

Trends in Hospital Prices for the Publicly and Privately Insured, 2009-15

Word Count: 2,485 words

Abstract

Objective: To study how hospital prices for enrollees in commercial insurance, Medicare Advantage (MA), and Medicare fee-for-service (FFS) have changed over time.

Data Sources: We use the American Hospital Utilization Database, which contains all-payer administrative claims data from 84 US acute care hospitals from 2009 to 2015.

Study Design: We compare prices negotiated by commercial and MA insurers to Medicare FFS reimbursements, controlling for differences in case-mix and hospital-mix across insurance types.

Principal Findings: We find inpatient prices rose significantly faster than outpatient prices. Inpatient commercial insurance prices increased by 25.8 percent from 2009 to 2015 in real terms, while MA and Medicare FFS inpatient reimbursements increased by 6.6 and 7.4 percent, respectively. In 2015, commercial prices were 153 percent of Medicare FFS rates for inpatient care and 239 percent for outpatient care. MA insurers paid 106 percent of Medicare FFS rates for inpatient care and 139 percent for outpatient care. While national MA insurers negotiated prices similar to those of Medicare FFS, regional MA insurers paid slightly more on average.

Conclusions: Growth in hospital prices from 2009 to 2015 was driven almost entirely by growth in prices negotiated by commercial insurers for inpatient care.

Keywords: Pricing, Hospital Charges, Health Insurance Reimbursement, Medicare, Medicare Advantage, Insurance

What is known on this topic:

- Recent studies have documented that commercial insurers pay significantly more than Medicare fee-for-service (FFS) for hospital services, while Medicare Advantage (MA) pays rates similar to those of Medicare FFS.
- However, most studies rely on data from only a few insurers and are cross-sectional; our study extends previous literature with a larger sample of insurers in a longitudinal analysis of prices, and looks at differences in price changes across insurer size.

What this study adds:

- In an analysis of hospital prices negotiated by the 60 largest US private insurers, we find inpatient prices increased significantly faster than outpatient prices from 2009 to 2015.
- In the period, the disparity between commercial and Medicare FFS rates widened significantly, while the difference between MA and Medicare FFS rates remained unchanged.
- Commercial insurers with significant market power negotiate lower prices than other insurers, and this disparity did not change over time.

1 Introduction

Health spending in the United States has surged over the last decade and is projected to continue to rise to 19.7 percent of GDP by 2028 (Keehan et al. 2020). This increased spending is primarily driven by acceleration in the growth of medical prices: the quip “it’s the prices, stupid,” from the oft-cited eponymous 2003 paper, is even more true today (Anderson et al. 2003; Anderson et al. 2019). Recently available data have allowed for cross-sectional glimpses behind the veil of secrecy surrounding hospital prices negotiated by private insurers (e.g. Cooper et al. 2019a; Curto et al. 2019; Maeda and Nelson 2018). However, evidence is sparse regarding how prices negotiated by commercial and Medicare Advantage (MA) insurers have changed over time. To better understand changes to health care spending, we take advantage of a novel data source to study how hospital prices paid by public and private payers have changed over time.

A large literature has examined hospital prices through a cross-sectional lens. Studies have found that commercial insurers pay significantly more than MA and Medicare fee-for-service (FFS) for hospital services (Cooper et al. 2019a; Curto et al. 2019; Maeda and Nelson 2018) while MA pays rates that are similar to (Maeda and Nelson 2018; Curto et al. 2019) or slightly lower than Medicare FFS (Baker 2016). A few existing studies have examined trends in private-public payer payment disparities: payments are growing quickly—especially for commercial plans—and are mostly driven by hospital prices (Cooper et al. 2019a). However, these studies have small survey samples of a few thousand inpatient visits per year and do not differentiate between Medicare FFS and MA claims (Selden 2020) or only include claims from a few private insurers (Baker et al. 2016; Cooper et al. 2019b). This study uses a novel data source to add to the evidence of how prices have changed over time.

Leveraging the American Hospital Utilization Database (AHUD), an all-payer hospital claims database, we examine health care pricing longitudinally. Extending previous literature, we analyze claims from 84 hospitals across the US from the 60 largest US health insurers in the commercial and MA markets and compare the prices these private insurers negotiate with hospitals to those paid by Medicare FFS. Unlike previously available data on prices, the AHUD claims data are sourced from hospitals rather than from a few insurers, allowing for an analysis of the entire insurance market.

We examine trends in prices paid by commercial plans, MA plans, and Medicare FFS for inpatient care, outpatient care, and four high-volume services: colonoscopies, hip replacements, knee replacements, and screening mammograms. Within the commercial and MA markets, we explore heterogeneity in these price trends based on the size and market dominance of insurers.

2 Methods

2.1 Data

We used data from the American Hospital Utilization Database (AHUD), which contains hospital claims data for all payers. This novel data source captures 474 acute care hospitals in 38 US states, accounting for roughly 14 percent of all acute care hospitals in the US. The data span from 2009 through 2016 and document over 300 million patient visits from over 80 million individuals. The unique aspect of the AHUD data is the inclusion of the actual prices paid by the insurer and patient, including Medicare reimbursements and prices negotiated by commercial and MA insurers.

2.2 Analysis Sample

We analyzed hospital prices for enrollees in commercial insurance, MA, and Medicare FFS for six samples: all inpatient care, all outpatient care, and four high-volume hospital services. We defined hospital prices to be the “allowed charges,” which are the sum of payments to the hospital from both the health insurer and the patient. We limited our analysis to hospitals submitting prices paid for at least 50 inpatient claims in every year from 2009 to 2015, resulting in a sample of 84 hospitals.

For all six samples, we restricted our analysis to claims for patients ages 18 and older. To control for differences in observable case-mix across insurance types and over time, we included only patient visits where the Charlson comorbidity index was zero. All prices were adjusted to 2015 dollars using the All Items Consumer Price Index (CPI-U) from the US Bureau of Labor Statistics. We removed any patient visits with zero or negative payments. Within each insurance type for each sample, we excluded patient visits that were below the first percentile or above the 99th percentile of the price distribution. These claims likely resulted from errors in medical billing or abnormally complex cases.

Birth-related services are among the most common inpatient services for commercially

insured patients, but Medicare enrollees rarely utilize these services, given the program’s age requirements. Thus, for the inpatient sample, we removed patient visits with Medicare Severity Diagnosis Related Groups (MS-DRGs) for birth-related services.

We chose four samples for specific hospital services: colonoscopies, hip replacements, knee replacements, and screening mammograms (with ICD-9 codes V7651, 8151, 8154, and V7612, respectively). These samples were selected because they are all high-volume stand-alone services with little variation in the quantity of care provided for each patient encounter. For the two inpatient services, hip and knee replacements, we removed patient visits where the MS-DRG indicated comorbidities or complications to further control for differences in case-mix. See Online Appendix Table A3 for the ICD-9 and MS-DRG combinations used to construct these samples.

This sample selection resulted in 24,307,632 outpatient discharges, 890,368 inpatient discharges, 154,614 colonoscopies, 18,454 hip replacements, 32,876 knee replacements, and 1,259,558 screening mammograms. This retrospective study received IRB approval from the Center for Population Health Sciences at Stanford University.

2.3 Statistical Methodology

Although we controlled for differences in observed case-mix by subsampling based on the Charlson comorbidity index and MS-DRG codes, price differences across insurance types may still be partially driven by unobserved differences in the quantity of care provided. Thus, we standardized prices by relying on charges to adjust prices for any unobserved differences in the quantity of care provided for each sample. Billed charges are calculated from the hospital’s chargemaster, capturing the sum of charges for all services rendered for an admission. Since these charges are independent of the payer, this standardization allows us to adjust prices to comparable levels across insurance types.

For each sample, we standardized prices by computing the average price-to-charge ratio for each hospital-payer pair and multiplying this by the average charge for that hospital across

all payers. In the construction of the standardized average prices, we weighted hospitals to control for differences in the hospital-mix across insurance types (the relative number of patients per hospital-payer pair) and changes to the hospital-mix over time. Our methods of price standardization are described in Online Appendix B.

3 Results

Figure 1 presents trends in the average standardized prices paid by different insurance types for inpatient and outpatient services. Inpatient hospital prices paid by commercial insurance increased by 25.8 percent from 2009 to 2015 after adjusting for inflation. MA and Medicare FFS inpatient reimbursements increased by 6.6 percent and 7.4 percent, respectively, over the same period. Changes in prices for outpatient care were more modest across all insurance types: prices increased by 10.2 percent for commercial insurance, rose by 1.5 percent for Medicare FFS, and decreased by 7.3 percent for MA in real terms. In 2015, commercial prices were 153 percent of Medicare FFS reimbursements for inpatient care and 239 percent for outpatient care. MA paid 106 percent of Medicare FFS for inpatient care and 139 percent for outpatient care in 2015.

Table 1 presents the changes in the average standardized prices from 2009 to 2015 for each of the six samples we analyzed. Commercial insurance prices for colonoscopies, for instance, increased from 222 percent of Medicare FFS reimbursements to 259 percent over the period, while MA prices increased from 146 percent to 154 percent of Medicare FFS. For the two inpatient procedures we analyzed, hip and knee replacements, Medicare FFS reimbursements nominally increased over time, but decreased in real terms (see Online Appendix Table C2). MA paid slightly more than Medicare FFS for these inpatient procedures, with prices increasing only slightly. In contrast, prices negotiated for commercial insurers grew at a rate of 2.5 percent and 2.3 percent annually, in excess of inflation, for hip and knee replacements, respectively.

