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To What Extent Are Hospitals Profit Maximizers? The Role of Market Concentration in Price Negotiation

ECON 699

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Abstract

Among OECD countries, the United States spends the most on healthcare, both as a proportion of GDP (16.9% in 2019) and per person ($10,586 in 2019).[1] With hospital spending accounting for 31% of total health care spending,[2] understanding what drives hospital prices can generate insight into cost-controlling policy solutions. Prior literature suggests that hospitals, anticipating negotiating payments with insurance companies, initially set high list prices to strengthen their bargaining position.[3] A 2021 rule issued by the Centers for Medicare and Medicaid Services (CMS) mandating that hospitals disclose standard charges provides an opportunity to more granularly investigate what factors contribute to a hospital's success in negotiating prices with insurance companies. Using disclosed pricing data to examine hospital bargaining power, this paper will investigate the role of market concentration on hospital-insurer price negotiation, defined as the difference between the gross price and the median payer-specific negotiated charge. I find limited evidence that increased market concentration is linked to a smaller difference between the gross price and the median payer-specific negotiated charge, suggesting that market concentration plays a role in a hospital's ability to secure higher payer-specific negotiated rates.

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[1] OECD, "Health at a Glance 2019 United States - OECD," https://www.oecd.org/unitedstates/ (Organisation for Economic Co-operation and Development, 2019), https://www.oecd.org/unitedstates/health-at-a-glance-united-states-EN.pdf.

[2] "Press Release: CMS Office of the Actuary Releases 2019 National Health Expenditures," cms.gov (Centers for Medicare & Medicaid Services, December 16, 2020), https://www.cms.gov/newsroom/press-releases/cms-office-actuary-releases-2019-national-health-expenditures.

[3] Christopher P. Tompkins, Stuart H. Altman, and Efrat Eilat, "The Precarious Pricing System for Hospital Services," *Health Affairs* 25, no. 1 (2006): pp. 45-56, https://doi.org/10.1377/hlthaff.25.1.45.

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Significance

Beginning in the 1990s a confluence of factors precipitated a widening gap between gross hospital charges (the non-discounted list price) and actual payments received (net revenue). First, in 1983, Medicare moved from a cost-based fee-for-service payment schedule to a prospective payment system (PPS), which utilizes predetermined payments; in turn, most state Medicaid programs abandoned cost-based payments. After Medicare payment rates decreased in the 1980s, hospitals compensated for lost revenue by increasing prices to privately insured patients.

Additionally, a shift to managed care and private insurance consolidation better allowed large insurers to bargain with hospitals based on contracts with negotiated rates. Before the rise of managed care, health insurance structures typically resembled traditional indemnity insurance, with little insurer insight over service utilization. Managed care—typified by insurer control over provider networks, selective contracting, targeted sets of covered services and varying levels of patient cost sharing—provided insurers with more leverage to secure greater discounts from hospitals.[4] With increased insurer consolidation, insurers were able to shift away from negotiating with hospitals based on charges and towards contracts based on negotiated rates with lower fee schedules. With the growth of managed care and increased insurer consolidation, patients paying gross (or list) charges represented an increasingly small portion of individuals, prompting hospitals to mark up gross charges faster than the cost of care.[5]

The passage of the Affordable Care Act (ACA) in 2010 was designed to reduce both uninsured and rising health care costs. While the ACA is associated with a reduction in the uninsured rate from 15.1% to 8.9% between 2009 and 2018, there is little evidence that the ACA's enactment reduced health care spending. The ACA aimed to reduce health care spending through increased insurer competition, reduced federal tax subsidies to generous employer-sponsored insurance, and a variety of Medicare and Medicaid payment reforms and

[4] Sherry Glied, Peter Smith, and Laurence Baker, "Managed Care ," in *The Oxford Handbook of Health Economics* (Oxford, U.K. : Oxford University Press, 2013).
[5] Christopher P. Tompkins, et. al, "The Precarious Pricing System for Hospital Services,"

reimbursement cuts.[6] Reimbursement cuts, which focused on hospitals and Medicare Advantage plans, cut the growth rate of payments to providers and enacted "delivery system reforms," wherein payment is tied to quality and spending goals. However, delivery system reforms coincided with increased provider consolidation; since the ACA's launch, there have been 1,792 hospital mergers, in addition to growing consolidation between hospitals and physician groups. Simultaneously, a lack of Medicaid expansion may have increased consolidation by precipitating increased closure among poorly performing rural hospitals, as increased Medicaid coverage reduces uncompensated care expenditures. As evidence suggests that hospital consolidation leads to increased hospital prices, it's distinctly possible that delivery system reforms were not adequate to reduce health care spending amidst a wave of consolidation.[7] The link between hospital market concentration and price is a point that will be extrapolated on further in Literature Review.

Today, gross charges are three times more than what hospitals are actually paid on average, and gross charges vary markedly across hospitals and within markets. Prior literature indicates that variation in gross charges is primarily driven by differences across hospitals and related to hospital characteristics, such as size, for-profit status and market concentration; variation across hospitals (as opposed to within) suggest that gross charges are not set ad hoc, but are instead at least partially driven by a hospitals' strategic market behavior.[8] Other evidence that hospital prices reflect hospitals' strategic behavior includes the presence of price variation for highly homogenous services, such as lower-limb magnetic resonance imaging (MRI)[9] and the weak relationship between hospital prices and quality of care.[10]

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[6] Nikpay, Sayeh., India Pungarcher, Austin Frakt; An Economic Perspective on the Affordable Care Act: Expectations and Reality. *J Health Polit Policy Law* 1 October 2020; 45 (5): 889–904. doi: https://doi.org/10.1215/03616878-8543340

[7] Ibid.

[8] Michael Batty and Benedic Ippolito, "Mystery of the Chargemaster: Examining the Role of Hospital List Prices in What Patients Actually Pay," *Health Affairs* 36, no. 4 (April 2017): pp. 689-696, https://doi.org/10.1377/hlthaff.2016.0986.

[9] Zack Cooper et al., "The Price Ain't Right? Hospital Prices and Health Spending on the Privately Insured," *The Quarterly Journal of Economics* 134, no. 1 (April 2018): pp. 51-107, https://doi.org/10.1093/qje/qjy020.

[10] Beauvais, Brad, Glen Gilson, Steve Schwab, Brittany Jaccaud, Taylor Pearce, and Thomas Holmes. "Overpriced? Are Hospital Prices Associated with the Quality of Care?" *Healthcare*, 135, 8, no. 2 (May 17, 2020). https://doi.org/10.3390/healthcare8020135.

While some argue that high gross hospital prices are irrelevant due to the small minority of individuals who pay the non-discounted prices, high gross charges disproportionately impact the uninsured, who lack the bargaining power of insurance companies to negotiate discounts; consequently, uninsured individuals may end up paying the gross, or undiscounted rate. Out-of-network patients, such as emergency room patients, and patients with high-deductible insurance plans, are similarly impacted.[11] Further, while there is extensive research on hospital pricing, systemic data on the exact payer-specific negotiated rate was previously difficult to acquire, as the results of these negotiations have historically been considered a commercially sensitive trade secret. The availability of de-identified pricing information under CMS' new rules provides researchers with a fresh opportunity to investigate what, if any, factors strengthen a hospital's bargaining power, providing insight into another piece of hospital prices. More broadly, a deeper understanding of what drives hospital prices, specifically the payer-specific negotiated rate, can illuminate policy solutions to ease high healthcare costs.

Literature Review: What market factors influence hospital prices?

The market for health insurance is composed of intermediaries; private commercial insurers offer a product that is not directly substitutable but negotiate with providers (hospitals) over prices, or the payer-specific negotiated rate.[12] Since insurers provide hospitals with a large volume of patients, insurers are typically able to secure a payer-specific negotiated rate that is lower than the gross charge. As hospitals play a critical role as an upstream supplier in this intermediary market,[13] a substantial body of research has focused on the impact of market concentration and mergers on hospital prices.

