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Market Power and Hospital Prices: Evidence from New Hampshire

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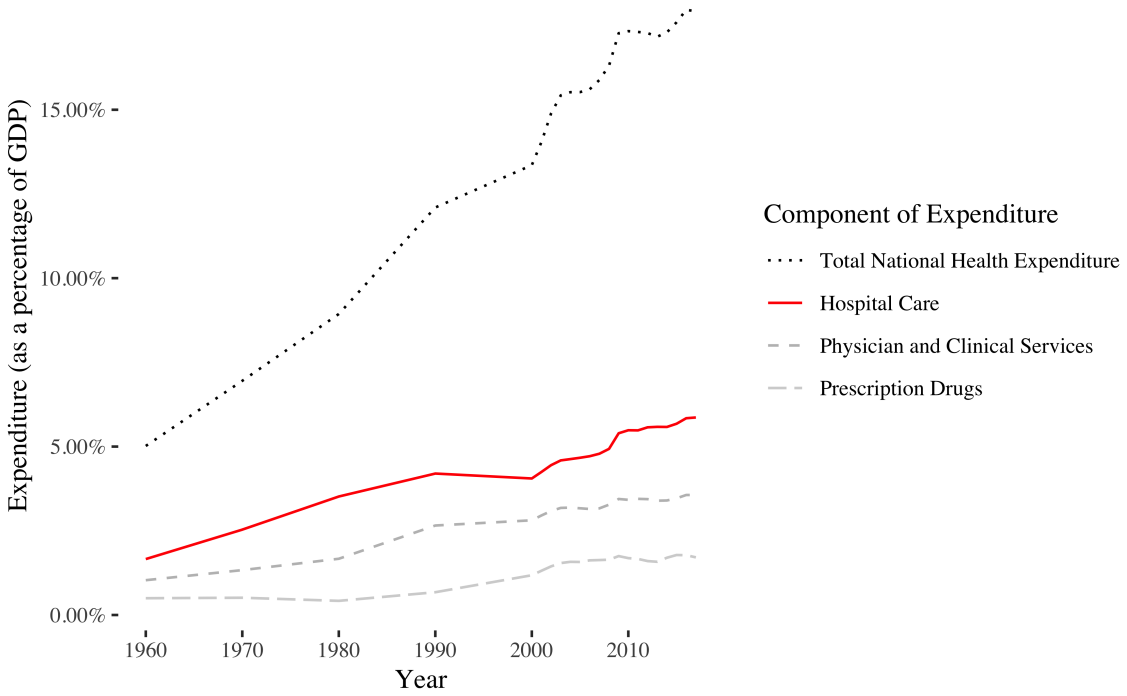
Abstract

This thesis evaluates how insurers and hospitals are able to exert market power in negotiating prices for hospital care, contributing new additional evidence to the literature on hospital and insurer market power. Using insurer-hospital-procedure-level prices for outpatient radiology services from New Hampshire's HealthCost website, I compare the prices for the same service first across insurers and then across hospitals to evaluate how this relates to the insurer or hospital's market share using linear fixed effects models. I find that on average Anthem, the largest commercial insurer in New Hampshire, pays the lowest private prices, Harvard Pilgrim, the second largest insurer, pays 13.9% more than Anthem, and CIGNA, the smallest major insurer, pays 21.2% more than Anthem. These results are all statistically significant at the 1% level. I also estimate that a hospital with one fewer competitor in its local market is able to charge 13% higher prices for each procedure after controlling for the insurer, quality, typical patient complexity, and socioeconomic characteristics. However, the effect of hospital density on negotiated prices varies heterogenously across different insurers, with Harvard Pilgrim prices being the most sensitive to hospital competition. These results are consistent with the hypothesis that hospital prices are inefficiently influenced by the market power of the negotiating parties, and that policy solutions that can decrease the relative market power of each hospital and increase the market power of insurers may help to reduce prices.