Given differences in market power, price levels and trends may vary widely based on the size or market dominance of private insurers. Indeed, there is a large body of literature documenting the inverse relationship between insurer market share and negotiated prices (e.g. Fronsdal, Bhattacharya, and Tamang 2020; Wu 2009; McKellar et al. 2013; Scheffler and Arnold 2017). In Panel A of Figure 2, we compare prices negotiated by the five largest national insurers in the commercial market (UnitedHealthcare, Anthem, Aetna, Cigna, and Humana) and the MA market (UnitedHealthcare, Anthem, Aetna, WellCare, and Humana) to those negotiated by the remaining 55 private insurers in our sample. We find that the top five commercial insurers tend to pay more for inpatient care than other insurers. However, the top five MA insurers tend to pay less relative to the broader MA market. Inpatient MA rates are similar to Medicare FFS for the top five insurers, but are higher for other insurers.

While the large national insurers control the largest segment of the national market, they may not have dominant market shares within the local commercial markets we study, explaining why they tend to pay more on average, relative to statewide and regional insurers. Indeed, Blue Cross Blue Shield affiliated insurers are the dominant commercial insurers for 45 of the 84 hospitals we studied. Therefore, we also examine the differential trends in prices negotiated by the dominant private insurer at a hospital (as defined by the insurer with the most claims) relative to all other private insurers at that hospital (see Figure 2 Panel B). We find that for inpatient care, the dominant commercial insurer negotiated prices that were 13 percent lower than other insurers in 2009 and 10 percent lower in 2015. For the MA market, this difference rose from less than one percent in 2009 to 5 percent in 2015.

4 Discussion

The difference between the MA and Medicare FFS price levels we find for inpatient visits contrasts slightly with the results from recent studies analyzing data from the Health Care Cost Institute (HCCI) on claims from UnitedHealthcare, Aetna, and Humana. These studies

found that MA pays inpatient rates similar to or slightly lower than Medicare FFS (Curto et al. 2019; Maeda and Nelson 2018; Baker et al. 2016). The HCCI studies examined claims from three of the five largest US insurers. In contrast, we consider 60 of the largest insurers. We found that the largest national insurers tend to pay less for MA than the market as a whole. When we limit our analysis to only UnitedHealthcare, Aetna, and Humana, we found that these MA insurers pay the roughly the same as Medicare FFS for inpatient care, explaining the discrepancies between the HCCI and AHUD results (see Online Appendix C.3).

Previous studies may help explain some observable trends. Over time, the gap between Medicare FFS and MA has narrowed slightly, perhaps propelled by the Affordable Care Act’s capitated payment reductions from the federal government to MA plans beginning in 2012 (Abrams et al. 2015). In their negotiations with MA insurers, hospitals may take into account these reductions, thereby allowing MA insurers to negotiate lower rates (Berenson et al. 2015).

4.1 Limitations

There are a few notable limitations of our work. First, the hospitals in the analysis sample are not representative of hospitals nationwide. The geographic distribution of hospitals in our sample is skewed towards the Middle Atlantic, Pacific, and West South Central US Census Divisions, and there is an overrepresentation of large, urban hospitals. Consequently, our results may not extend to other populations, such as those in rural areas, and the relative prices for different insurance types may not precisely mirror prices nationwide.

Second, the growth in prices for hospital care may be driven by improvements in the quality of care—for example, improved implants for hip replacements—or by increases in the quantity of care provided for a given procedure—for example, an increase in the frequency of fluoroscopy imaging during hip replacements.

Third, Medicare FFS may make additional pass-through payments to hospitals, which

are lump-sum payments that are not directly tied to a specific hospital visit and thus are not included in the claims-level data. Further, we cannot observe the extent to which private insurers’ negotiated contracts also include lump-sum payments, such as additional quality incentives for hospitals, although this practice is relatively uncommon according to industry sources (Berenson 2015).

Lastly, AHUD does not clearly delineate between in-network and out-of-network claims, nor does it include details on the type of plan (e.g. health maintenance organization or preferred provider organization). Thus, our analysis of prices for the privately insured includes prices negotiated with in-network hospitals and those paid to out-of-network hospitals for all plan types.

4.2 Policy Implications

Ballooning health spending in the US has predominantly been driven by growing prices rather than utilization (Anderson et al. 2019). Our findings indicate that the increase in prices has been almost entirely due to the growth in prices negotiated by *commercial* insurers. In the effort to abate spending growth, focus should be placed on factors that are contributing to rising prices for the privately insured—namely, decreased hospital competition. In 2016, 90 percent of hospital markets were considered “highly concentrated” (Fulton 2017). A recent study found that one in five markets is now a true monopoly with only one hospital system (Johnson and Frakt 2020). A large body of research has found that past hospital mergers and acquisitions have significantly increased prices (e.g. Cooper et al. 2019a; Gowrisankaran, Nevo, and Town 2015; Dafny 2009). Policymakers should pursue active antitrust enforcement and explore policies that lower the barriers to entry for new hospitals to promote further competition. Policymakers may also assess proposals to regulate health care prices. For instance, most Maryland hospitals have all-payer global budgets set by a state commission rather than negotiating payments with insurers (Haber et al. 2019). However, policymakers should recognize the potential perverse incentives such regulations may have on the quantity

and quality of care. Further, policymakers should consider creating state agencies—such as the Massachusetts Health Policy Commission—to study health care inefficiencies and spending growth and develop policy recommendations.

5 Conclusion

Inpatient and outpatient hospital prices for commercial insurers grew significantly faster than rates for MA and Medicare FFS from 2009 to 2015. Prices for inpatient care increased faster than those for outpatient care. Commercial insurers that enrolled the largest number of patients at a given hospital negotiated 10-13 percent lower rates, on average, relative to all other insurers at that hospital. The dominant MA insurer negotiated 1-5 percent lower rates, on average, relative to all other insurers at that hospital. Our findings suggest that, as policymakers seek to implement new measures to abate rising health spending, focus should be placed on growing hospital inpatient prices paid for the privately insured.

References

Abrams M, Nuzum R, Zezza R, Ryan R, Kiszla J, Guterman G. The Affordable Care Act's payment and delivery system reforms: a progress report at five years [Internet]. The Commonwealth Fund. 2015 May [cited 2020 Aug 12] (Commonwealth Fund Pub. 1816 Vol. 12). Available from: <https://www.commonwealthfund.org/publications/issue-briefs/2015/may/affordable-care-acts-payment-and-delivery-system-reforms>

Anderson GF, Hussey, P, Petrosyan V. It's still the prices, stupid: why the US spends so much on health care, and a tribute to Uwe Reinhardt. *Health Aff (Millwood)*. 2019;38(1):87-95.

Anderson GF, Reinhardt UE, Hussey PS, Petrosyan V. It's the prices, stupid: why the United States is so different from other countries. *Health Aff (Millwood)*. 2003;22(3):89-105.

Arnold D, Whaley C. Who pays for health care costs? The effects of health care prices on wages [Internet]. Santa Monica (CA): Rand Corporation. 2020 Jul [cited 2020 Aug 12] (Rand Health Care Working Paper WR-A621-2). Available from: <https://www.rand.org/pubs/working-papers/WRA621-2.html>

Baker L, Bundorf MK, Devlin AM, Kessler DP. Medicare Advantage plans pay hospitals less than traditional Medicare pays. *Health Aff (Millwood)*. 2016;35(8):1444-51.

Berenson RA, Sunshine JH, Helms D, Lawton E. Why Medicare Advantage plans pay hospitals traditional Medicare prices. *Health Aff (Millwood)*. 2015;34(8):1289-95.

Centers for Medicare and Medicaid Services. Medicare and Medicaid programs: CY 2020 hospital outpatient PPS policy changes and payment rates and ambulatory surgical center payment system policy changes and payment rates. Price transparency requirements for hospitals to make standard charges public. Final rule. *Fed Regist*. 2019;84(229):65524-606.

Cooper Z, Craig SV, Gaynor M, Van Reenen J. The price ain't right? Hospital prices and health spending on the privately insured. *Q J Econ*. 2019;134(1):51-107.

Cooper Z, Craig S, Gaynor M, Harish NJ, Krumholz HM, Van Reenen J. Hospital prices grew substantially faster than physician prices for hospital-based care in 2007–14. *Health Aff (Millwood)*. 2019;32(2):184-9.

Curto V, Einav L, Finkelstein A, Levin J, Bhattacharya J. Health care spending and utilization in public and private Medicare. *Am Econ J Appl Econ*. 2019;11(2):302-

32.

Dafny, L. Estimation and identification of merger effects: an application to hospital mergers. *J Law Econ.* 2009;52(3):523-50.

Federal Trade Commission and Department of Justice. Improving health care: a dose of competition Washington (DC): FTC/DOJ; 2004. 361 p.

Fronsdal TL, Bhattacharya J, Tamang S. Variation in health care prices across public and private payers [Internet]. Cambridge (MA): National Bureau of Economic Research; 2020 Jul [cited 2020 Aug 12]. (NBER Working Paper No. 27490). Available for download (fee required) from: <https://www.nber.org/papers/w27490>

Fulton BD. Health care market concentration trends in the United States: evidence and policy responses. *Health Aff (Millwood)*. 2017;36(9):1530-38.