In a systematic review of studies on hospital consolidation since 2006, Gaynor and Town highlight key findings on hospital market concentration. Consistent with findings from 2006, Gaynor and Town's review finds broad agreement in the literature that an increase in hospital

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[11] Ge Bai and Gerard F. Anderson, "Extreme Markup: The Fifty US Hospitals with the Highest Charge-to-Cost Ratios," *Health Affairs* 34, no. 6 (June 2015): pp. 922-928, https://doi.org/10.1377/hlthaff.2014.1414.
[12] Dafny, Leemore, Kate Ho, and Robin S. Lee. "The Price Effects of Cross-Market Mergers: Theory and Evidence from the Hospital Industry." *The RAND Journal of Economics* 50, no. 2 (April 10, 2019): 286–325. https://doi.org/10.1111/1756-2171.12270.
[13] Ibid.

market concentration leads to increases in the price of hospital care, with hospital mergers within more concentrated markets resulting in larger price increases (often exceeding 20%).[14]

Expanding on the wide body of literature that demonstrates within-market hospital mergers increase prices (i.e., within the same geographic area and product market), Dafny, Ho, and Lee examine the price effects of cross-market mergers, or mergers where one hospital acquires another hospital that is either outside of a narrow geographic market or a new hospital system that is out-of-state (non-acquired hospitals are included as a control). As the market for health insurance consists of intermediaries, demand for insurance may not be separable across markets. Common customers, particularly large employers, demand insurance products that cover a wide range of geographic markets. Therefore, Dafny et. al theorized that cross-market hospital mergers may allow hospitals to negotiate higher reimbursement rates from insurers via the increased bargaining power of a merged hospital system.[15]

To test their theory, Dafny et al. focus on "bystander" hospitals, or hospitals that are not large "crown jewel" hospitals or within a 30 minutes' drive of each other; as bystander hospitals are exogenously treated, this technique minimizes omitted variables that may impact price. Dafny et al.'s analysis found that in-state merger acquisitions correspond to a 7-10% price increase, while out-of-state acquisitions do not, suggesting that the effect of a common consumer base (e.g. employers who demand insurance that covers areas where employees live and work) drives post-merger price increases. With less competition among hospitals for inclusion in an insurer's provider networks, hospitals are better able to command higher prices, suggesting that market concentration plays a role in hospital pricing.[16]

One mechanism through which mergers increase prices is hospitals' adoption of an "all-or-nothing" bargaining strategy. Large hospital systems have the bargaining power to demand

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[14] Gaynor, Martin and Town, Robert. "The Impact of Hospital Consolidation - Update." Robert Wood Johnson Foundation10.13140/RG.2.1.4294.0882. 2012. http://www.rwjf.org/en/library/research/2012/06/the-impact-of-hospital-consolidation.html

[15] Dafney, Ho, Lee, "The Price Effects of Cross-Market Mergers: Theory and Evidence from the Hospital Industry."

[16] Ibid.

insurers include all of the system members into an insurer's preferred network.[17] Using data provided by Blue Shield of California, one analysis found that prices at the largest, multi-hospital systems grew substantially more than prices at all other California hospitals after controlling for hospital characteristics such as total beds, admissions through the ER, and market concentration (113 percent and 70 percent, respectively).[18]

While the above literature indicates that hospital mergers in concentrated markets result in price increases and that large hospital systems have leverage to command higher prices, insurers may also command bargaining power. Cooper, Craig, Gaynor and Reenen used data on health insurance claims from three of the five largest insurance companies (Aetna, Humana, and UnitedHealthcare) to explore prices and spending on the privately insured. Notably, the authors find within hospital pricing variation, providing the first national evidence that the payer-specific negotiated rate (as opposed to the gross charge) is markedly different among insurers for the same procedure at the same hospital.[19]

Evidence from Cooper et al. on within hospital pricing variation, combined with the large body of research on the role of hospital market concentration in determining prices, underscores the descriptive strength of insurer-hospital bargaining models.[20] While insurers exert bargaining power through an ability to exclude hospitals from their network, hospitals exert bargaining power through their ability to increase the breadth of an insurer's preferred network.[21]

Taking advantage of disclosed payer-specific hospital pricing data at the procedure/hospital level, this paper seeks to add to literature on hospital pricing by linking procedure and hospital level gross prices to the median payer-specific negotiated rate, or the end result of negotiations. As the literature suggests that increases in market concentration can lead

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[17] Glenn A. Melnick and Katya Fonkych, "Hospital Prices Increase in California, Especially Among Hospitals in the Largest Multi-Hospital Systems," *INQUIRY: The Journal of Health Care Organization, Provision, and Financing* 53 (January 1, 2016): pp. 1-7, https://doi.org/10.1177/0046958016651555.
[18] Ibid.
[19] Zack Cooper et al., "The Price Ain't Right? Hospital Prices and Health Spending on the Privately Insured,"
[20] Ibid.
[21] Joseph Farrell et al., "Economics at the FTC: Hospital Mergers, Authorized Generic Drugs, and Consumer Credit Markets," *Review of Industrial Organization* 39, no. 4 (October 1, 2011): pp. 271-296, https://doi.org/10.1007/s11151-011-9320-x.

to increases in hospital prices, it is possible that hospitals in more concentrated markets are better able to secure higher payer-specific negotiated rates from insurers. Understanding drivers for the key outcome variable of interest, the difference between list price and median payer-specific negotiated charge, can deepen empirical understandings of how payer-specific negotiated prices are determined and inform directions for future research on the role of market forces in insurer-hospital bargaining.

Data

The main dataset is from Turquoise Health, a search engine platform that aggregates publicly available hospital pricing data disclosed by hospitals. The dataset lists the facility fee for a select list of services mandated for disclosure by CMS; ancillary fees, such as surgeon's fees, and additional charges, such drug or medical device costs, are not included.[22] Each observation corresponds to a specific procedure at an individual hospital, as identified by the hospital's Medicare Provider ID, and the payer-specific charge associated with the procedure; multiple observations list the same procedure at the same hospital, with unique payer-specific charges. As hospitals are required to provide the code associated with a procedure or service as used for accounting or billing purposes, the structure of the data allows for a direct comparison between the gross charge and each payer-specific negotiated rate. 650 hospitals across 154 hospital systems, 104 Core Based Statistical Areas (CBSAs)[23] and 37 states are included in the data.

The data includes several additional elements as required by CMS, including a description of each item or services provided; additionally, hospitals must include the lowest price a hospital has negotiated with all third party payers (de-identified minimum negotiated charge) and the highest price a hospital has negotiated with all third party payers (de-identified maximum negotiated charge), as well as the charge that applies to an individual who pays cash (discounted cash price). For the purposes of this paper, observations listing the discounted cash price are excluded, as the research question focuses on price negotiation between insurance

[22] "Hospital Price Transparency Research Dataset: Turquoise Health," Turquoise Health, accessed February 16, 2022, https://turquoise.health/researchers.

[23] CBSAs are geographic areas defined by the Office of Management and Budget; CBSAs consist of an urban center and surrounding areas highly integrated into the urban center. For more information see: "2020 Standards for Delineating Core Based Statistical Areas" available at: https://www.federalregister.gov/d/2021-15159

companies and hospitals, not private individuals. Similarly, observations corresponding to Medigap insurance[24] coverage are excluded.

The dependent variable *Bargain*, discussed further in Descriptive Statistics and Variable Specification, serves as a proxy for hospitals' market power and is defined as the difference between the list price and the median payer-specific negotiated charge for each observation at the hospital/procedure level. A value of *Bargain*=0 means that there is no difference between the list price and payer-specific negotiated charge; in other words, the payer received no "discount" and paid the hospital's "sticker price."

In some instances *Bargain* is less than zero, implying that the median-payer specific negotiated rate is higher than the list price. There are two possibilities for observations of *Bargain* less than zero: (1) data entry errors or (2) certain payer-specific negotiated rates are indeed higher than the list price. Evidence suggests that the latter case is correct. Importantly, the data includes observations from traditional insurance companies and rental networks. While insurance companies pay for the medical care of plan enrollees directly, rental networks are a type of provider network that is rented out to other companies. Using Turquoise Health data, an analysis from the *Wall Street Journal* found that, on average, rental networks' payer-specific negotiated rates were more expensive than 79 percent of negotiated rates across hospital services (excluding government insurance programs). Moreover, the gap between rental networks' rates and insurance company rates can be large. In one example from Summerlin Hospital Medical Center in Las Vegas, the price for a computed tomography abdominal scan with contrast dye would cost $1,856 for a patient covered by Amthem Inc. but $13,249 under the rental network MultiPlan.[25] Given this prior analysis related to rental networks in the Turquoise Health dataset, observations where *Bargain* < 0 are included in the analysis.

[24] Medigap insurance plans are private insurance plans designed to cover expenses not covered by Medicare, such as copayments, coinsurance, and deductibles. For more information see: "What's Medicare Supplemental Insurance? (Medigap)" available at: https://www.medicare.gov/supplements-other-insurance/whats-medicare-supplement-insurance-medigap

[25] Anna Wilde Mathews and Tom McGinty, "Hospital Prices Are Arbitrary. Just Look at the Kingsburys' $100,000 Bill.," The Wall Street Journal (Dow Jones & Company, October 29, 2021), https://www.wsj.com/articles/hospital-prices-arbitrary-healthcare-medical-bills-insurance-11635428943.