I Introduction

The United States' expenditure on health care has grown rapidly since World War II and has outpaced that of many peer countries without significant returns to quality (OECD 2017; Etehad and Kim 2017; Reinhardt et al., 2004). From 1960 to 2017, the growth rate of health care spending has surpassed that of GDP, averaging 6.3% annually, and although this rate recently slowed to only 3.9% in 2017 (Center for Medicare and Medicaid Services 2018), it remains positive and continues to outpace the annual growth rate of real GDP (Bureau of Economic Advisors 2019). Given that the $3.5 trillion spent on health care (17.9% of GDP) in 2017 (CMS 2018) erodes the budgets of households and governments, exploring the sources of spending has generated a large body of relevant research in health economics. Hospital care, physician services, and pharmaceutical drugs are the largest sources of spending, with hospital care constituting the largest share at 32.7% ($1.1 trillion) of total national health expenditure in 2017 (CMS 2018) as shown in Figure 1. Hospital care expenditures are also one of the faster growing components of total health care spending, growing on average over the last decade at 5.8% annually, while spending of physician services and prescription drugs over the same period grew on average at 4.8% and 4.1%, respectively (CMS 2018). While the prevalence of third party payers and certain unhealthy behaviors of the American lifestyle may encourage higher utilization of medical care, the biggest driver behind the U.S.'s spending on hospital care and total health expenditure is not greater utilization or social spending but simply higher prices (Anderson et al., 2003; Papanicolas et al., 2018).

Due to the size and relevance of hospital care spending, an important health economics literature investigates the sources of hospital price variation. However, the process of determining and defining hospital prices has long been a challenging element of this research as the list prices hospitals put on their "chargemasters" have little systematic



Notes: All dollar amounts are nominal. National Health Expenditure data up to 2017 comes from CMS 2018 NHE Estimates; GDP data from Bureau of Economic Advisors 2019.

Figure 1: Health Care Expenditure in the U.S. over time

relation to what payers actually pay (Reinhardt 2006). The actual hospital transaction prices for private payers have largely been considered commercially sensitive, but relatively recently a select number of states have begun to require that these prices be reported to the state. What has been discovered as these price data have become more available is that prices vary dramatically for different payers. Public payers such as Medicare and Medicaid set their prices at the federal or state level, which may vary somewhat across regions to reflect costs but usually do not vary within region. Because Medicare and Medicaid account for 20% and 17% of total national health expenditure respectively (CMS 2018), they are able to exert significant monopsony power and pay the lowest prices for hospital services as hospitals would stand to lose significant revenues if they refused to serve Medicaid and particularly Medicare patients. Private payers, on the other hand, account for 34% of total national health spending (CMS

2018) but because there are many of them, no one payer accounts for more than 5% of total spending. Thus commercial insurers negotiate price contracts separately with each hospital they choose to and often pay an additional 50-200% of the Medicare price for hospital services (Selden et al. 2015; Cooper et al. 2018; Bai and Anderson 2018), a gap that has only been growing in recent decades (Selden et al. 2015). In addition to the public-private gap, a few studies (Cutler et al., 2000; Bai and Anderson, 2018; Cooper et al. 2019) have also identified price gaps between different private payers and private payer types, such that for the same care at the same hospital, different insurers are paying significantly different prices. Considering the fact that 49% of Americans receive health care coverage from their employer through private insurance plans rather than through Medicare (21%) and Medicaid (14%) (Kaiser Family Foundation 2017), this price variation in different private insurer-hospital contracts affects what many Americans pay out of pocket and in premiums for their health care. Moreover, Cooper et al. (2019) finds evidence that this variation persists even when costs and quality are arguably held constant.

In this paper, I estimate how prices for outpatient radiology services in New Hampshire are related to the market share of the insurer and the market share of the hospital through multivariate fixed effects linear regressions. New Hampshire has been a pioneer of price transparency in health care among the U.S. states and therefore provides the opportunity to more closely evaluate the forces shaping hospital prices. I use publicly available data on insurer-hospital-procedure-level prices from the NH HealthCost website, information on state-level health insurance coverage from the New Hampshire Insurance Department, and geographical data from Dartmouth Atlas of Health Care and NH HealthCost. While much of the previous literature analyzes inpatient care, I choose to focus my analysis on hospitals' outpatient radiology services for several reasons. In terms of relevance, outpatient services have expanded steadily in recent decades (Fuchs 2012; American Hospital Association 2016), and by 2016, outpatient