Gowrisankaran G, Nevo A, Town R. Mergers when prices are negotiated: evidence from the hospital industry. *Am Econ Rev.* 2015;105(1):172-203.

Haber S, Beil H, Amico P, Morrison M, Akhmerova V, Beadles C, et al. Evaluation of the Maryland All-Payer Model: third annual report [Internet]. Waltham (MA): RTI International; 2019 Mar [cited 2020 Aug 12]. (RTI Project Number 0212790.013.000.001). Available from: <https://hscrc.maryland.gov/Documents/Modernization/md-all-payer-thirdannrpt.pdf>

Johnson D, Frakt A. Hospital markets in the United States, 2007–2017. *Healthc (Amst)*. 2020;8(3), forthcoming.

Keehan SP, Cuckler GA, Poisal JA, Sisko AM, Smith SD, Madison AJ, et al. National health expenditure projections, 2019–28: expected rebound in prices drives rising spending growth. *Health Aff (Millwood)*. 2020;39(4):704-14.

Maeda JKL, Nelson L. How do the hospital prices paid by Medicare Advantage plans and commercial plans compare with Medicare fee-for-service prices? *Inquiry*. 2018;55:1-8.

McKellar MR, Naimar S, Landrum MB, Gibson TB, Chandra A, Chernew M. Insurer market structure and variation in commercial health care spending. *Health Serv Res.* 2013;49(3):878-92.

Scheffler, RM, Arnold DR. Insurer market power lowers prices in numerous concentrated provider markets. *Health Aff (Millwood)*. 2017;36(9):1539-46.

Selden, TM. Differences between public and private hospital payment rates narrowed, 2012–16. *Health Aff (Millwood)*. 2020;39(1):94-9.

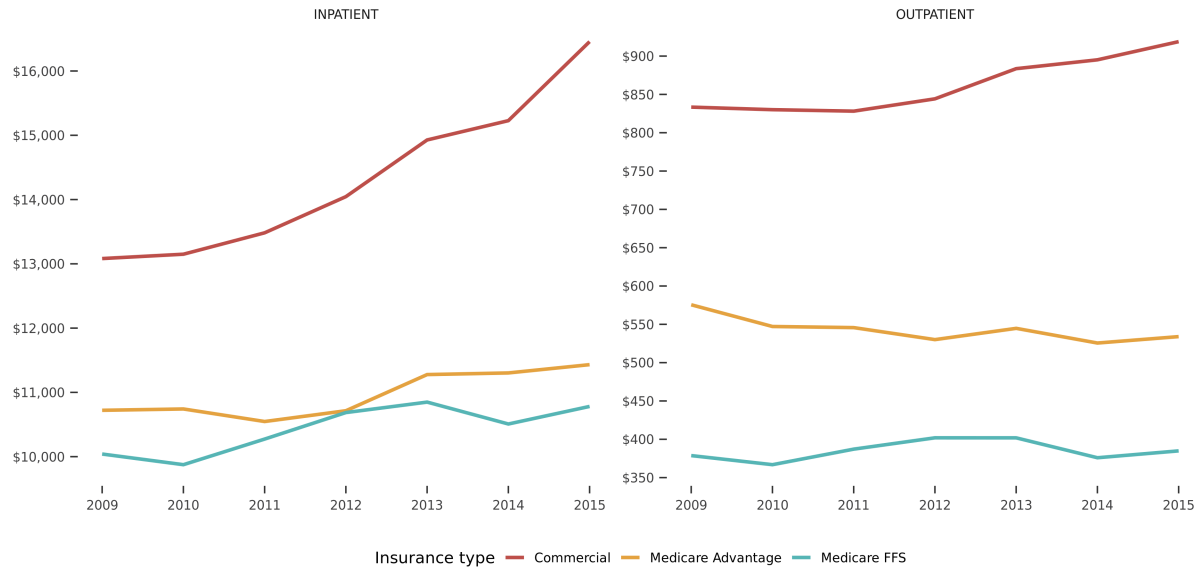
Wu VY. Managed care's price bargaining with hospitals. *J Health Econ.* 2009;2(2):350-60.

Table 1: Changes in hospital prices, by insurer size, 2009-15

Sample	Insurance Type	2009		2015		% Change	Compound Annualized Growth Rate
		N	Price	N	Price		
Colonoscopy	Commercial	12,011	1,480.02	18,331	1,760.73	18.97	2.94
	Medicare Advantage	1,792	972.18	3,656	1,088.50	11.96	1.90
	Medicare FFS	4,309	665.97	7,442	707.20	6.19	1.01
Hip Replacement	Commercial	1,110	21,322.10	1,063	24,741.20	16.04	2.51
	Medicare Advantage	313	15,622.45	416	15,639.71	0.11	0.02
	Medicare FFS	1,295	14,815.18	938	14,041.47	-5.22	-0.89
Knee Replacement	Commercial	1,813	20,997.60	1,195	24,051.31	14.54	2.29
	Medicare Advantage	763	15,325.50	681	15,995.72	4.37	0.72
	Medicare FFS	2,593	15,030.68	1,519	14,401.33	-4.19	-0.71
Screening Mammogram	Commercial	120,305	226.16	102,864	251.20	11.07	1.77
	Medicare Advantage	16,272	143.95	22,758	147.07	2.17	0.36
	Medicare FFS	50,722	108.77	49,819	120.60	10.88	1.74
Inpatient	Commercial	74,080	13,082.19	48,515	16,456.87	25.80	3.90
	Medicare Advantage	15,081	10,721.36	14,217	11,431.44	6.62	1.07
	Medicare FFS	67,986	10,040.68	49,244	10,781.47	7.38	1.19
Outpatient	Commercial	1,837,995	833.42	1,756,778	918.86	10.25	1.64
	Medicare Advantage	334,644	575.51	490,214	533.98	-7.22	-1.24
	Medicare FFS	1,341,143	378.71	1,347,716	384.88	1.63	0.27

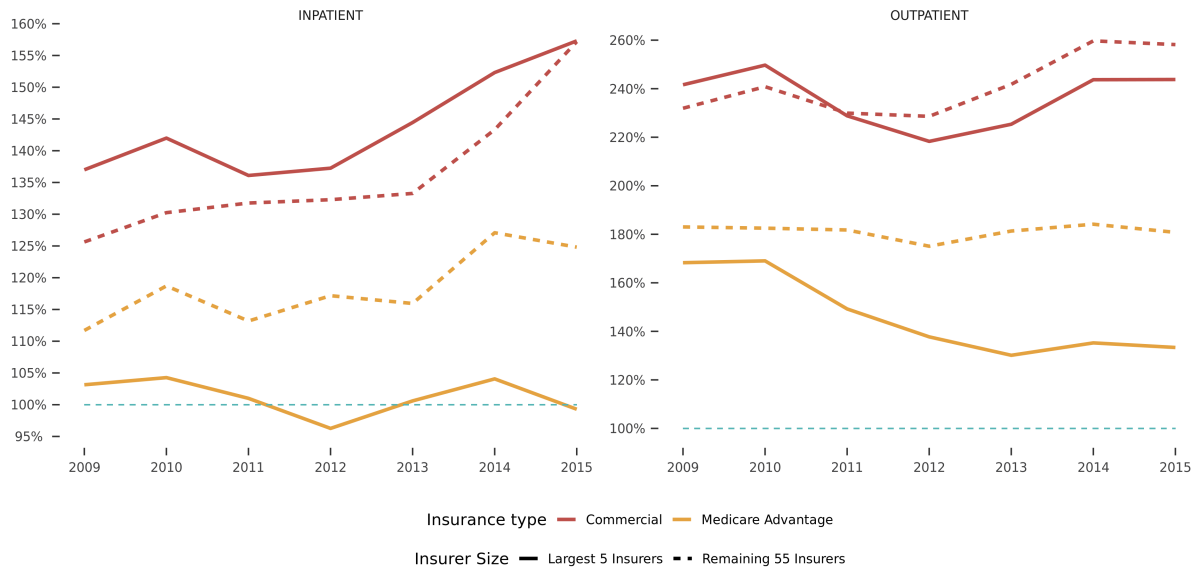
Notes: All hospital prices are adjusted to 2015 US dollars using the All Item Consumer Price Index. Hospital prices are standardized and weighted to control for differences in case-mix, hospital-mix, and charges across insurance types, as described in Online Appendix B.9. The inpatient sample excludes birth-related hospital services. The two inpatient medical services samples (hip and knee replacements) include only procedures without complications. FFS is fee-for-service.