One limitation of the Turquoise Health data is the high presence of missing variables. CMS' price transparency rule is relatively new (approximately 15 months old at the time of writing), and overall compliance with the rule remains a challenge. It is possible that hospitals demonstrating high reporting compliance differ from hospitals with low reporting compliance in some unobservable way that is insufficiently captured by the data.

Data on hospital market concentration comes from the Health Care Cost Institute (HCCI). Using a sample of in-patient facility claims, the HCCI constructed a Herfindahl-Hirschman Index (HHI) measure of market concentration at the Core Based Statistical Area (CBSA) level. The HCCI data defines the market as a set of hospital systems at which patients from a CBSA receive care in a given year, and the HHI is measured as the sum of squared hospital system shares of inpatient admissions for individuals from CBSA *g* in year *t*.[26] Each observation at the CBSA level records HHI concentration as a continuous variable, *HHI Index Value*.[27] The U.S. Department of Justice considers markets with an HHI value between 1,500 and 2,500 to be moderately concentrated, and markets with HHI values above 2,500 points to be highly concentrated.[28]

Though the HCCI data includes observations from 2013 to 2017, included observations are limited to the most recent year available, 2017. Because certain CBSAs (such as New York City, NY) are quite large, the actual level of market concentration may be understated. Highly populated, dense CBSAs may be more appropriately described as containing several local markets.[29]

To control for state level effects and insurer bargaining power, a measure of the percent market share of the largest insurer in the state is included as a state-level fixed effect. This measurement, *Market Share of Largest Insurer in State*, is from the Kaiser Family Foundation

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[26] "2020 Healthy Marketplace Index ," healthcostinstitute.org (Health Care Cost Institute, June 2020), https://healthcostinstitute.org/images/pdfs/hmi_2020_technical_appendix.pdf.
[27] "Healthy Marketplace Index," Health Care Cost Institute , accessed February 23, 2022, https://healthcostinstitute.org/hcci-originals/healthy-marketplace-index/hmi.
[28] "Herfindahl-Hirschman Index." justice.gov. The United States Department of Justice, July 31, 2018.
[29] "2020 Healthy Marketplace Index FAQ," healthcostinstitute.org (Health Care Cost Institute, June 2020), accessed February 24, 2022, https://healthcostinstitute.org/images/pdfs/hmi_2020_faq.pdf.

(KFF) and is constructed as a simple average of the largest insurer's market share across Individual, Small Group, and Large Group insurance.[30] An average is used in order to capture a measure of insurance bargaining power across all forms of private insurance competition. As discussed in Literature Review, insurance companies also possess bargaining power through their ability to supply a large volume of patients to hospitals; omitting a measure of insurer bargaining power would amount to excluding a key detail. Further, premiums and contract negotiations differ according to insurance groups and by state. For example, Small Group plan premiums are set by insurance companies (as opposed to negotiated with employers) and are generally sold to businesses with 1-50 employees. However, some states have expanded the definition of Small Group plans to employers with 1-100 employees.[31] In other words, insurance regulations, like hospital regulations, are heterogeneous across states, and *Market Share of Largest Insurer in State* is intended to capture state-level effects arising from differences in insurance competition across states; including this state level control variable also allows each state to have its own intercept in the regression. This will be discussed further in Methodology. For consistency with the HCCI dataset, data from the KFF is restricted to the year 2017.

Two additional datasets with further control variables are included: an Area Health Resources File (AHRF) and CMS' Area Wage Index dataset. CBSA-level control variables relevant to the demand for health care, such as per-capita income, are drawn from AHRF, an annual dataset from the Health Resources and Services Administration that aggregates health care and health care data at the county, state, and national level.[32] Likewise, CBSA-level control variables relevant to hospital finances come from CMS' Area Wage Index. The Area Wage Index lists the average hourly wage, defined as the total wage costs divided by total hours worked for all hospitals in a CBSA. A National Average Hourly Wage Index, defined as the ratio of a CBSA's average hourly wage to the national average, is also included.[33] For consistency

[30] "Insurance Market Competitiveness," kff.org (Kaiser Family Foundation), accessed May 8, 2022, https://www.kff.org/state-category/health-insurance-managed-care/insurance-market-competitiveness/.
[31] "Market Rating Reforms," cms.gov (Centers for Medicare & Medicaid Services, December 10, 2021), https://www.cms.gov/CCIIO/Programs-and-Initiatives/Health-Insurance-Market-Reforms/state-rating.
[32] "Area Health Resources File (AHRF)," data.hrsa.gov (Health Resources and Services Administration), accessed March 8, 2022, https://data.hrsa.gov/data/download.
[33] "CMS Area Wage Index," CMS.gov, accessed March 8, 2022, https://www.cms.gov/Medicare/Medicare-Fee-for-Service-Payment/AcuteInpatientPPS/wageindex.

with the HCCI data on market concentration, AHRF and CMS Area Wage Index data are limited to observations in 2017.

Descriptive Statistics and Variable Specification

The dependent variable *Bargain* is defined as the difference between the list price (also referred to as the gross charge) and the median payer-specific negotiated charge. In line with previous research using Turquoise Health data, the median rate, as opposed to the specific rate for each payer, is used.[34] The unit of observation is at the hospital/procedure level. For 166 observations, *Bargain* is less than zero. A table of summary statistics for *Bargain* and the gross charge/list price by the fourteen specific procedures included in the data are listed Table 1 of the Appendix. The independent variable measuring market concentration, *HHI Index Value*, is from the HCCI and is specified as a continuous variable.

Previous literature findings that hospital mergers within more concentrated markets correspond to larger price increases suggest that there is a negative relationship between market concentration and prices. Extrapolating from this finding, the relationship between the list price minus the median payer-specific negotiated price (*Bargain*) and market concentration is theorized to be inversely related. To better understand the true relationship between hospitals' bargaining power and market concentration, a simple linear regression, Model 1, is examined:

Model 1: $$Bargain_{ji} = \beta_0 + \beta_1 \, HHI\ Index\ Value$$

Where:

$Bargain_{ji}$ is the List Price – Median Payer Specific Negotiated Rate for procedure *j* at hospital *i*.

HHI Index Value is a continuous variable corresponding to the HHI measure of market concentration for the CBSA in which hospital *i* is located.

[34] See: Roy Xiao et al., "Payer-Negotiated Prices in the Diagnosis and Management of Thyroid Cancer in 2021," *JAMA* 326, no. 2 (2021): pp. 184-185, https://doi.org/10.1001/jama.2021.8535.

Looking at a scatter plot with a linear fit line suggests that *Bargain* is not linearly related to market concentration (Figure 1).

Figure 1: Scatter Plot, *Bargain* and *HHI Index Value* with linear fit

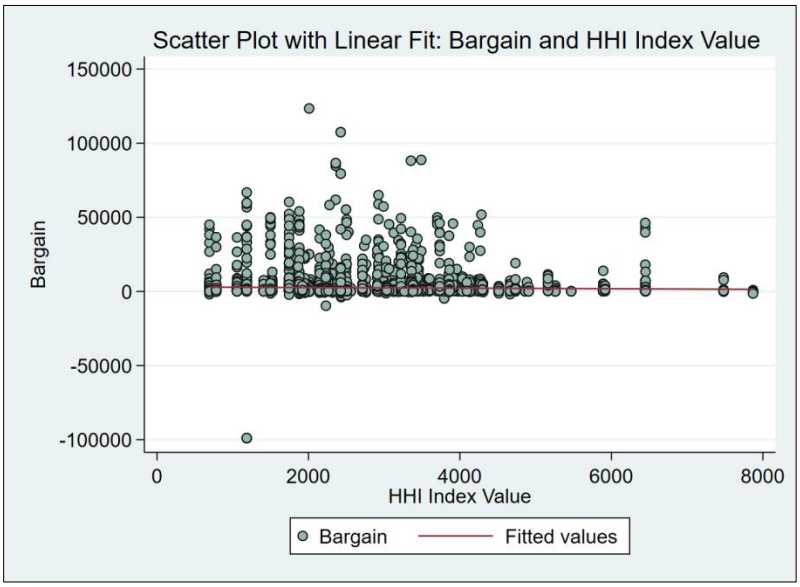


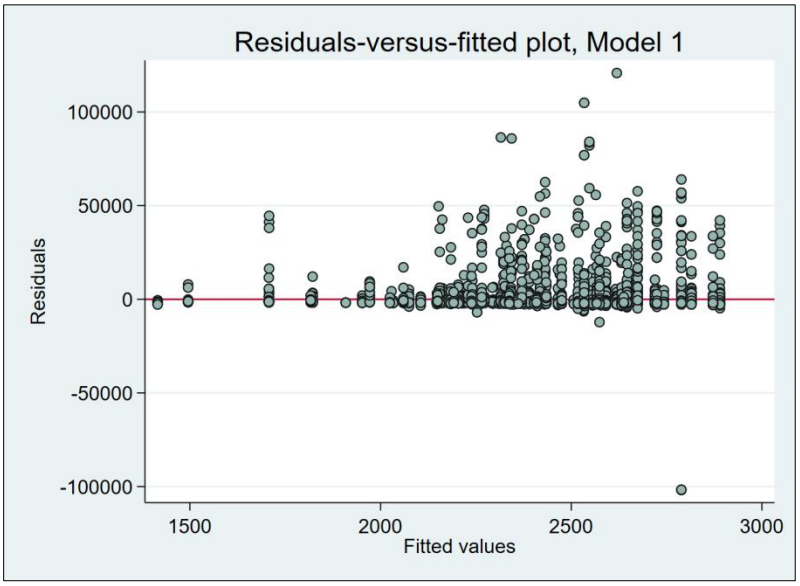
Figure 1 indicates that, for lower levels of market concentration as measured by the *HHI Index Value*, values of *Bargain* are larger, suggesting that in less concentrated markets, hospitals have less market power to secure the full list price. At higher levels of market concentrations, values of *Bargain* become smaller, implying that, in more concentrated markets, hospitals can better secure higher prices.