revenues accounted for 47% of total hospital revenues (American Hospital Association 2018) and therefore compose a significant proportion of hospital spending.[1] Radiology services are some of the most common and costly outpatient services (Pelech, CBO 2018), and in New Hampshire, 17 out of the 82 most common outpatient procedures are radiology services (New Hampshire Hospital Association 2017). Due to both their high demand and high per-unit revenue to per-unit cost ratio, radiology services often constitute the largest source of outpatient profits for many hospitals at roughly 35% (Becker's Hospital Review 2015). In addition to being relevant to hospital spending, radiology services are unique in that their quality is more constant across hospitals compared to other types of services, like surgical procedures, and particularly within hospitals, the quality of the same radiology service is conceivably fixed.

Upon examining the prices for these services, as available through NH HealthCost, I find statistically significant differences between the prices different insurers face across the state as well as statistically significant relationships between hospital density and prices, although this effect varies somewhat across insurers. Specifically, I find that, on average for a particular procedure, Anthem, the largest commercial insurer in New Hampshire, pays the lowest prices at 181% of the Medicare price for that procedure; Harvard Pilgrim, the second largest insurer, pays 26.2% of the Medicare price more than Anthem; and CIGNA, the smallest insurer, pays 38.3% of the Medicare price above Anthem. Furthermore, hospitals in markets with higher hospital density are more likely to receive lower prices for each procedure when considering all insurers. The addition of one hospital within five miles of a hospital, which often places these hospitals in the same HSA, is associated with a reduction in the prices that hospital receives for each procedure equivalent to 21% of the Medicare price; if a hospital is added within 25 miles of a hospital, this is associated with only a 6% of the Medicare price decrease, though the relationship remains statistically significant. However,

[1] Inpatient services accounted for the remaining 53% of hospital revenues in 2014.

interacting hospital density and insurer identity reveals that the trends at the local level are driven primarily by Harvard Pilgrim, for which the addition of one hospital to a hospital's HSA is associated with a decrease in negotiated prices equivalent to 36% of the Medicare price, while the coefficients for Anthem and CIGNA are negative but not statistically significant. When considering hospital density at the HRR level however, the relationships are negative and statistically significant for all three insurers although there is no statistical difference between the magnitude of this relationship between Anthem and CIGNA. These results suggest that, for outpatient radiology services, price variation within each hospital is strongly associated with insurer market shares, but the variation across hospitals is only somewhat related to hospital density and heterogeneously across insurers in a manner unrelated to the insurer's market share.

This paper builds on a significant literature that has also examined price variation across private payers and hospitals.

Radiology services (CT scans, MRIs, ultrasounds, x-rays, etc.) generally involve the use of an imaging device to capture an image which is then read (examined) by a radiologist who reports their findings to the patient or patient's doctor. The initial cost of purchasing one of these imaging devices is expensive and may vary somewhat, but the per unit cost of procuring and reading an image is likely to be similar across providers once controlling for wages. Particularly within the same hospital, it is plausible that the per unit cost of each radiology service is constant. Similarly, within the same hospital, it is plausible that quality is constant for the same radiology service. Furthermore, across hospitals, the quality of radiology services is assumed to be relatively similar. While the number of specialized radiologists employed by each hospital may vary, the emergence of telemedicine and New Hampshire legislation encouraging its use (mHealth Intelligence, 0ct. 27, 2015) may help to mitigate these disparities as rural hospitals

can send imaging to be reliably read by specialized radiologists employed by telemedicine firms. Particularly after controlling for the hospital's overall quality, I assume that imaging service quality is minimally different between hospitals.

Section II of this paper lays out the conceptual framework motivating this analysis, and Section III provides background on the New Hampshire market for health services. Section IV supplies an explanation of the data sources being used, how they were obtained, and the relevant information contained therein. Section V describes the empirical approach and Section VI presents the results. A discussion of the results takes place in Section VII and the paper concludes with Section VIII.