Figure 1: Inpatient and outpatient hospital prices, 2009-15

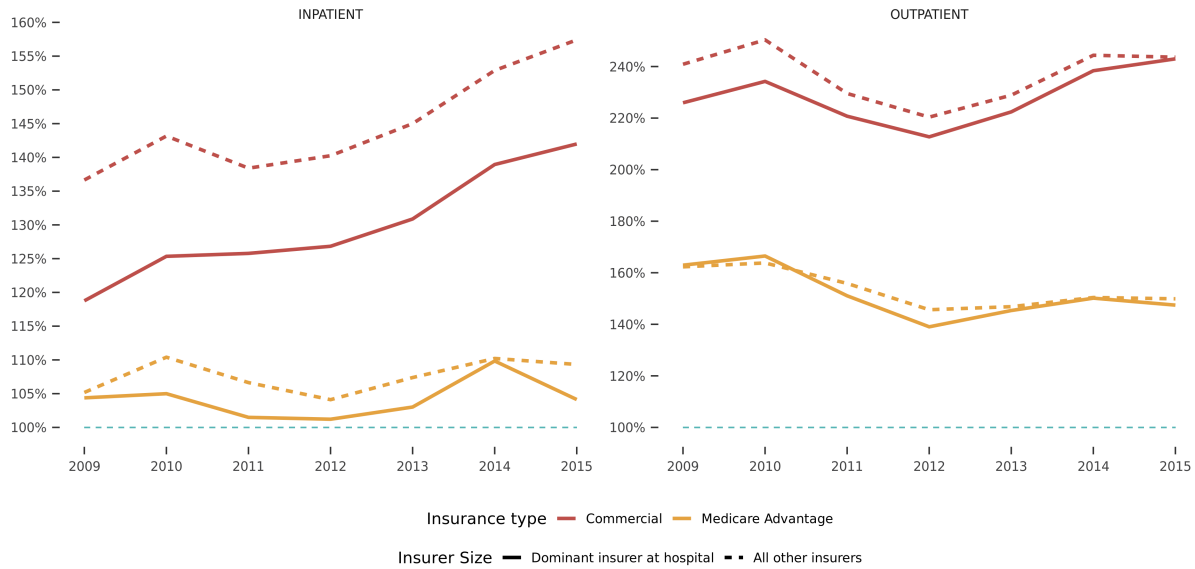


Notes: All hospital prices are adjusted to 2015 US dollars using the All Item Consumer Price Index. Hospital prices are standardized and weighted to control for differences in case-mix, hospital-mix, and charges across insurance types, as described in Online Appendix B. The inpatient sample excludes birth-related hospital services. FFS is fee-for-service.

Figure 2: Inpatient and outpatient hospital prices as a percentage of Medicare FFS rates, 2009-15



(a) Insurer Size



(b) Insurer Hospital Dominance

Notes: All hospital prices are adjusted to 2015 US dollars using the All Item Consumer Price Index. Hospital prices are standardized and weighted to control for differences in case-mix, hospital-mix, and charges across insurance types, as described in Online Appendix B.9. The inpatient sample excludes birth-related hospital services. The largest five national insurers for the commercial market are UnitedHealthcare, Anthem, Aetna, Cigna, and Humana. The largest five national insurers for the Medicare Advantage market are UnitedHealthcare, Anthem, Aetna, WellCare, and Humana. FFS is fee-for-service. At each hospital, the dominant insurer is the private insurer enrolling the greatest number of patients in their market (commercial or Medicare Advantage). FFS is fee-for-service.

ONLINE APPENDIX

Trends in Hospital Prices for the Publicly and Privately Insured, 2009-15

Contents

A Data	2
A.1 Included Private Insurers	2
A.2 Selection of Samples	4
B Calculating Standardized Average Prices	7
B.1 Standardizing Prices	7
B.2 Weighting Methods	7
C Additional Results	9
C.1 Trends in Prices for Medical Services Samples	9
C.2 Comparison of Large National Private Insurers to Other Insurers	11
C.3 Comparison of HCCI Insurers to Non-HCCI Insurers	13
C.4 Comparison of Dominant Insurer at Hospital to All Other Insurers	15
C.5 Methodological Variations	16

A Data

For an overview of the American Hospital Utilization Database (AHUD), its limitations, variable construction, and a comparison to other data sources that contain hospital prices paid by private insurers, consult Fronsdal, Bhattacharya, and Tamang (2020).

A.1 Included Private Insurers

For this analysis, we included the largest 60 private insurers in the commercial and Medicare Advantage markets in the 38 states contained in the AHUD data. The largest 60 insurers were identified based on data on insurers' market shares for each state provided by the Kaiser Family Foundation.¹ In addition, we included all claims by subsidiaries of these insurers (e.g., UniCare, RightCHOICE, Empire Blue Cross Blue Shield, Blue Cross of California, Blue Cross Blue Shield of Georgia, Comp-Care, and CareMore are all subsidiaries of Anthem). Subsidiaries were identified from the SEC Form 10-K filings for each insurer. The distinction between Medicare Advantage plans and commercial was made by classifying private plans as Medicare Advantage if the patient's age at the time of the admission is 65 or older and as a commercial plan otherwise. [Appendix Table A1](#) below presents the list of included private insurers and their subsidiaries.

Table A1: Included Private Insurers and Subsidiaries

Private Insurance Company	Included Subsidiaries and Products
UnitedHealthcare	TouchPoint Care Oxford Health Plans PacifiCare Sierra Health Evercare AmeriChoice Mid Atlantic Medical Services Ovation Unison Health Plan Arnett HealthPlans
WellPoint/Anthem	UniCare RightCHOICE Empire Blue Cross Blue Shield Blue Cross of California Blue Cross Blue Shield of Georgia Comp-Care CareMore
Aetna	
Cigna	Allegiance Great-West Healthcare
Humana	Solicare Health Plans CarePlus Health Plans Cariten Healthcare Emphesys
Centene	Ambetter Allwell Health Net
Molina	
WellCare	

¹See Fronsdal, Bhattacharya, Tamang (2020) for details on the selection mechanism for private insurers.

Health Care Service Corporation (HCSC)	Blue Cross and Blue Shield of Illinois Blue Cross and Blue Shield of New Mexico Blue Cross and Blue Shield of Oklahoma Blue Cross and Blue Shield of Texas Blue Cross and Blue Shield of Montana
HealthSpring Coventry	BravoHealth First Health Advantra Altius Health Plans HealthAmerica Pennsylvania HealthCare USA of Missouri HealthCare USA of Tennessee WellPath of South Carolina
Amerigroup Kaiser EmblemHealth Harvard Pilgrim Tufts Health Plan HealthPartners Medica PacificSource Assurant Cambia Health Solutions	Regence Asuris Northwest Health BridgeSpan Health LifeMap Blue Cross and Blue Shield of Oregon Blue Shield of Idaho Blue Shield of Washington Blue Cross of Northeastern Pennsylvania Blue Cross and Blue Shield of West Virginia
Highmark	
Blue Cross and Blue Shield of Alabama Blue Cross and Blue Shield of Arizona Blue Cross and Blue Shield of Arkansas QualChoice Blue Shield of California GuideWell	Florida Blue (Blue Cross and Blue Shield of Florida)
Advantage Health Solutions Wellmark BCBS Blue Cross and Blue Shield of Kansas City Blue Cross and Blue Shield of Kansas Louisiana Health Service HealthMarkets Blue Cross and Blue Shield of Massachusetts Blue Cross and Blue Shield of Minnesota Blue Cross and Blue Shield of Michigan Henry Ford Health System Spectrum Health Group Mississippi Insurance Group New West Health Services	Blue Cross and Blue Shield of Iowa Blue Cross and Blue Shield of Louisiana Health Alliance Plan (HAP) Priority Health

Blue Cross and Blue Shield of Maine	
Horizon Blue Cross Blue Shield of New Jersey	
Aegon	
Presbyterian Health Plan	
Ardent Health Services	
Lifetime Healthcare Companies	Excellus BlueCross BlueShield
	Univera Healthcare
Blue Cross and Blue Shield of North Carolina	
Medical Mutual of OH	
CommunityCare	
Providence	
Independence Blue Cross	Keystone Health Plan East
Capital Blue Cross	Keystone Health Plan Central
Blue Cross and Blue Shield of South Carolina	
Blue Cross and Blue Shield of Ten- nessee	
Tennessee Rural Health Group	Farm Bureau Health Plans
CareFirst	
Premiera Blue Cross	
Blue Cross and Blue Shield of Wyoming	
Blue Cross and Blue Shield Federal	
Blue Cross and Blue Shield (Un- classified)	

A.2 Selection of Samples

Although the AHUD data contain claims from 2009 to 2016, we excluded claims from 2016 due to the complications of switching from ICD-9 to ICD-10 codes on tracking prices for specific medical services over time. Some hospitals in the AHUD data do not contain claims for all seven years of the analysis sample or reported only the charges based on their chargemaster rather than the prices actually paid by the payer. We excluded hospitals that were not in the data all years of our analysis and hospitals that did not include the prices paid for claims. In addition, we limited our hospital sample to only hospitals that had at least 50 inpatient admissions in each year. This resulted in a sample of 84 hospitals. [Appendix Table A2](#) presents summary statistics describing the hospitals in our sample. Relative to the geographic distribution of hospitals in the United States, hospitals included in this sample are more likely to be larger and in urban locations.