Plotting the residuals against the fitted values forms an arc from the lower left to the upper right, indicating that the variance of the residuals increases as *HHI Index Value* increases (Figure 2). Further, while not surprising given the lack of control variables, a plot of the residuals vs. the independent variable, *HHI Index Value* (Figure 1, Appendix) demonstrates that the fitted values are more accurate for larger values of *HHI Index Value*, pointing to omitted variable bias.

Figure 2 shows that the residuals become larger as the fitted values become larger, suggesting that a concave transformation, such as a logarithmic or square root transformation, may more accurately capture the relationship between *Bargain* and the measure of market

concentration, *HHI Index Value*. However, many values for *Bargain* are either 0 or negative, meaning that there is no difference between the median payer-specific negotiated price and the gross charge, or that the median payer-specific negotiated rate is higher than the gross charge, respectively. Zero and negative values for *Bargain* make logarithmic or square root transformations impossible. While it will make interpretation less direct, a cubic root transformation, $(Bargain)^{(⅓)}$, is selected to more accurately model the relationship between the two variables while preserving observations where *Bargain*=0 and *Bargain* < 0. During sensitivity analysis, the model will be analyzed with negative values of *Bargain* excluded.

Figure 2: Residuals vs. Fitted Plot, Model 1

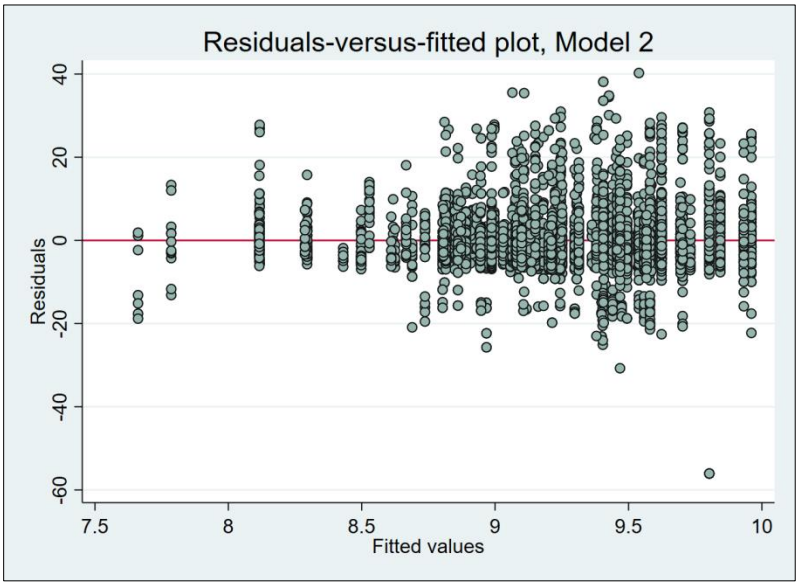


After transforming *Bargain* into $(Bargain)^{(⅓)}$, a second simple linear model, model 2 is examined to check for improvement in modeling the relationship between hospitals' bargaining power and market concentration.

Model 2: $\sqrt[1/3]{Bargain}_{j\,i} = \beta_0 + \beta_1$ HHI Index Value

Where $\sqrt[1/3]{Bargain}_{j\,i}$ is the cubed root of (List Price – Median Payer Specific Negotiated Rate) for procedure *j* at hospital *i*. While there are still outliers, plotting the residuals against the fitted values points to improved model fit, as the residuals better form a horizontal band around the residual=0 line.

Figure 3: Residuals vs. Fitted Plot, Model 2



Model 2's plot of the residuals vs. the independent variable, *HHI Index Value* (Figure 2, Appendix) similarly shows improvement. Histograms of *Bargain* and $(Bargain)^{(1/3)}$ are listed in the Appendix.

Control variables include a hospital's *Overall Rating*, specified as a likert scale from 1 (worst) to 5 (best), *Total Beds*, *Ownership* (nonprofit, for-profit, government), *Type* (Acute Care, Children's, Critical Access, and Psychiatric), *Procedure*, and *Compliance*, a Turquoise Health defined variable that grades hospitals according to their compliance with CMS' Price Transparency Rule on a likert scale from 1 (worst) to 5 (best). *Ownership, Type, and Procedure* are specified as dummy variables.

The fourteen *Procedures* in the dataset are included as a series of dummy variables to control for pricing heterogeneity among procedures. Looking at the interquartile range and median Gross Charge by procedure reveals that the spread of prices for some procedures, such as *Uterine and adnexa procedures, non-malignancy* and *Emergency Level 4*, are quite large, confirming that prices are heterogeneous across hospitals and procedures (Table 1). The interquartile range and value of *Bargain* by procedure shows similar heterogeneity and a large interquartile range for some procedures, such as *Knee arthroscopic cartilage removal* (Table 2). Note that for Table 2, the values are across all hospitals included in the data.

Table 1: Summary Statistics, Gross Charge by Procedure

Procedure and Procedure Code	Interquartile Range	Median
Uterine and adnexa procedures, non-malignancy 743	26,229.730	41,199.840
Knee arthroscopic cartilage removal 29881	10,512.930	12,267.990
Colonoscopy, diagnostic 45378	2,174	3,062.530
MRI scan of brain before and after contrast 70553	2,997.880	4,613.915
CT scan, pelvis, with contrast 72193	1,883.760	2,542.510
Ultrasound of abdomen, complete 76700	880.910	1160
Kidney Function Blood Test Panel, 80069	217.400	178.960
Electrocardiogram, routine, with interpretation & report 93000	308.770	166
New patient office or other outpatient visit, 30 min 99203	202.590	301.250
New patient office of other outpatient visit, 45 min 99204	260	389
New patient office of other outpatient visit, 60 min 99205	375.670	510.050
Emergency Level 3 99283	717	1107
Emergency Level 4 99284	11,13.960	1727
Emergency Level 5 99285	1,590.850	2512

Table 2: Summary Statistics, Bargain by Procedure (all hospitals)

Procedure and Procedure Code	Interquartile Range	Median
Uterine and adnexa procedures, non-malignancy 743	30003.300	23800.550
Knee arthroscopic cartilage removal 29881	11914.950	5139.390
Colonoscopy, diagnostic 45378	1744.850	1477.960
MRI scan of brain before and after contrast 70553	3215.825	2511.265
CT scan, pelvis, with contrast 72193	1767.600	1407.715
Ultrasound of abdomen, complete 76700	902.040	580.820
Kidney Function Blood Test Panel, 80069	184.930	90.470
Electrocardiogram, routine, with interpretation & report 93000	137.210	35.620
New patient office or other outpatient visit, 30 min 99203	169.227	122.043
New patient office of other outpatient visit, 45 min 99204	238.380	158.260
New patient office of other outpatient visit, 60 min 99205	305.880	202.505
Emergency Level 3 99283	520.720	405.895
Emergency Level 4 99284	874.340	671.110
Emergency Level 5 99285	1292.895	1101.703

To control for the demand for private health insurance and hospital financials, the following control variables at the CBSA level are included: *Per Capita Income*, *Persons < 65 with Health Insurance*, *Hospital Adjusted Hourly Wage*, and *Adjusted Hourly Wage Index*. *Per Capita Income* and *Persons < 65 with Health Insurance* were selected to control for the demand for health care, while *Hospital Adjusted Hourly Wage* and *Adjusted Hourly Wage Index* were selected to control for hospital financials and the relative cost of hospital labor across CBSAs, respectively. As mentioned in Data, *Hospital Adjusted Hourly Wage* is defined as the total wage costs divided by total hours worked for all hospitals in a CBSA, while *Adjusted Hourly Wage Index* is defined as the ratio of a CBSA's average hourly wage to the national average.