II Conceptual Framework

The market for hospital services is deviates from perfect competition in several ways. Only about 14% of total health spending is out-of-pocket (Fuchs 2012), and therefore most consumers do not face the full costs of the services they require due to health insurance coverage. Health insurance is made necessary because the market for health care involves a large amount of risk; care is both highly expensive and unpredictable as an individual consumer does not know how much care she will need and when. Thus, insurance helps distribute the risk associated with each consumer across a pool of plan enrollees by bearing some of the costs of care in exchange for monthly premiums. However, this structure leads to reduced pressure on hospitals to offer competitive prices as consumers rarely "shop" for care on the basis of price. Because most patients do not observe the full prices for the care they receive, their hospital utilization choices are not based on the true costs of care (Manning et al., 1987; Finkelstein et al., 2012). Instead, they "shop" for insurance plans or employers who provide insurance plans on the basis of plan premiums and the convenience of the hospital networks offered by

each plan (Ho 2006).

Thus, private insurers and other third-party payers are the most proximate agents to the price setting process with hospitals, particularly for expensive technologically advanced services, and each hospital and private insurer negotiate explicit contracts of the insurer's reimbursement rates, often on an annual basis. This process is highly detailed–a price is usually negotiated for each service the hospital offers–and only possible because there are relatively few hospitals and relatively few insurers present in each market for health care. Because of the small number of payers and providers, the norm of bilateral contract negotiations, and the lack of price transparency for the consumer, the market for hospital care deviates from a perfectly competitive model. In standard micro-economic theory, resources are optimally allocated in a perfectly competitive market via the mechanism of price, which results from the intersection of the supply and demand curves, which are aggregations of many producers' cost functions and many consumers' preferences. The resulting price is equivalent to the marginal cost of production and the value of the marginal consumer's marginal unit of utility, but no one consumer's consumption decision or one producer's production decsion will effect the market price as there are so many consumers and producers. Thus in this standard model, both producers and consumers are price takers, making their production or consumption decisions based on an exogenous price, and economic profits are equivalent to zero. However, if there is a small number of suppliers or consumers in the market, individual agents' production or consumption decisions can affect price such that it is no longer exogenous. In this scenario, the agent is no longer a price taker but also a price setter and can exercise market power, allowing for profits. When profits are introduced, the price is no longer welfare maximizing as a less than optimal amount of the good is consumed. The most extreme example of supplier market power is the monopolist, which sets its price to maximize non-zero profits given the demand curve for the good.

Unlike the perfectly competitive market where all agents are price takers, insurers and hospitals are both price setters in the health care market because the decision of the marginal producer or consumer affects the price for hospital services. An insurer can threaten not to include a hospital in its network, thereby reducing the likelihood that the patients it covers will go there for care. If the insurer covers many potential patients in that hospital's market, this threat could result in reduced volume and revenues for the hospital, so hospitals may concede lower prices in order to attract the insurer's plan members. However in return, hospitals can threaten not to be included in the insurer's network, making the insurer's plan less attractive to potential enrollees and therefore hurting the insurer's revenues. If the hospital is a major hospital or the only hospital in a large geographic region, this threat can generate significant bargaining leverage as potential enrollees may be willing to pay more to have convenient or well-known hospitals in their network and may chose to avoid plans that do not include certain hospitals in their network. However, the credibility of these threats are important to the bargaining model. While an insurer may cover a large proportion of a hospital's potential patients, the insurer's threat to not include that hospital in plans' networks may be diminished if the potential patient population of that hospital composes a large share of that insurer's total enrollment. Conversely, if a large proportion of a hospital's total patients are Medicare or Medicaid patients, which hospitals often lose money on, the hospital's threat not to serve that insurer's patients may be less credible as the hospital may be more desperate to make up for lost profits by attracting private payers, which typically pay prices that are 150-300% of the Medicare price. As long as profits are still positive for private patients, hospitals may be willing to trade off slightly lower negotiated prices in order to attract privately-insured volume. Thus, the prices that result from these negotiations may reflect the relative bargaining power of the insurer and the hospital rather than the marginal cost and marginal utility of the services provided.