Table A2: Hospital Sample

	N	Percent	Price-to-charge ratio		Cost-to-charge ratio	
			Mean	Std. Dev.	Mean	Std. Dev.
All Hospitals	84	100%	0.30	0.09	0.23	0.06
Teaching Status						
Non-Teaching	53	63%	0.28	0.09	0.22	0.06
Teaching	31	37%	0.34	0.06	0.25	0.06
Number of Beds						
Less Than 100 Beds	15	18%	0.34	0.09	0.25	0.06
100-199 Beds	24	29%	0.29	0.09	0.22	0.07
200-299 Beds	12	14%	0.28	0.10	0.21	0.07
300-499 Beds	20	24%	0.29	0.08	0.23	0.06
500 or More Beds	13	15%	0.33	0.06	0.24	0.06
Urban or Rural Status						
Rural	4	5%	0.34	0.07	0.23	0.07
Urban	80	95%	0.30	0.09	0.23	0.06
Region						
East North Central	6	7%	0.38	0.08	0.28	0.09
Middle Atlantic	15	18%	0.29	0.02	0.22	0.04
New England	3	4%	0.42	0.05	0.33	0.10
Pacific	18	21%	0.22	0.08	0.19	0.05
South Atlantic	18	21%	0.36	0.08	0.24	0.04
West North Central	3	4%	0.32	0.07	0.27	0.07
West South Central	21	25%	0.30	0.08	0.23	0.07

SOURCE: Authors' analysis of data from the American Hospital Utilization Database. **NOTES:** Data from 2009 to 2015. Cost-charge ratios are obtained from Medicare cost reports for each hospital. Price-to-Charge ratios are calculated as the average billed hospital price divided by the average charges for each hospital

We selected six analysis samples from all admissions at these 84 hospitals: inpatient and outpatient samples, and samples for four specific procedures or medical services. We limited the scope to hospital visits for patients ages 18 or older for all samples. We further include only visits where the Charlson comorbidity index was zero. The Charlson comorbidity index was calculated using the methodology described in Quan et al. (2005), in which comorbidities are defined using “Enhanced ICD-9” coding scheme.

Birth-related services are among the most common inpatient services for commercially insured patients, but Medicare FFS and Medicare Advantage enrollees rarely utilize these services, given these programs’ age requirements. Thus, for the inpatient sample, we removed all Medicare Severity-Diagnosis Related Groups (MS-DRGs) in Major Diagnostic Category (MDC) 14 (Pregnancy, Childbirth and the Puerperium) and MDC 15 (Newborns and Other Neonates with Conditions Originating in Perinatal Period). The MS-DRG codes in MDC 14 are 765-782 and the MS-DRG codes in MDC 15 are 789-795.

The selection of each of the medical services samples is described in [Appendix Table A3](#). ICD-9 codes were used to select specific medical services samples and MS-DRG codes were used for inpatient medical services samples to restrict the sample to only patient visits for which there were no comorbidities or complications.

Table A3: Selection of Procedure Samples

Procedure/Diagnosis	ICD-9	MS-DRG
Colonoscopy	V7651	
Hip Replacement	8151	470
Knee Replacement	8154	470
Screening Mammogram	V7612	

NOTE: ICD-9 and MS-DRG codes used to construct procedure and diagnosis samples.

We removed any patient visits with payments that were negative or zero. Lastly, within each insurance type (commercial, Medicare Advantage, and Medicare FFS), we excluded any patient visits that were below the first percentile or above the 99th percentile of the price distribution for each sample. For claims paid by private insurers, we cannot differentiate between in-network and out-of-network patient visits, and thus both are included in our analysis of private insurance rates. This sample selection resulted in 24,307,632 outpatient discharges, 890,368 inpatient discharges, 154,614 colonoscopies, 18,454 hip replacements, 32,876 knee replacements, and 1,259,558 screening mammograms.

B Calculating Standardized Average Prices

B.1 Standardizing Prices

Prices were first adjusted to December 2015 dollars using the All Items Consumer Price Index: US City Average All Urban Consumers (CPI-U) provided by the US Bureau of Labor Statistics. [Appendix Table C2](#) provides the results for all six samples without adjusting for inflation.

When comparing non-standardized average prices across insurance types, differences in price levels could be driven by differences in the case-mix of enrollees for different insurance types or the hospital-mix of each insurance type. We controlled for this in a few ways. By restricting the sample to only admissions for which the Charlson comorbidity index is zero and the MS-DRG code indicates no comorbidities or complications, we removed variation in prices driven by differences in observed severity and case-mix. However, there could still be *unobserved* differences in the quantity of care provided, which could drive price differences. A hospital's billed charges are based on the hospital's chargemaster, capturing the sum of the charges for all services rendered for an admission, and are independent of the payer. Thus, we relied on charges to adjust prices for any unobserved differences in quantity of care provided for a given sample.

We standardized prices by computing the average price-to-charge ratio for each payer-hospital pair and multiplying this by the average charge for that hospital across all payers. This method of price standardization, along with our methods for weighting the average price measures, is described in greater detail in the following section.

B.2 Weighting Methods

We implemented weighting methods that control for differences in hospital-mix (the relative number of patients for each hospital-payer pair) both across insurance types and over time. This ensures that changes in prices over time and between payers are not driven by changes in the relative number of patients at each hospital.

Our method for computing the standardized weighted average prices is as follows. Let \bar{p}_{hijt} and \bar{c}_{hijt} be the average price and average charge, respectively, for sample j (inpatient, outpatient, or specific medical service) at hospital h paid by insurance type i in year t . To obtain \tilde{p}_{hijt} , the standardized average price, we calculate

$$\tilde{p}_{hijt} = \frac{\bar{p}_{hijt}}{\bar{c}_{hijt}} \cdot \bar{c}_{hjt}$$

where

$$\bar{c}_{hjt} = \sum_i \frac{n_{hij}}{n_{hj}} \cdot \bar{c}_{hijt}.$$

and n is the number of discharges. Note that, in \bar{c}_{hjt} , the average price for each payer-hospital-sample is weighted by the sum of discharges over all years, thereby removing differences in charges resulting from changes in the relative number of discharges per insurance type over time.

We then compute the average standardized price, \tilde{p}_{ijt} , for insurance type i for sample j in year t as the following:

$$\tilde{p}_{ijt} = \sum_h \frac{n_{hj}}{n_j} \cdot \tilde{p}_{hijt}$$

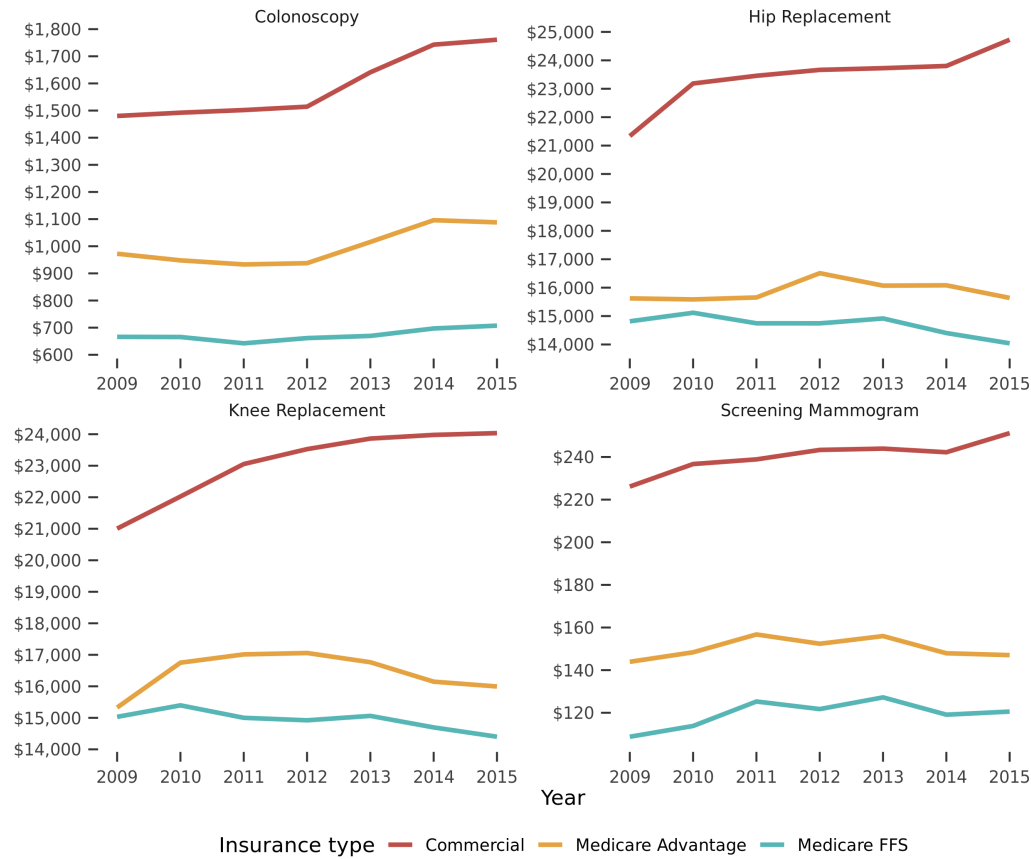
Note again that hospitals are weighted by the sum of discharges over all years and across all insurance types. We weight by the sum of discharges over all years to control for differences in prices resulting from changes in the relative number of discharges per hospital over time. Additionally,

we weight by the number of discharges across all insurance types to ensure a hospital is weighted equally for each insurance type. Great imbalances in number of discharges across insurance types within a hospital could drive differences in price levels across insurance types (e.g. commercial insurers in the sample may tend to send patients to hospitals with more expensive prices overall, while Medicare patients tend to go to hospitals with lower prices overall). We also consider a variant for calculating the average standardized prices, instead weighting based on the number of discharges *within* a given insurance type for all years: $\tilde{p}_{ijt} = \sum_h \frac{n_{hij}}{n_{ij}} \cdot \tilde{p}_{hijt}$. These results are presented in [Appendix Figure C7](#). This method of weighting does not meaningfully change our results.

