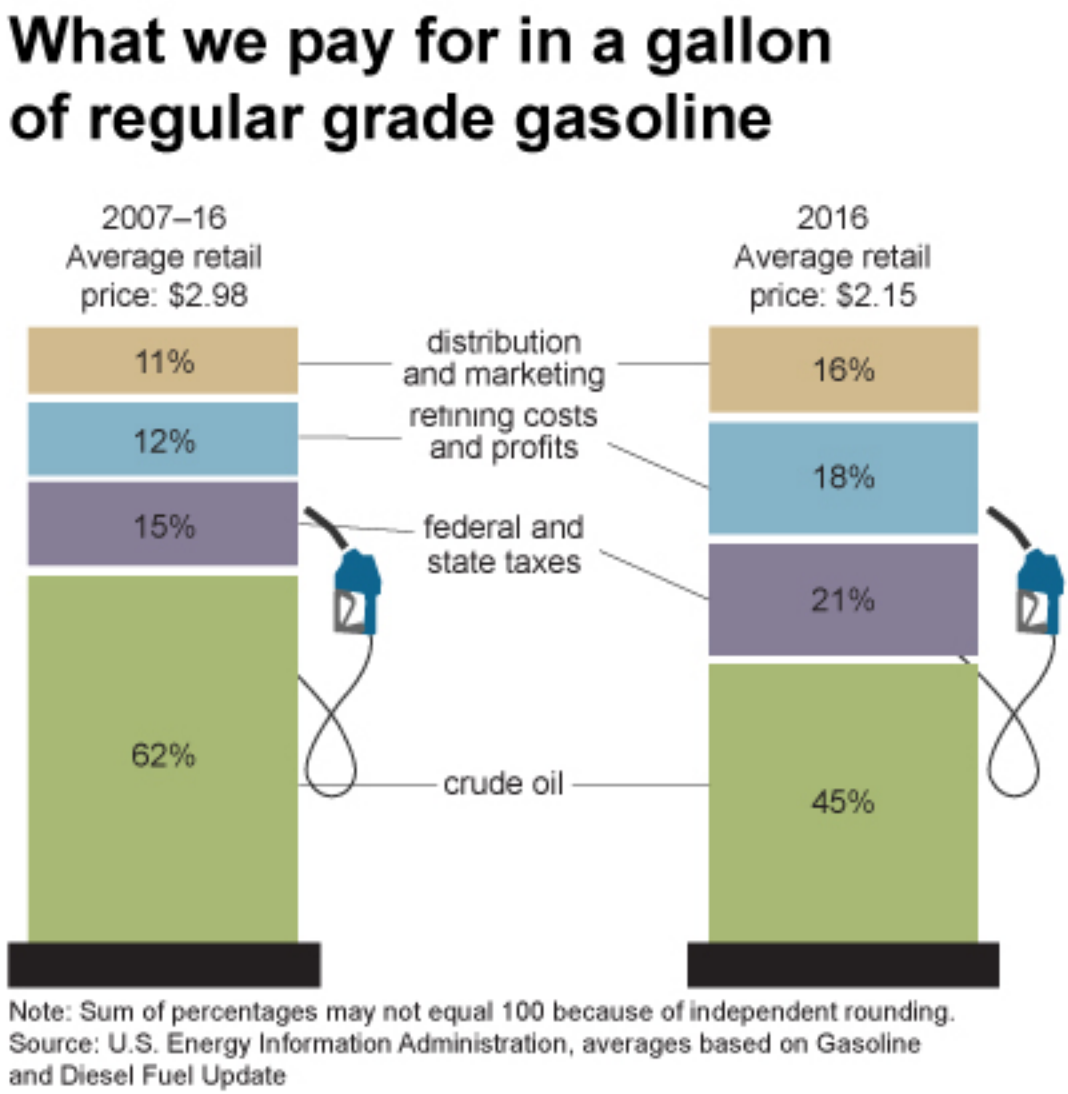
Notes: This figure shows the average MHHI delta over the sample period.

Figure 3.6: Parallel path assumption



This figure gives the intuiation of parallel paths between treated group and control group before and after the external shock.

Figure 3.7: Breakdown of retailing gasoline prices



Source: U.S. Energy Information Administration

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Biography

Mengde Liu is a Ph.D. student at the department of Economics. His five years of academic training as an economist prepare him to be an effective researcher and instructor. His dissertation examines the effect of market competition at the shareholder level on firm behaviors and product prices. In his research, he constructs a theoretical model that shows a new objective function of firms which are commonly owned by the same shareholders. Empirically, he calculates the Modified Herfindahl-Hirschman Index (M-HHI) to represent the market competition at the shareholder level, and he tests the theoretical model by applying a difference-in-differences strategy. The empirical work shows consistent results to his theoretical model. His dissertation contributes to the literature on institutional investors involvements in corporate governance, and it draws attentions for anti-trust issues at the shareholder level.

During his graduate training, he was also fortunate enough to have served as teaching assistants and occasionally substitute lecturer for Introduction to Microeconomics and Introduction to Macroeconomics. He found that his professional experience as an Economist provided him with a broad view that is useful in assisting students with projects and assignments. These experiences have built his confidence and an interest in teaching and he looks forward to the opportunity to not only teach existing course, but also work to develop new ones.