In these bilateral negotiations, I assume the following: both the provider and the payer want to maximize the number of health consumers they serve while maximizing their profit margins per consumer, even if the provider is a non-profit (Horwitz 2005). Providers want to receive higher prices for their services but also to be included in payers' networks, as patients face lower out-of-pocket costs when going to providers in network. Payers want to pay lower prices for providers' services to minimize their costs but also want to attract enrollees by including convenient providers in their network as this is an important aspect of plan selection for individuals (Ho 2006). Thus, insurers or hospitals that can exercise market power most effectively are expected to negotiate more favorable prices for themselves in the bargaining process. The most intuitive source of market power is market share, and most of the analysis that follows explores whether prices are indeed more favorable for the hospitals or insurers with greater market shares. Additionally, I examine whether there is heterogeneity in the sensitivity of prices to hospital market share across insurers to investigate whether there may be additional sources of market power such as the credibility of bargaining threats present in the market for outpatient radiology services.

III Background on the New Hampshire Market

The state of New Hampshire has been a pioneer of price transparency through the creation of the Comprehensive Health Care Information System (CHIS), and in the same legislation that created CHIS, the state enacted statutes that mandated that health insurance carriers submit their encrypted health care claims data and Health Employer Data and Information Set (HEDIS) data to the state. This has led to a rich set of health claims data that has allowed for the creation of an online public tool NH HealthCost, which allows individuals to find estimates for what the total price for certain services will be at each hospital given their insurance carrier and from

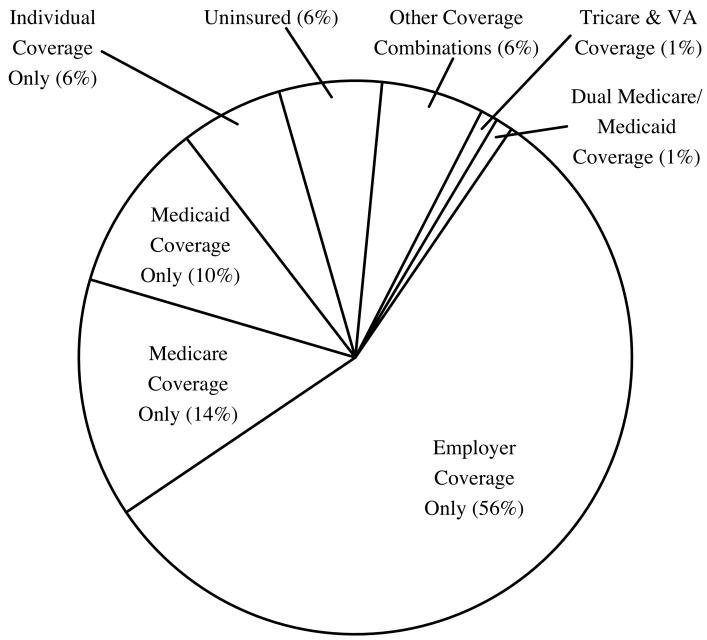
which I construct most of my data set as described in further detail in Section IV. The following subsections describe the New Hampshire insurance landscape as well as the provider landscape.

III.I Health Insurance Coverage

New Hampshire is a small state (8,953 square miles) with a population of 1.3 million (90.5% white) and median household income of $71,305 (Census Bureau 2017). Additionally, 17.6% of the population is over the age of 65, which is slightly higher than the national average of 15.6% (Census Bureau 2017). Figures 2 and 3 show the insurance status of New Hampshire residents in 2017 and the market share of major private insurers, respectively. In 2017, 62% of residents (approximately 820,000 individuals) received health insurance through the private insurance market, 56% through employer-sponsored insurance and 6% through individual private insurance, and this translates to 543,900 enrolled members (New Hampshire Health Insurance Department 2018).[2] Of the privately insured, 81% received coverage through employer-sponsored insurance plans (12.6% Small Group, 19.8% Large Group Fully Insured, and 48.9% Large Group Self Insured) and the remainder either purchase their coverage individually (11.0%) or received subsidies for private coverage through New Hampshire's Premium Assistance Program (7.7%). This paper concerns only the prices faced by members of employer-based insurance plans (group insurance).