C Additional Results

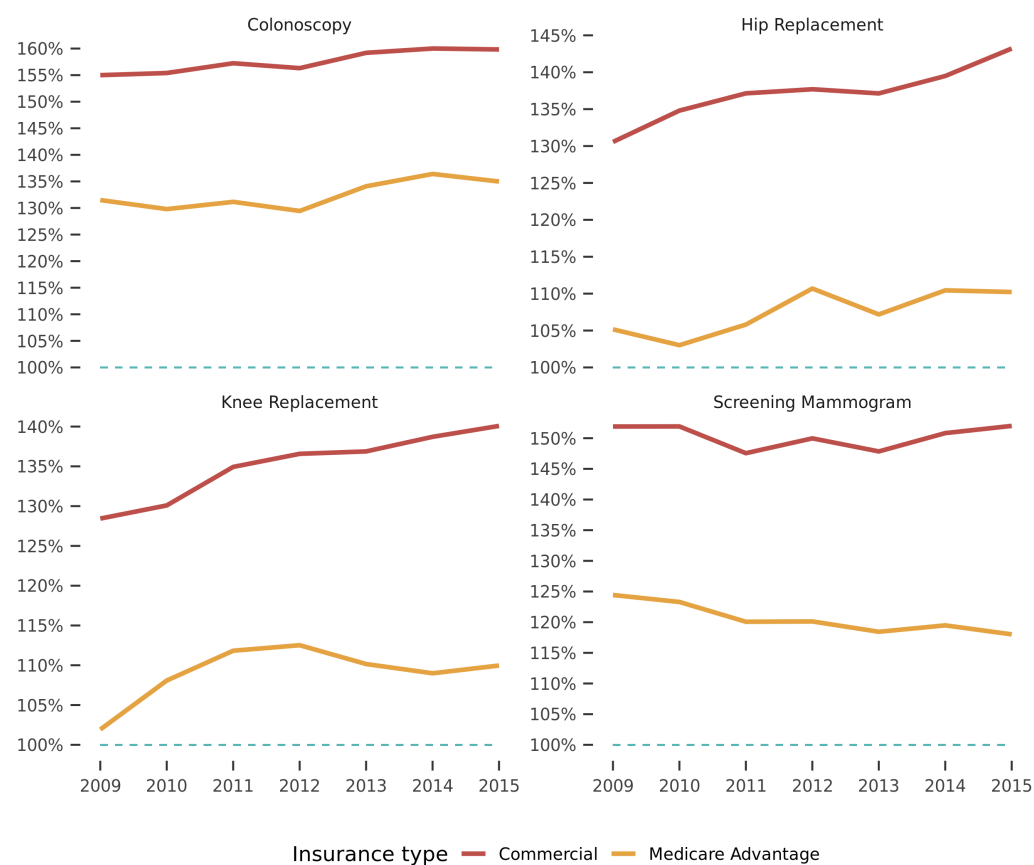
C.1 Trends in Prices for Medical Services Samples

Figure C1: Hospital prices for four high-volume medical services, 2009-15



SOURCE: Authors' analysis of data from the American Hospital Utilization Database. **NOTES:** All hospital prices are adjusted to 2015 US dollars using the All Item Consumer Price Index. Hospital prices are standardized and weighted to control for differences in case-mix, hospital-mix, and charges across insurance types, as described in [Appendix B](#). The two inpatient medical services samples (hip and knee replacements) include only procedures without complications. FFS is fee-for-service.

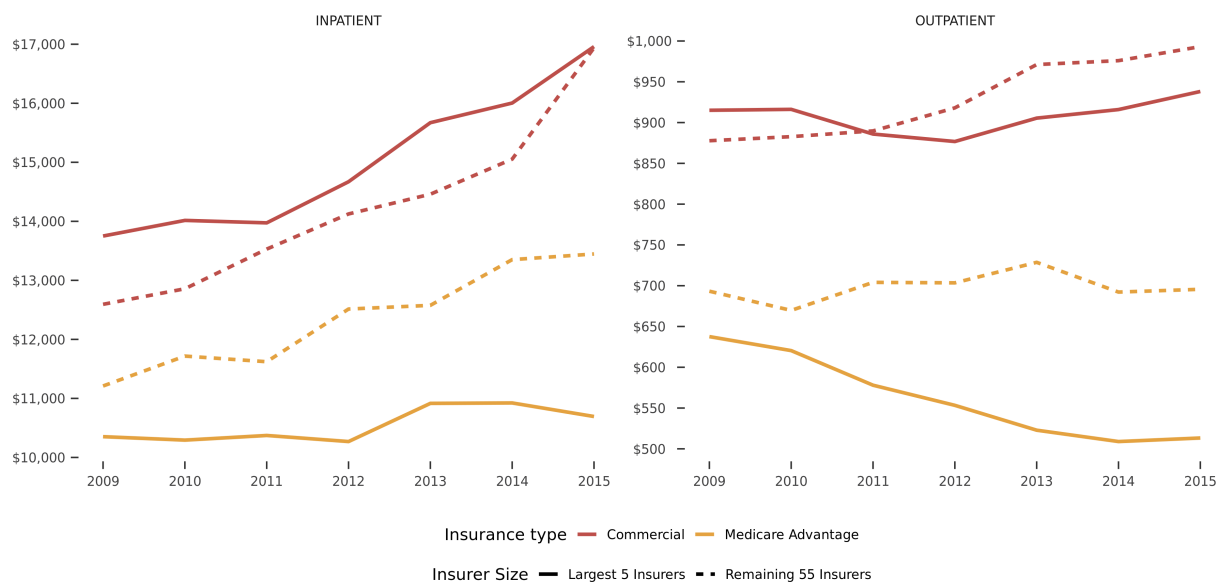
Figure C2: Hospital prices as a percentage of Medicare FFS rates for four high-volume medical services, 2009-15



SOURCE: Authors' analysis of data from the American Hospital Utilization Database. **NOTES:** All hospital prices are adjusted to 2015 US dollars using the All Item Consumer Price Index. Hospital prices are standardized and weighted to control for differences in case-mix, hospital-mix, and charges across insurance types, as described in [Appendix B](#). The two inpatient medical services samples (hip and knee replacements) include only procedures without complications. FFS is fee-for-service.

C.2 Comparison of Large National Private Insurers to Other Insurers

Figure C3: Inpatient and outpatient hospital prices, 2009-15
Comparison by insurer size



SOURCE: Authors' analysis of data from the American Hospital Utilization Database. **NOTES:** All hospital prices are adjusted to 2015 US dollars using the All Item Consumer Price Index. Hospital prices are standardized and weighted to control for differences in case-mix, hospital-mix, and charges across insurance types, as described in [Appendix B](#). The inpatient sample excludes birth-related hospital services. The largest five national US insurers for the commercial market are UnitedHealthcare, Anthem, Aetna, Cigna, and Humana. The largest five national US insurers for the Medicare Advantage market are UnitedHealthcare, Anthem, Aetna, WellCare, and Humana.