Market Share of Largest Insurer is included to control for state-level differences in insurer competition. As shown in Table 3, the market share of the largest insurer varies by state, suggesting that state-level differences in insurer market concentration need to be accounted for.

Table 3: Summary Statistics, Market Share of Largest Insurer by State

State	Mean	State	Mean
ARIZONA	.42	NEW HAMPSHIRE	.487
ARKANSAS	.677	NEW JERSEY	.59
CALIFORNIA	.357	NEW MEXICO	.427
COLORADO	.407	NEW YORK	.237
CONNECTICUT	.413	NORTH CAROLINA	.673
FLORIDA	.467	OHIO	.37
GEORGIA	.42	OKLAHOMA	.71
ILLINOIS	.697	OREGON	.417
INDIANA	.477	PENNSYLVANIA	.367
IOWA	.76	RHODE ISLAND	.733
KANSAS	.553	SOUTH CAROLINA	.877
KENTUCKY	.64	TENNESSEE	.493
LOUISIANA	.737	TEXAS	.463
MASSACHUSETTS	.487	UTAH	.537
MINNESOTA	.433	VIRGINIA	.423
MISSISSIPPI	.703	WASHINGTON	.333
MISSOURI	.39	WEST VIRGINIA	.793
NEBRASKA	.577	WISCONSIN	.227
NEVADA	.593		

Additional summary statistics are as follows:

Table 4: Summary Statistics
Descriptive Statistics

Variable	Observ.	Mean	Std. Dev.	Min	Max
Bargain	5,695	2,471.46	8,329.097	-99,025	12,3451.35
$\text{Bargain}^{(1/3)}$	5,695	9.308	7.177	-46.265	49.793
HHI Index Value	5,695	2,730.186	1,203.433	6,92.833	7,870.571
Total Beds	5,682	273.992	287.574	0	2,891
Hospital Overall Rating	4,366	3.332	1.135	1	5
Compliance	5,640	4.471	.744	1	5
Hospital Adjusted Hourly Wage	4,174	39.278	6.259	29.845	71.754
Adjusted Hourly Wage Index	4,174	.954	.152	.725	1.743
Per Capita Income	5,695	52,592.945	13,767.011	2,5617	119,868
Persons <65 with Health Insurance	5,695	943,020.07	15,04123	6,066	7,798,975
Market Share of Largest Insurer	5,695	.503	.15	.227	.877

Descriptive Statistics

Variable	Frequency	Percent	Cumulative Total
For Profit	1,070	18.79	18.79
Government	726	12.75	31.54
Nonprofit	3,328	58.44	89.98
Missing	571	10.02	100
TOTAL	5,695		
Acute Care	4,462	78.35	78.35
Children's	231	4.06	82.41
Critical Access	399	7.01	89.42
Psychiatric	32	0.56	89.98
Missing	571	10.02	100
TOTAL	5,695		
Uterine and adnexa procedures, non-malignancy 743	232	4.07	4.07
Knee arthroscopic cartilage removal 29881	199	3.49	7.57
Colonoscopy, diagnostic 45378	335	5.88	13.45
MRI scan of brain before and after contrast 70553	570	10.01	23.46
CT scan, pelvis, with contrast 72193	570	10.01	33.47
Ultrasound of abdomen, complete 76700	595	10.45	43.92
Kidney Function Blood Test Panel, 80069	535	9.39	53.31
Electrocardiogram, routine, with interpretation & report 93000	86	1.51	54.82
New patient office or other outpatient visit, 30 min 99203	388	6.81	61.63
New patient office of other outpatient visit, 45 min 99204	385	6.76	68.39
New patient office of other outpatient visit, 60 min 99205	366	6.43	74.82
Emergency Level 3 99283	491	8.62	83.44
Emergency Level 4 99284	475	8.34	91.78
Emergency Level 5 99285	468	8.22	100.00
TOTAL	5,695		

Descriptive Statistics

Variable	Count
CBSA	104
State	37
Hospitals	650
Hospital Systems	154

Methodology

Given the cross-sectional nature of the data, the analysis is conducted through an OLS model with absorbing indicators corresponding to the largest insurer's market share by state. OLS models function by minimizing the sum of squared residuals (where the residual is the difference between the observed y_i its fitted value $\hat{y}_i$). So long as model assumptions are satisfied,[35] an OLS model will provide the Best Unbiased Linear Estimator (BLUE), where

[35] The five assumptions are: Linear in Parameters, Random Sampling, Zero Conditional Mean, Sample Variation in Independent Variables, Homoskedasticity of Error Terms

"best" is defined as the estimators with the smallest variance.[36] Absorbing indicators are used to control for differences among state insurance markets without the need to specify each state as a separate dummy variable,[37] which would unnecessarily reduce the model's degrees of freedom. Were state effects excluded, the model would assume that values of *Bargain* are wholly independent across states. This would be a dubious assumption since hospitals across states are likely to differ in state-level insurance market characteristics, in addition to differences in population compositions, health care regulations, and economic activity. Finally, robust standard errors are used to account for heteroskedasticity. The final regression model is specified as:

Linear Regression with Absorbing Indicators

$$\sqrt[1/3]{Bargain}_{j\,i\,s} = \beta_0 + \beta_1\ HHI\ Index\ Value + O\gamma + T\eta + C\upsilon + \alpha_i X_i + \epsilon$$

Where:

$\sqrt[1/3]{Bargain}_{j\,i\,s}$ is the cubed root of (List Price – Median Payer Specific Negotiated Rate) for procedure *j* at hospital *i* in state *s*.

HHI Index Value is a continuous variable corresponding to the HHI measure of market concentration for the CBSA in which hospital *i* is located.

Oγ is an (n x 3) matrix containing dummy variables for the three category response to *Hospital Ownership*.

Tη is an (n x 4) matrix containing dummy variables for the four category response to *Hospital Type*.

Cυ is an (n x 14) matrix containing dummy variables for the fourteen category response to *Procedure*.

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[36] Jeffrey M. Wooldridge, *Introductory Econometrics: A Modern Approach*, 2e ed. (Mason, OH: Thomson Learning, 2003). 30-61; 103-104.

[37] McCaffrey, Daniel F., J. R. Lockwood, Kata Mihaly, and Tim R. Sass. "A Review of Stata Commands for Fixed-Effects Estimation in Normal Linear Models." The Stata Journal 12, no. 3 (September 2012): 406–32. https://doi.org/10.1177/1536867X1201200305.

$\alpha_i X_i$ represents control variables: *Hospital Overall Rating*, *Total Beds*, *Compliance Score*, *Per Capita Income*, *Persons < 65 with Health Insurance*, *Hospital Adjusted Hourly Wage*, and *Hospital Adjusted Hourly Wage Index*.

ϵ is the error term.

The Absorbing Indicators are the average *Market Share of Largest Insurer* in state *s* across individual, Small Group, and Large Group insurance markets.

Results & Post Estimation Testing

Results are presented in Table 5. Notably, the coefficient on *HHI Index* value is approximately zero, meaning that, holding all else constant, for a one-unit change in *HHI Index Value*, the expected change in $Bargain^{(1/3)}$ is approximately zero. As $Bargain^{(1/3)}$ indicates the end result of a hospital's negotiations with a payer at the procedure/hospital level, initial results suggests that, holding hospital characteristics (e.g., ownership, type), state insurance markets, procedure, and CBSA characteristics (e.g., per capita income, hospital adjusted hourly wage) equal, a one-unit increased in *HHI Index Value* may not allow a hospital to extract substantially higher prices from an insurance company.