The three major private insurers are Anthem/Matthew Thorton (39%), Harvard Pilgrim Healthcare (27%), and CIGNA (20%). Other insurers include Ambetter (3.5%), Minuteman Health (3.4%), Tufts (3.0%), Community Health Options (2.1%), United (1.2%), and Aetna (0.2%) and each constitute less than 5% of the commercial market. The NH HealthCost website does not distinguish between these other insurers

[2]A plan member can be a household or an individual; these estimates exclude individuals covered by the Federal Employees Health Benefits Program (FEHBP)

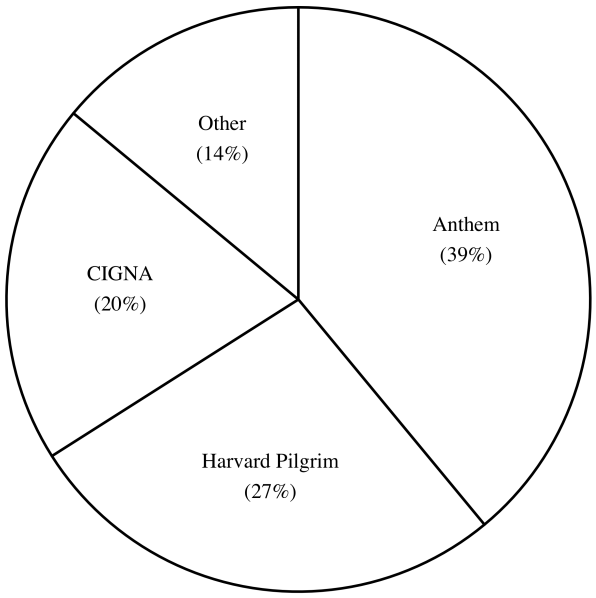


Source: New Hampshire Health Insurance Department, Nov. 2018

Figure 2: Health Insurance Status of New Hampshire Residents in 2017

and often does not provide prices for them at all, so I do not include them in my analysis. Anthem plans are underwritten by Matthew Thorton Health Plan, Inc. in New Hampshire, a fully owned subsidiary of Anthem, but are referred to as "Anthem" throughout the paper. Of the three major insurers, both Anthem and CIGNA have a significant national presence, Anthem being the larger of the two with 40.2 million members compared to CIGNA's 15.9 million members (Becker's Hospital Review, 2019). Thus group insured New Hampshire residents constitute roughly 0.5% of Anthem's total membership and 0.7% of CIGNA's total membership. Harvard Pilgrim Health Care is a non-profit private company that primarily operates in the northeastern United States (Crunchbase, 2019) and has only 1.2 million members, so while it is the second largest insurer in New Hampshire, it is a relatively small national player. As a result, group insured New Hampshire residents constitute 12.2% of total Harvard

Pilgrim membership, a significantly larger portion than for Anthem or CIGNA.



Source: New Hampshire Health Insurance Department, Nov. 2018

Figure 3: Distribution by Insurer for NH Commercial Market in 2017

III.II New Hampshire Providers

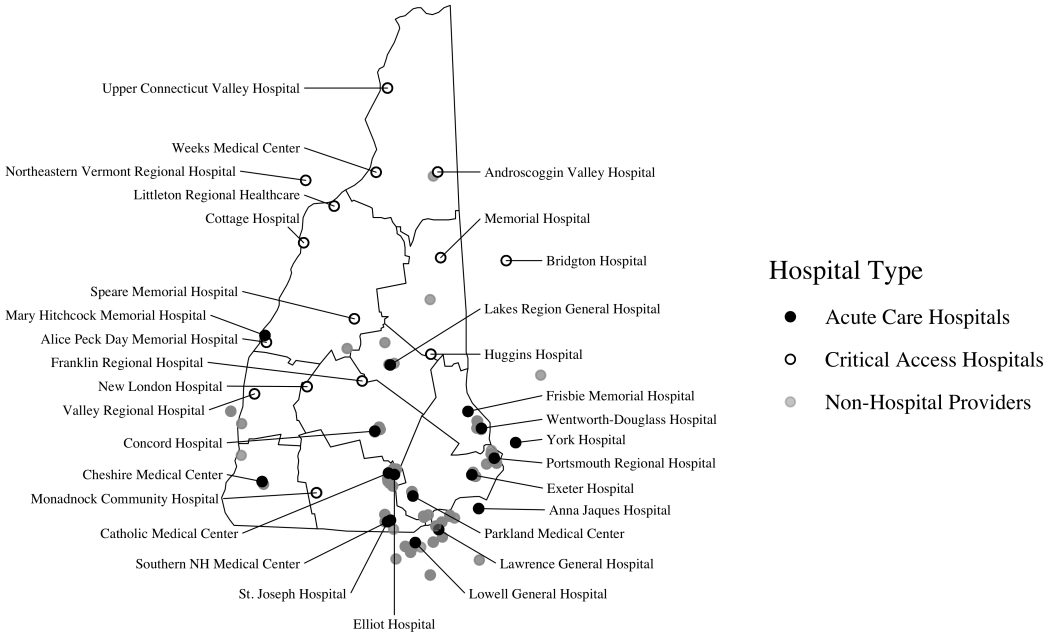
My primary analysis examines prices at New Hampshire's 26 acute-care hospitals. The state has a total of 31 hospitals and 3,503 beds, and of these hospitals, 13 with 2,704 beds are Prospective Payment Systems (PPS) Hospitals, 13 with 301 beds are Critical Access Hospitals (CAH), and 5 with 498 beds are Specialty Hospitals. PPS hospitals are normal acute-care hospitals that are reimbursed by Medicare through prospective payments[3] for inpatient stays. CAHs are acute-care hospitals that serve