Table C1: Changes in hospital prices, by insurer size, 2009-15

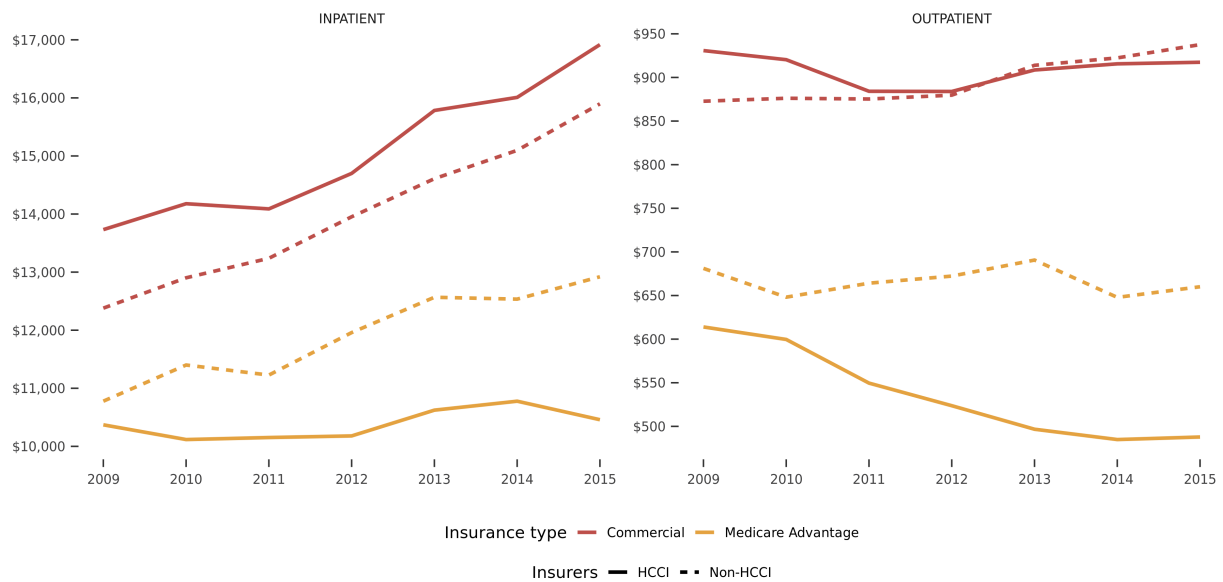
Sample	Insurance Type	Insurer Size	2009		2015		% Change	Compound Annualized Growth Rate
			N	Price	N	Price		
Colonoscopy	Commercial	Largest 5 Insurers	4,073	1,526.28	5,409	1,947.12	27.57	4.14
		Remaining 55 Insurers	7,926	1,490.17	12,819	1,638.08	9.93	1.59
	Medicare Advantage	Largest 5 Insurers	680	1,063.71	1,812	960.66	-9.69	-1.68
		Remaining 55 Insurers	1,108	981.67	1,844	1,167.73	18.95	2.93
Hip Replacement	Commercial	Largest 5 Insurers	328	23,079.35	320	26,351.98	14.18	2.23
		Remaining 55 Insurers	779	20,832.98	742	23,033.11	10.56	1.69
	Medicare Advantage	Largest 5 Insurers	113	17,796.80	195	14,557.93	-18.20	-3.29
		Remaining 55 Insurers	202	15,276.10	221	16,588.23	8.59	1.38
Knee Replacement	Commercial	Largest 5 Insurers	561	21,659.49	389	23,780.21	9.79	1.57
		Remaining 55 Insurers	1,257	21,106.18	805	24,329.04	15.27	2.40
	Medicare Advantage	Largest 5 Insurers	287	15,607.61	323	15,062.64	-3.49	-0.59
		Remaining 55 Insurers	476	15,818.27	358	17,100.62	8.11	1.31
Screening Mammogram	Commercial	Largest 5 Insurers	893	8,621.63	284	11,685.73	35.54	5.20
		Remaining 55 Insurers	1,575	9,095.01	799	11,594.51	27.48	4.13
	Medicare Advantage	Largest 5 Insurers	108	7,505.06	84	8,934.18	19.04	2.95
		Remaining 55 Insurers	11,206	148.47	11,341	161.88	9.03	1.45
Inpatient	Commercial	Largest 5 Insurers	36,919	13,771.54	22,350	16,975.02	23.26	3.55
		Remaining 55 Insurers	37,180	12,621.77	26,170	16,953.99	34.32	5.04
	Medicare Advantage	Largest 5 Insurers	7,535	10,362.29	7,822	10,700.85	3.27	0.54
		Remaining 55 Insurers	7,543	11,222.12	6,404	13,459.64	19.94	3.08
Outpatient	Commercial	Largest 5 Insurers	846,478	914.61	828,344	937.80	2.54	0.42
		Remaining 55 Insurers	991,379	877.99	928,475	993.21	13.12	2.08
	Medicare Advantage	Largest 5 Insurers	121,352	637.05	266,469	512.89	-19.49	-3.55
		Remaining 55 Insurers	213,260	692.50	223,697	695.39	0.42	0.07

SOURCE: Authors' analysis of data from the American Hospital Utilization Database. **NOTES:** All hospital prices are adjusted to 2015 US dollars using the All Item Consumer Price Index. Hospital prices are standardized and weighted to control for differences in case-mix, hospital-mix, and charges across insurance types, as described in [Appendix B](#). The inpatient sample excludes birth-related hospital services. The two inpatient medical services samples (hip and knee replacements) include only procedures without complications. The largest five national US insurers for the commercial market are UnitedHealthcare, Anthem, Aetna, Cigna, and Humana. The largest five national US insurers for the Medicare Advantage market are UnitedHealthcare, Anthem, Aetna, WellCare, and Humana. FFS is fee-for-service.

C.3 Comparison of HCCI Insurers to Non-HCCI Insurers

Much that is known about prices negotiated by commercial and Medicare Advantage insurers comes from data from the Health Care Cost Institute (HCCI). The HCCI data provide claims from individuals with employer-sponsored insurance from UnitedHealthcare, Aetna, and Humana, three of the five largest US private insurers. A natural question, then, is how well these findings extend to the broader insurance market. Notably absent from the HCCI data are claims by individuals insured by Blue Cross Blue Shield Association (BCBSA) affiliated insurers, which cover roughly one in three Americans (BCBSA 2018). Using the AHUD data, we compare the prices negotiated by the “HCCI insurers” to those negotiated by all other insurers included in our study (See [Appendix Table A1](#)). The price levels we find for the HCCI insurers are comparable to those found in the HCCI studies.² However, the HCCI insurers exhibit different price levels and trends relative to other insurers, particularly in the Medicare Advantage market.

Figure C4: Inpatient and outpatient hospital prices, 2009-15
Comparison of HCCI and non-HCCI insurers

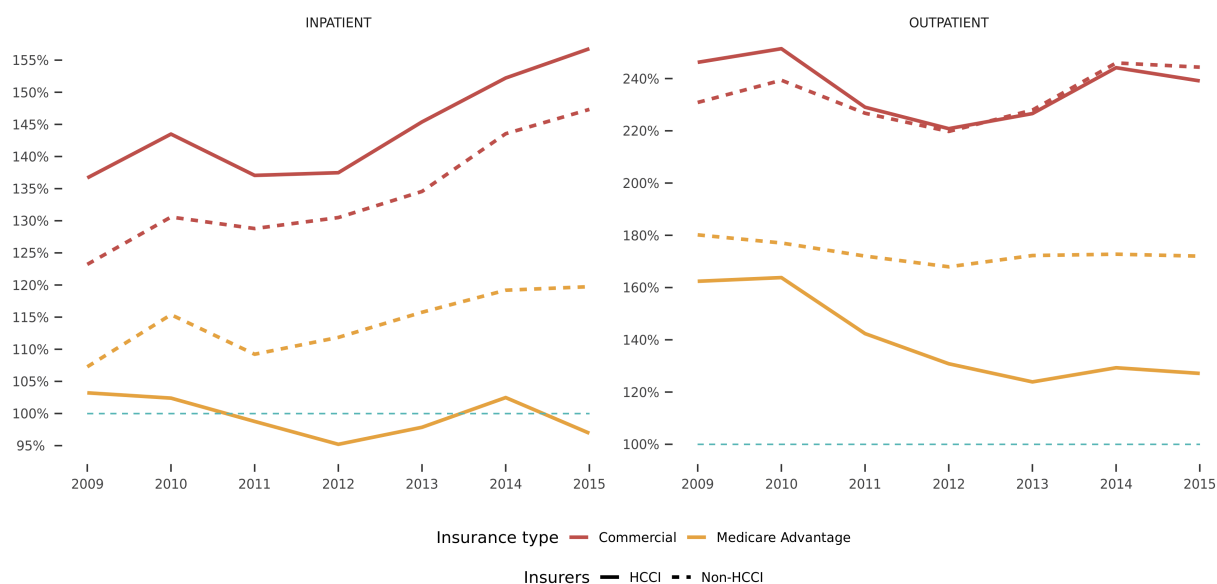


SOURCE: Authors' analysis of data from the American Hospital Utilization Database. **NOTES:** All hospital prices are adjusted to 2015 US dollars using the All Item Consumer Price Index. Hospital prices are standardized and weighted to control for differences in case-mix, hospital-mix, and charges across insurance types, as described in [Appendix B](#). The inpatient sample excludes birth-related hospital services. The “HCCI insurers” are UnitedHealthcare, Aetna, and Humana, the insurers with claims included in the Health Care Cost Institute’s data.

²See Baker et al. (2016), Cooper et al. (2019a, 2019b), Curto et al. (2019), and Maeda and Nelson (2018).

Figure C5: Inpatient and outpatient hospital prices as a percentage of Medicare FFS rates, 2009-15

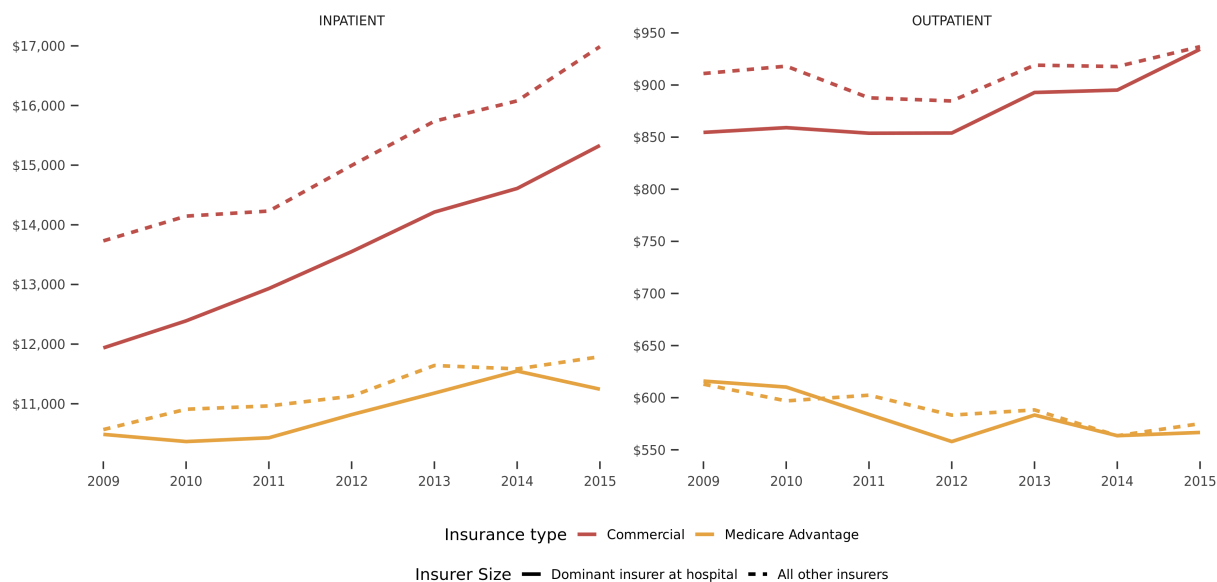
Comparison of HCCI and non-HCCI insurers



SOURCE: Authors' analysis of data from the American Hospital Utilization Database. **NOTES:** All hospital prices are adjusted to 2015 US dollars using the All Item Consumer Price Index. Hospital prices are standardized and weighted to control for differences in case-mix, hospital-mix, and charges across insurance types, as described in [Appendix B](#). The inpatient sample excludes birth-related hospital services. The "HCCI insurers" are UnitedHealthcare, Aetna, and Humana, the insurers with claims included in the Health Care Cost Institute's data. FFS is fee-for-service.