Table 5: Linear Regression with Absorbing Indicators: $\sqrt[1/3]{Bargain}_{j\,i} = \beta_0 + \beta_1\ HHI\ Index\ Value + O\gamma + T\eta + C\upsilon + \alpha_i X_i + \epsilon$

Bargain$^{(1/3)}$	Coef.	St.Err.	t-value	p-value	[95% Conf	Interval]	Sig
HHI Index Value	-0.000243	0	-2.31	.021	0	0	**
: Base group, For Profit	0	.	.	.	.	.	
Government	-1.147	.311	-3.69	0	-1.757	-.538	***
Non Profit	-1.257	.273	-4.60	0	-1.793	-.722	***
: Base group, Acute, Children's, Psy.	0	.	.	.	.	.	
Critical Access	-1.343	.498	-2.70	.007	-2.32	-.367	***
Uterine and adnexa procedures, non-malignancy 743	0	.	.	.	.	.	
Knee arthroscopic cartilage removal 29881	-11.008	1	-11.01	0	-12.968	-9.047	***
Colonoscopy, diagnostic 45378	-16.147	.722	-22.37	0	-17.562	-14.731	***
MRI scan of brain before and after contrast 70553	-13.648	.644	-21.19	0	-14.911	-12.385	***
CT scan, pelvis, with contrast 72193	-15.81	.639	-24.76	0	-17.062	-14.558	***
Ultrasound of abdomen, complete 76700	-18.384	.622	-29.53	0	-19.604	-17.163	***
Kidney Function Blood Test Panel, 80069	-22.455	.617	-36.41	0	-23.665	-21.246	***
Electrocardiogram, routine, with interpretation & report 93000	-23.099	.723	-31.96	0	-24.517	-21.682	***
New patient office or other outpatient visit, 30 min 99203	-22.53	.636	-35.41	0	-23.778	-21.283	***
New patient office of other outpatient visit, 45 min 99204	-22.086	.639	-34.56	0	-23.339	-20.833	***
New patient office of other outpatient visit, 60 min 99205	-21.951	.659	-33.33	0	-23.242	-20.659	***
Emergency Level 3 99283	-20.498	.649	-31.60	0	-21.77	-19.226	***
Emergency Level 4 99284	-18.98	.662	-28.67	0	-20.278	-17.682	***
Emergency Level 5 99285	-17.634	.673	-26.20	0	-18.954	-16.315	***
Hospital Overall Rating	-.135	.1	-1.36	.175	-.33	.06	
Total Beds	0	0	1.81	.07	0	.001	*
Compliance	-.389	.159	-2.44	.015	-.701	-.076	**
Per Capita Income	0	0	-2.22	.026	0	0	**
Persons <65 with Health Insurance	0	0	5.54	0	0	0	***
Hospital Adjusted Hourly Wage	33.431	94.058	0.36	.722	-150.993	217.855	
Adjusted Hourly Wage Index	-1375.639	3871.702	-0.36	.722	-8967.02	6215.743	
Constant	31.092	1.668	18.64	0	27.822	34.362	***

Mean dependent var	9.351	SD dependent var	6.731
R-squared	0.625	Number of obs	3133
F-test	190.179	Prob > F	0.000
Akaike crit. (AIC)	17818.487	Bayesian crit. (BIC)	17969.730

* p<0.05, ** p<0.01, ***p<0.001 Standard Errors are robust.

There are several possibilities for a *HHI Index Value* coefficient of approximately zero. One possibility, of course, is that the model reasonably captures the relationship between market concentration and a hospital's bargaining power and, given the control variables, the effect of market concentration on a hospital's bargaining power is negligibly small. However, looking at the coefficients on the fourteen *Procedures* included suggests an alternative explanation; the coefficient values on the fourteen *Procedures* are all negative and statistically significant ($p<0.001$). This may suggest that the service line is an important factor in the end result of a hospital's negotiations with a payer. Moreover, the negative sign on *HHI Index Value* may suggest that there is indeed an inverse relationship between market concentration and a hospital's ability to extract higher payments from an insurance company.

Before more closely examining differences across service lines, the model is tested for misspecification with a link test. A link test functions by regressing the observed dependent variable on the fitted values and fitted-squared values. If the model is correctly specified, then the fitted-square values should not have explanatory power. Link test results are presented in Table 6. As shown in the table, the fitted-square values are not significant ($P>0.05$), suggesting that the model is adequately specified.

Table 6: Link test

H0: The current model is an adequate fit to the data.
HA: Alternative modeling is needed.

Linear regression, absorbing indicators

Number of obs = 3,133
No. of categories = 31
F(2, 2,301.87) = 2301.87
Prob > F = 0.0000
R-squared = 0.6249
Adj R-squared = 0.6210
Root MSE = 4.1438

Bargain[(1/3)]	**Coef.**	**Std.Err.**	**t**	**P>t**	**[95%Conf.**	**Interval]**
_hat	0.921	0.050	18.340	0.000	0.822	1.019
_hatsq	0.003	0.002	1.660	0.098	-0.001	0.006
_cons	0.424	0.300	1.410	0.158	-0.164	1.013

Results:
_hat is statistically significant at the 99% level of confidence (p=0.000).
_hatsq is not significant (p=0.098)
I fail to reject H0, suggesting the model is not misspecified.

F test of absorbed indicators: F(30, 3100) = 15.429 Prob > F = 0.000

Next, to determine whether there are significant differences across the fourteen *Procedures*, a joint test of linear restrictions on the fourteen *Procedure* dummy variables is performed. In cases of joint linear testing, results can provide evidence that at least one of the *Procedure* coefficients is not equal to the others; in this way, it is possible to better understand if there is a significant difference across hospital service lines. Results are presented in Table 7.

Table 7: Joint Tests of Linear Restriction, Procedure Dummies

H0: Coefficient values are equal
HA: Coefficient values are not equal

Dummies and H0	**Results**
Procedure Code H0: β Uterine and adnexa procedures, non-malignancy 743=…..=β Emergency Level 5 99285 = 0	F(12, 96923) = 7726.62 ; Prob > F = 0.0000 The null is rejected.

The null hypothesis is rejected, indicating that at least one of the *Procedures*' effects on the dependent variable differs. Given this test result, it is reasonable to hypothesize that the specific service line is an important determinate of hospital-insurer bargaining.

Sensitivity Analysis

As mentioned in Data, for 166 observations, *Bargain* is less than zero; these observations may represent instances in which the payer price was above the gross charge, or they may be data entry errors. To test the model's robustness, the final regression model displayed in Table 5 is re-run with negative values of $Bargain^{(1/3)}$ excluded. A comparison of coefficient values is presented in Table 8. The original regression is referred to as Regression A and the re-run regression with values of $Bargain^{(1/3)} < 0$ excluded is referred to as Regression B. While some coefficient differences are quite large, such as *Hospital Adjusted Hourly Wage*, notably, in both regression, the coefficient value for *HHI Index Value* is negative and approximately 0. Moreover, the significance level on the coefficient *HHI Index Value* across both regressions are significant at the 99.99% level of confidence ($p<0.01$). Hence, in both instances, the general conclusions remain the same: there is an inverse and statistically significant relationship between $Bargain^{(1/3)}$ and *HHI Index Value.* Additionally, across both regressions, the coefficient values on the fourteen *Procedures* are all negative and statistically significant. The results presented in Table 8 indicates that the model is robust to accounting for observations where $Bargain^{(1/3)}$

< 0, potentially signaling that market concentration is an important factor in hospital-insurer bargaining even when the payer price is higher than the gross charge.

Table 8: Linear regressions, absorbing indicators. Coefficient comparison.

Coefficient	(A) $Bargain^{(1/3)}$	A) Excluding $Bargain^{(1/3)} < 0$	Difference (A-B)
HHI Index Value	-0.000243** (-2.31)	-0.000200** (-3.06)	-.000043
: Base group, For Profit	0	0	.
Government	-1.147*** (-3.69)	-1.572*** (-5.89)	.425
Non Profit	-1.257*** (-4.60)	-1.214*** (-5.17)	-.043
: Base group, Acute, Children's, Psy.	0	0	.
Critical Access	-1.343** (-2.70)	-0.924** (-3.21)	-.419
Uterine and adnexa procedures, non-malignancy 743	0	0	.
Knee arthroscopic cartilage removal 29881	-11.01*** (-11.01)	-10.19*** (-11.44)	-.82
Colonoscopy, diagnostic 45378	-16.15*** (-22.37)	-15.52*** (-22.49)	-.63
MRI scan of brain before and after contrast 70553	-13.65*** (-21.19)	-13.48*** (-21.00)	-.17
CT scan, pelvis, with contrast 72193	-15.81*** (-24.76)	-15.55*** (-24.54)	-.26
Ultrasound of abdomen, complete 76700	-18.38*** (-29.53)	-18.41*** (-29.41)	.03
Kidney Function Blood Test Panel, 80069	-22.46*** (-36.41)	-22.36*** (-36.09)	-.1
Electrocardiogram, routine, with interpretation & report 93000	-23.10*** (-31.96)	-23.03*** (-32.93)	-.07
New patient office or other outpatient visit, 30 min 99203	-22.53*** (-35.41)	-22.10*** (-35.21)	-.43
New patient office of other outpatient visit, 45 min 99204	-22.09*** (-34.56)	-21.67*** (-34.39)	-.42
New patient office of other outpatient visit, 60 min 99205	-21.95*** (-33.33)	-21.22*** (-33.50)	-.73
Emergency Level 3 99283	-20.50*** (-31.60)	-19.55*** (-31.48)	-.95
Emergency Level 4 99284	-18.98*** (-28.67)	-17.95*** (-28.68)	-1.03
Emergency Level 5 99285	-17.63*** (-26.20)	-16.61*** (-26.37)	-1.02
Hospital Overall Rating	-1.35 (-1.36)	-0.211** (-2.84)	-1.139
Total Beds	-0.135 (1.81)	0.000472* (2.48)	-.135472
Compliance	-0.389* (-2.44)	-0.392** (-3.13)	.003
Per Capita Income	-0.0000190* (-2.22)	-0.0000113 (-1.71)	-7.700e-06
Persons <65 with Health Insurance	0.000000949*** (5.54)	0.000000934*** (6.55)	1.500e-08
Hospital Adjusted Hourly Wage	33.43 (0.36)	-102.8 (-1.65)	136.23
Adjusted Hourly Wage Index	-1375.6 (-0.36)	4231.4 (1.65)	-5607
Constant	31.09*** (18.64)	31.20*** (22.66)	.
N	3,133	3,040	93

t statistics in parentheses * p<0.05, ** p<0.01, *** p<0.001 Standard Errors are robust.