[3]Medicare prospective payments are predetermined, fixed amounts based on the classification system of the care received. For example, acute-care hospitals are reimbursed for inpatient stays according to the patient's diagnosis, corresponding to a diagnosis-related group (DRG), rather than according to the services provided to that patient.

rural populations and are therefore eligible to receive cost-based reimbursements from Medicare for inpatient stays. Specialty hospitals provide a specialized category of services (such as children's hospitals, orthopaedic hospitals, cancer hospitals, etc.) and are omitted from my analysis for lack of price information. While the way these hospitals are reimbursed for inpatient hospital stays by Medicare may differ, these distinctions are largely irrelevant in the outpatient setting where physician and clinical services are reimbursed on a service level basis through Medicare Part B, and the structure of Medicare reimbursement does not affect how hospitals are reimbursed by private insurers.

In addition to the 26 New Hampshire hospitals, there are 6 out-of-state hospitals relevant to my analysis that are located close to New Hampshire's borders: Anna Jaques Hospital, Lawrence General Hospital, and Lowell General Hospital (Massachusetts); Bridgton Hospital and York Hospital (Maine); and Northeastern Vermont Regional Hospital (Vermont). I do not evaluate the prices each insurer pays at these hospitals because I only have access to the statewide market shares of each insurer within New Hampshire and this share may differ substantially across state lines. Furthermore, there are 99 non-hospital providers such as ambulatory surgical centers, clinics, and private physician groups both in- and out-of-state that also provide some of the relevant outpatient procedures, and 79 of these providers are within the state of New Hampshire. Though my primary analyses concern only hospitals, I include these non-hospital providers in a secondary analysis of provider density, and plot them in Figure 4 for context. Non-hospital providers are often highly concentrated in certain areas and some even exist on the same campus as other non-hospital providers, clinics, or hospitals, so it is difficult to determine whether they are competing with hospitals or a part of the hospital's system.

There has only been one official hospital merger involving a hospital in New Hampshire:



Note: Location of hospitals and non-hospital providers provided by NH HealthCost. County divisions are shown.

Figure 4: Location of New Hampshire Hospitals

Massachusetts General Hospital (MGH)/Partners HealthCare from Massachusetts acquired Wentworth-Douglass on January 1, 2017. However, if two pending quasi-mergers go through, "22 out of New Hampshire's 26 acute-care hospitals will have established some kind of organizational connection with other institutions, often mergers in all but name" (Concord Monitor Jan 26, 2019). In May 2018 Partners HealthCare also made a bid to acquire Exeter Health Resources, and this merger is still pending approval.