C.4 Comparison of Dominant Insurer at Hospital to All Other Insurers

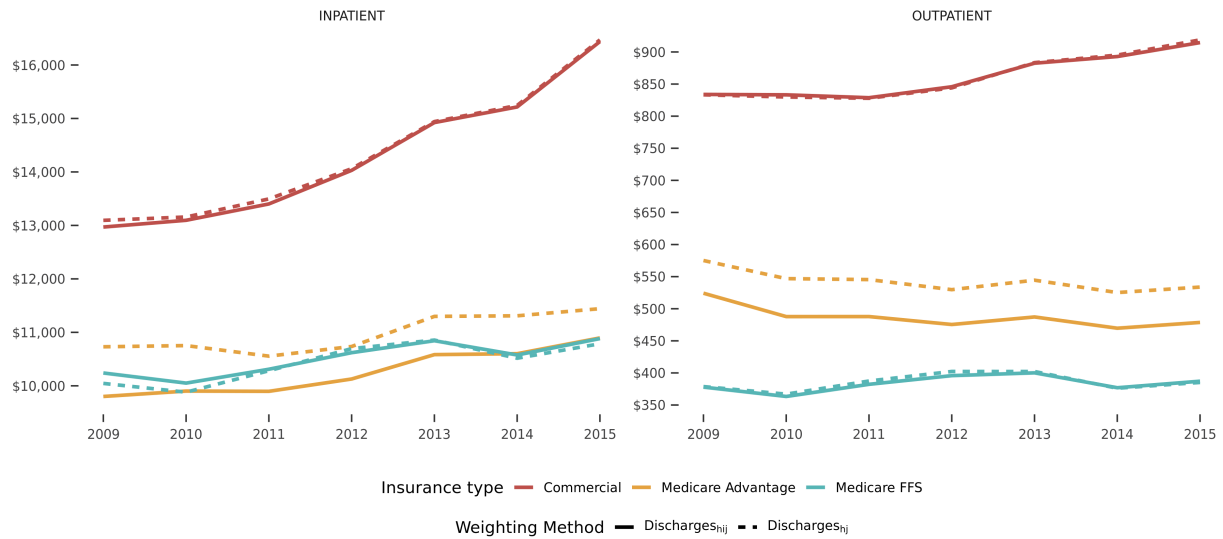
Figure C6: Inpatient and outpatient hospital prices, 2009-15
Comparison of dominant insurer at hospital to other insurers



SOURCE: Authors' analysis of data from the American Hospital Utilization Database. **NOTES:** All hospital prices are adjusted to 2015 US dollars using the All Item Consumer Price Index. Hospital prices are standardized and weighted to control for differences in case-mix, hospital-mix, and charges across insurance types, as described in [Appendix B](#). The inpatient sample excludes birth-related hospital services. At each hospital, the dominant insurer is the private insurer enrolling the greatest number of patients in their market (commercial or Medicare Advantage).

C.5 Methodological Variations

Figure C7: Inpatient and outpatient hospital prices, 2009-15
Comparison of weighting methods



SOURCE: Authors' analysis of data from the American Hospital Utilization Database. **NOTES:** All hospital prices are adjusted to 2015 US dollars using the All Item Consumer Price Index. Hospital prices are standardized and weighted to control for differences in case-mix, hospital-mix, and charges across insurance types, as described in [Appendix B](#). Results using two different methods for calculating weighted averages for standardized prices. In our main analysis, hospitals are weighted by the sum of discharges over all years and across all insurance types (Discharges_{hj}). We also present averages here weighted by the sum of discharges over all years for the specified insurance type (Discharges_{hij}). See [Appendix B.2](#) for more information on our weighting method. The inpatient sample excludes birth-related hospital services. FFS is fee-for-service.

Table C2: Changes in hospital prices, by insurer size, 2009-15
Without inflation adjustment

Sample	Insurance Type	2009		2015		% Change	Compound Annualized Growth Rate
		N	Price	N	Price		
Colonoscopy	Commercial	12,026	1,346.82	18,278	1,757.91	30.52	4.54
	Medicare Advantage	1,785	889.90	3,640	1,072.31	20.50	3.16
	Medicare FFS	4,312	609.52	7,437	706.18	15.86	2.48
Hip Replacement	Commercial	1,104	19,377.12	1,065	24,664.21	27.29	4.10
	Medicare Advantage	313	14,165.71	418	15,601.38	10.13	1.62
	Medicare FFS	1,295	13,438.31	938	14,023.17	4.35	0.71
Knee Replacement	Commercial	1,811	19,156.68	1,202	23,961.31	25.08	3.80
	Medicare Advantage	764	13,972.48	680	15,940.14	14.08	2.22
	Medicare FFS	2,602	13,664.15	1,517	14,374.81	5.20	0.85
Screening Mammogram	Commercial	2,468	8,838.77	1,081	12,194.08	37.96	5.51
	Medicare Advantage	219	7,850.52	142	8,900.49	13.37	2.11
	Medicare FFS	49,196	99.27	49,849	120.46	21.35	3.28
Inpatient	Commercial	73,940	11,958.90	48,512	16,375.39	36.93	5.38
	Medicare Advantage	15,090	9,791.58	14,204	11,380.18	16.22	2.54
	Medicare FFS	68,032	9,150.55	49,212	10,746.27	17.44	2.72
Outpatient	Commercial	1,837,903	763.91	1,756,022	907.95	18.86	2.92
	Medicare Advantage	326,230	530.20	490,393	527.69	-0.47	-0.08
	Medicare FFS	1,340,995	347.62	1,346,636	379.56	9.19	1.48

SOURCE: Authors' analysis of data from the American Hospital Utilization Database. **NOTES:** Hospital prices are standardized and weighted to control for differences in case-mix, hospital-mix, and charges across insurance types, as described in [Appendix B](#). The inpatient sample excludes birth-related hospital services. The two inpatient medical services samples (hip and knee replacements) include only procedures without complications. FFS is fee-for-service.

References

- Baker L, Bundorf MK, Devlin AM, Kessler DP. Medicare Advantage plans pay hospitals less than traditional Medicare pays. *Health Affairs (Millwood)*. 2016;35(8):1444–51.
- Blue Cross Blue Shield Association. Blue facts: healthcare coverage designed for your community, accessible across the country [Internet]. Chicago (IL): Blue Cross Blue Shield Association; 2018 May [cited 2020 Aug 12]. Accessed from: https://www.bcbs.com/sites/default/files/file-attachments/page/BCBS.Facts__0.pdf
- Cooper Z, Craig S, Gaynor M, Harish NJ, Krumholz HM, Van Reenen J. Hospital prices grew substantially faster than physician prices for hospital-based care in 2007–14. *Health Affairs (Millwood)*. 2019a;32(2):184–9.
- Cooper Z, Craig SV, Gaynor M, Van Reenen J. The price ain't right? Hospital prices and health spending on the privately insured. *The Quarterly Journal of Economics*. 2019b;134(1):51–107.
- Curto V, Einav L, Finkelstein A, Levin J, Bhattacharya J. Health care spending and utilization in public and private Medicare. *American Economic Journal: Applied Economics*. 2019;11(2):302–32.
- Fronsdal TL, Bhattacharya J, Tamang S. Variation in health care prices across public and private payers [Internet]. Cambridge (MA): National Bureau of Economic Research; 2020 Jul [cited 2020 Aug 12]. (NBER Working Paper No. 27490). Available for download (fee required) from: <https://www.nber.org/papers/w27490>
- Maeda JKL, Nelson L. How do the hospital prices paid by Medicare Advantage plans and commercial plans compare with Medicare fee-for-service prices? *INQUIRY: The Journal of Health Care Organization, Provision, and Financing*. 2018;55:1–8.
- Quan H, Sundararajan V, Halfon P, Fong A, Burnand D, Luthi JC, et al. Coding algorithms for defining comorbidities in ICD-9-CM and ICD-10 administrative data. *Medical Care*. 2005;43(11):1130–9.