Next, to test whether results differ across service lines, the regression is re-run for select groups of procedures. Specifically, the regression is re-run for Uterine and adnexa procedures, non-malignancy (code 743); Knee arthroscopic cartilage removal (code 29881); MRI scan of brain before and after contrast (code 70553); New Patient (codes 99203, 99204, and 99205); and Emergency Level procedures (codes 99283, 99284, and 99285). These procedures were selected either for their large range in values of *Bargain* as shown in Figure 5 of the Appendix (Uterine, Knee, and MRI) or variation in *Bargain* and the Gross Charge across different "levels" of treatment (New Patient and Emergency Level). For this part of the analysis, New Patient Office Visits and Emergency Level codes are grouped together. Results are presented in Table 9. Note that for the results presented in Table 9, *Procedure* dummies, $C\upsilon$, are excluded.

For Uterine and adnexa procedures (code 743) and MRI scan of the brain (code 70553), the number of clusters was too large for the limited number of observations,[38] resulting in missing F-tests (Prob > F .). As the F-test is a global test of the regression's validity in fitting the data,[39] the missing F-test signals that it is not possible to assess the Uterine and MRI models' predictive capability.

While all coefficient values on *HHI Index Value* are close to zero, the significance levels differ. For example, for *New Patient Office or Other Outpatient Visits 30, 45, 60 minutes*, there is a negative and statistically significant relationship between *HHI Index Value* and the dependent variable; in contrast, the coefficient value on *Emergency Level 3, 4, and 5* is non-significant. While it is unclear what might be driving differences in the significance level of *HHI Index Value* across service lines, the differences in the significance level of the dependent variable across regressions may signify that the end result of a hospital's negotiation with an insurance company is in part contingent on the specific service.

[38] Uterine: 25 clusters and 138 observations; MRI: 31 clusters and 315 observations.
[39] The null hypothesis is that all regression coefficients are equal to zero.

Table 9: Linear regressions, absorbing indicators, by procedures. Coefficient Comparison.

$\sqrt[1/3]{Bargain}_{j\,i\,s} = \beta_0 + \beta_1\ HHI\ Index\ Value + \mathrm{O}\gamma + \mathrm{T}\eta + \alpha_i X_i + \epsilon$

	Uterine and adnexa procedures, non-malignancy 743	Knee arthroscopic cartilage removal (29881)	MRI scan of brain before and after contrast (70553)	New patient office or other outpatient visits, 30, 45, 60 minutes	Emergency Level 3. 4, and 5
HHI Index Value	-0.000718 (-1.10)	0.00175 (1.42)	-0.000504* (-2.16)	0.000423** (2.61)	-0.000306 (-1.30)
Base group, For Profit	0	0	0	0	0
Government	-1.305 (-0.43)	-5.299 (-1.01)	-1.811* (-2.36)	-1.020 (-1.71)	1.102 (1.51)
Non Profit	-2.197 (-0.83)	-6.319* (-2.05)	-2.280*** (-3.40)	0.230 (0.48)	0.429 (0.61)
Base group, Acute, Children's, Psy.	0	0	0	0	0
Critical Access	0.438 (0.07)	1.254 (0.15)	-2.697** (-2.82)	1.103 (1.52)	-2.704** (-2.80)
Hospital Overall Rating	0.454 (0.56)	-0.387 (-0.33)	0.302 (-1.11)	-0.321* (-2.12)	0.112 (0.49)
Total Beds	0.00349 (1.72)	-0.00193 (-0.65)	0.000269 (0.38)	-0.000197 (-0.48)	0.000684 (1.39)
Compliance	0.514 (0.27)	1.336 (0.79)	-0.553 (-1.46)	-0.150 (-0.89)	-0.171 (-0.52)
Per Capita Income	0.000136 (1.55)	0.000164 (1.38)	-0.00000984 (-0.40)	0.00000451 (0.42)	-0.0000742*** (-3.37)
Persons <65 with Health Insurance	0 (0.37)	-0.000000999 (-0.79)	0.000000883 (1.94)	0.000000465 (1.67)	0.00000176*** (4.29)
Hospital Adjusted Hourly Wage	792.0 (0.02)	1647.3 (1.07)	37.77 (0.19)	124.1 (0.76)	-95.75 (-0.51)
Adjusted Hourly Wage Index	792.0 (0.02)	-67832.8 (-1.07)	-1559.8 (-0.19)	-5102 .7 (-0.76)	3946.5 (0.51)
Constant	27.50 (1.52)	30.00 (1.77)	25.26*** (5.83)	1.582 (0.94)	6.407 (1.57)
N	138	98	315	635	804

t statistics in parentheses * p<0.05, ** p<0.01, *** p<0.001 Standard Errors are robust.

Limitations

First, the data on hospital pricing from Turquoise Health represents observations at a single point in time, ruling out panel data techniques. It was therefore not possible to account for time-invariant unobserved heterogeneity across hospitals. Perhaps it is the case that unobserved characteristics, such as a hospital's perceived "prestige" or administrative culture, meaningfully factors into hospital-insurer bargaining. Since hospitals are required to post pricing information at least once per year, a future researcher might be able to track prices at the procedure/hospital level over time and use panel data techniques to control for variables that cannot be observed or measured.

As previously described, CMS' reporting requirements are a recent rule; hospitals may be confused about reporting requirements, or lack sufficient administrative systems to ensure data accuracy. In other words, there is a nonzero chance that a sufficient amount of data in this analysis is inaccurate, in which case the results would not be valid. One way to overcome this limitation would be to use more observations. This analysis used a limited, free researched dataset from Turquoise Health. Larger, paid datasets are available and could help to ensure that an adequate amount of accurate data is included. A larger dataset would likewise help address the high presence of missing variables in the limited dataset by providing more observations that are complete. More complete observations would also allow for a more thorough analysis of hospital-insurer bargaining according to the specific service; due to the limited number of observations and large number of absorbing indicators, it was not possible to run a model of hospital-insurer bargaining for every procedure included in the Turquoise Health dataset.

Finally, as discussed in Data, certain CBSAs are large, covering both a wide geographic area and densely populated urban centers, potentially understating the level of market concentration as measured by the Herfindahl-Hirschman Index (HHI). A different measure of market concentration, perhaps one derived from spatial analysis, may provide a more granular and accurate measure of market concentration. An alternative measure of market concentration would also provide another avenue for sensitivity analysis; if the inverse relationship between $Bargain^{(1/3)}$ and an independent variable representing market concentration holds despite the alternative specification, this would provide additional evidence that market concentration is indeed an important determinant of a hospital's ability to extract higher payments from payers.

Conclusions

Previous literature demonstrated that increases in market concentration often results in price increases, and that different insurers face disparate payer-specific negotiated rates at the same hospital, underscoring that hospital prices are set strategically and not ad hoc. Using disclosed pricing data from CMS' new Price Transparency rule, this analysis has contributed to the literature by examining the role of market concentration on hospitals' bargaining power, defined as the difference between the gross price and the median payer-specific negotiated charge. While the coefficient on *HHI Index Value* was approximately zero, the regression results demonstrated an inverse relationship between $Bargain^{(1/3)}$ and *HHI Index Value*. This inverse relationship was robust to the inclusion and exclusion of observations where $Bargain^{(1/3)} < 0$, suggesting that, holding all else equal, an increase in market concentration does allow a hospital to secure a higher payer-specific negotiated rate. At the same time, the significance level on *HHI Index Value* differed according to the specific procedure, denoting that the specific service may play an influential role in hospital-insurer bargaining. Future releases of disclosed hospital pricing or an alternative measure of market concentration could help to confirm or refute these findings.

Appendix

Figure 1: Residuals vs. x-values plot, Model 1

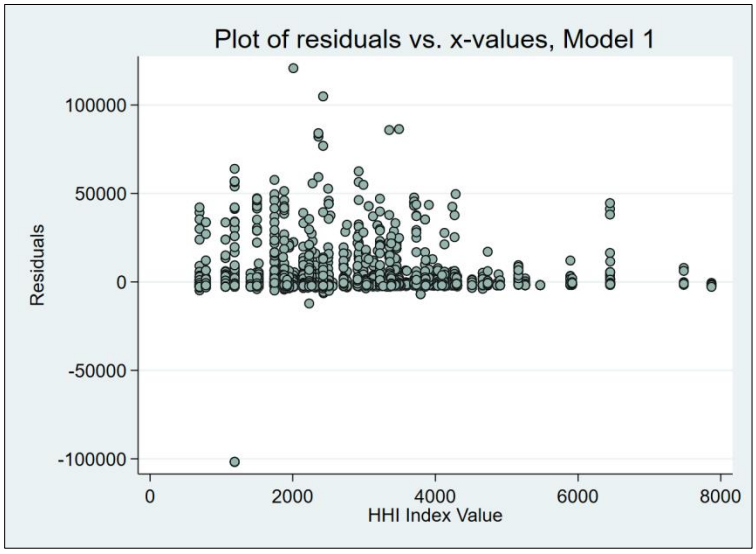


Figure 2: Residuals vs. x-values plot, Model 2

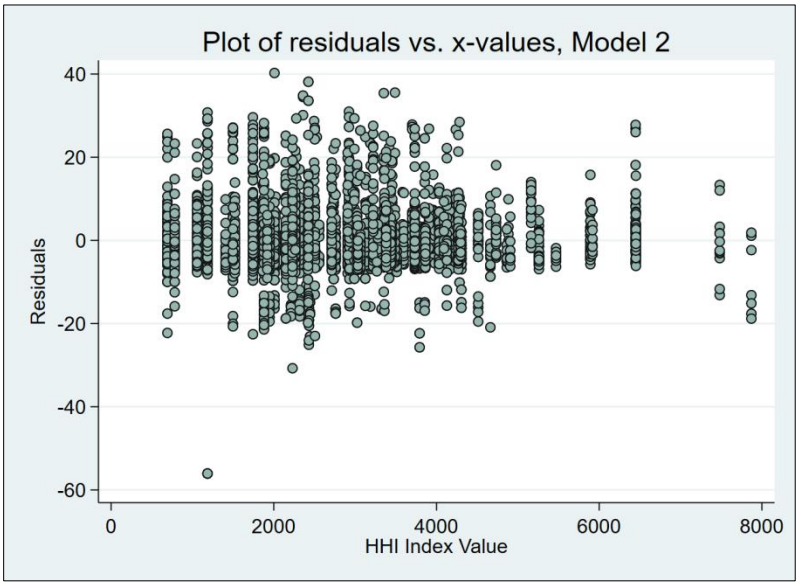
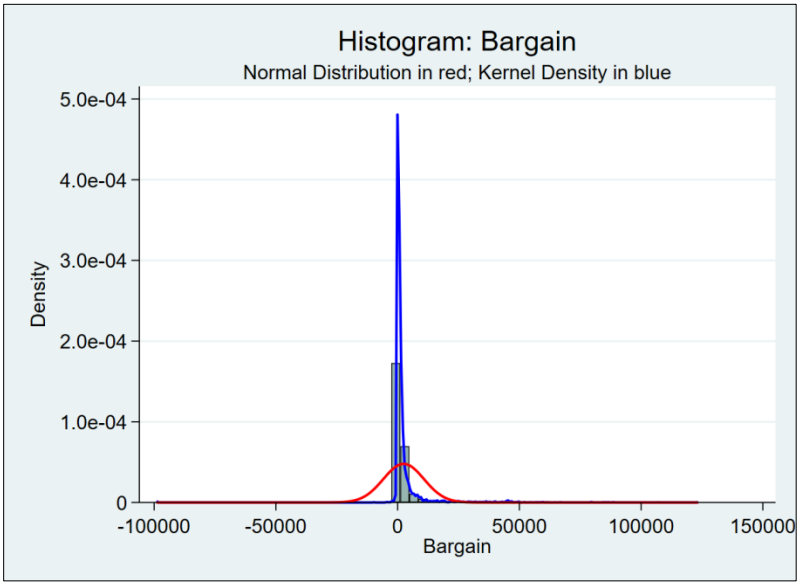


Figure 3: Histogram of *Bargain* and *(Bargain)*$^{(1/3)}$



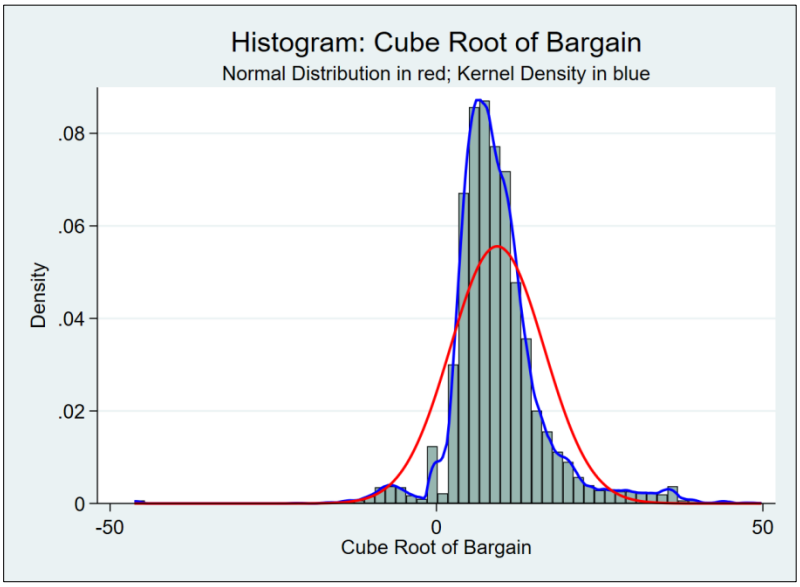


Figure 5: Bargain and Gross Charge Summary Statistics

Gross Charge Summary Statistics: N mean sd min max by(procedure)

code	N	mean	sd	min	max
Uterine and adnexa procedures, non-malignancy 743	232	43840.466	21139.792	1.74	143180.92
Knee arthroscopic cartilage removal 29881	199	15289.389	13816.303	1063.6	101792
Colonoscopy, diagnostic 45378	335	4540.979	5537.991	53	46,403.879
MRI scan of brain before and after contrast 70553	570	5006.507	2713.897	5	16,858
CT scan, pelvis, with contrast 72193	570	2919.184	1700.836	4.75	10077
Ultrasound of abdomen, complete 76700	595	1302.097	798.701	23	5101
Kidney Function Blood Test Panel, 80069	535	263.586	812.948	.01	18434.5
Electrocardiogram, routine, with interpretation and report 93000	86	246.718	223.149	32.82	846
New patient office or other outpatient visit, typically 30 min 99203	388	380.21	393.567	1	5241.86
New patient office of other outpatient visit, typically 45 min 99204	385	495.065	443.187	1	4254
New patient office of other outpatient visit, typically 60 min 99205	366	609.469	478.887	1	3570
Emergency Level 3 99283	491	1137.208	658.275	23.12	6089.5
Emergency Level 4 99284	475	1838.585	1138.847	48.7	13275.27
Emergency Level 5 99285	468	2677.958	1749.851	.34	19087.551

Summary Statistics Bargain: N mean sd min max by(procedure)

code	N	mean	sd	min	max
Uterine and adnexa procedures, non-malignancy 743	232	28232.261	21022.186	-9617.97	123451.35
Knee arthroscopic cartilage removal 29881	199	10130.019	12710.737	-3862	79479
Colonoscopy, diagnostic 45378	335	2956.946	5494.301	-2164	45789.301
MRI scan of brain before and after contrast 70553	570	3294.132	2813.365	-453.62	16351.435
CT scan, pelvis, with contrast 72193	570	1887.397	1696.135	-1650.64	9358.2
Ultrasound of abdomen, complete 76700	595	847.217	806.946	-1090	4946
Kidney Function Blood Test Panel, 80069	535	176.747	484.039	-116.58	10495.925
Electrocardiogram, routine, with interpretation and report 93000	86	103.722	141.149	-50.735	786.25
New patient office or other outpatient visit, typically 30 min 99203	388	-314.381	7122.424	-99025	4927.35
New patient office of other	385	-260.696	7153.722	-98994	3730

outpatient visit, typically 45 min 99204					
New patient office of other outpatient visit, typically 60 min 99205	366	-250.926	7336.521	-98885	3124.17
Emergency Level 3 99283	491	507.556	572.481	-2513	4077.905
Emergency Level 4 99284	475	867.142	1020.044	-2386	12478.75
Emergency Level 5 99285	468	1304.851	1540.400	-4688.5	17942.301

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