IV Data

My primary source of data on private prices comes from the New Hampshire Insurance Department's HealthCost website, which is a publicly available tool that provides

insurer-hospital-procedure-level prices in New Hamprhire for roughly 150 services and from which I am able to construct a dataset containing insurer-hospital specific prices for each of the 33 radiology services listed on the site. The prices reported on NH HealthCost are the median amounts that the hospital is paid for providing each service to patients covered by each insurer. I then calculate what percentage of the Medicare price for the same service at the same hospital each price represents using CMS data in order to standardize the prices across different procedures. However, the prices listed on NH HealthCost reflect "bundled" costs and seem somewhat inflated compared to Medicare prices, which are unbundled, so I perform one further standardization to deflate my estimates to be more in line with prior literature and to execute my estimations conservatively. In order to obtain measures of market share, I use data from the New Hampshire Health Insurance Department on statewide commercial insurance coverage and geographical information from the Dartmouth Atlas of Health Care and NH HealthCost. Lastly, I include supplementary data from the 2017 Census and Hospital Compare to provide controls for hospital quality and costs associated with providing the selected services.

IV.I NH HealthCost Data

For the most part, the actual transaction prices between hospitals and insurers have been treated as commercially sensitive information, but there have been recent legislative efforts in the last few years to increase price transparency in health care. New Hampshire is one of the few states that has made information on private prices publicly available, hence why I use it as a case study for my analysis. The prices are calculated using claims data from the New Hampshire Comprehensive Healthcare Information System (NHCHIS) to determine the median amount that insurance carriers and patients pay for each service. The estimated costs therefore reflect the

rates negotiated between health care providers and insurance carriers (often referred to as the "allowable amount") rather than provider charges, which have been shown to have little relation to what most privately insured individuals actually pay for a given service.

The reported prices may be "bundled" to include multiple services or independent providers; that is, the prices represent aggregated transaction costs under the "lead provider" for what may be treatment received from several providers billing separately rather than distinguishing between what is paid to the facility versus the physicians who treat the patient. Reported prices for radiology services use a modified bundle that includes the facility and the professional fees associated with the patient receiving that service but not any other costs that the patient may have incurred on the same day. For example, the prices reflect what a patient was billed for receiving an outpatient foot x-ray and not what they may have been billed for receiving an orthopaedic surgery or cast on that same day.

Each service on HealthCost is identified with a description (e.g. "X-Ray - Foot") and one of the American Medical Association's Current Procedural Terminology (CPT) codes. However, while most procedures correspond to a single CPT code, certain procedures are actually categories of multiple CPT codes. For example, an abdominal x-ray is associated with different codes for a different number of views, so NH HealthCost counts the CPT codes for similar services and identifies the most common ones through the frequency distribution. From there, the representative CPT code and description is chosen based on what will be the simplest and most easily recognized procedure, and, when available, clinical insight is also considered. This means that in some cases, multiple CPT codes may be combined, as long as the cost is similar, under a single service. As a result of this challenge and data availability from NH HealthCost, my dataset includes 33 unique outpatient radiology services.

Additionally, NH HealthCost includes indicators of variability for each estimate under the "Precision of the Cost Estimate" field, where "High" corresponds to transaction cost estimates with little variability from one patient to the next at the same hospital for the same procedure, and risk-adjustment indicators under the "Typical Patient Complexity" field, which are evaluated for each hospital within that procedure. I restrict my analysis only to cost estimates where the precision of the cost estimate is "Medium" or "High," and keep the the measure of typical patient complexity as a useful control for care intensity and quality in my analysis. The typical patient complexity control attempts to account for how a hospital may attract a more complex population than other hospitals when considering a specific procedure. For instance, if a hospital tends to attract a more complex population of patients for brain MRIs compared to other hospitals providing brain MRIs, this hospital would have a "High" typical patient complexity for brain MRIs. However, HealthCost does not include visits where an infrequent and high cost procedure is performed in conjunction with the reported service on the website because the more expensive procedure may have also impacted the cost for performing the more routine services.

Lastly, NH HealthCost provides several additional sources of information that I take advantage of to perform several secondary analyses. First, while my primary analysis concerns the prices faced by the three major private payers, NH HealthCost also provides data on the prices paid py the uninsured at each hospital for each procedure, allowing me to examine whether the effects of hospital market share are different between the privately insured and uninsured. Secondly, NH HealthCost also lists prices paid at non-hospital providers, such as clinics, private physician groups, and ambulatory surgery centers, which enabled me to evaluate whether hospitals may face additional sources of competition when considering outpatient services. In sum, these data allowed me to construct a data set containing the price for 33 radiology services and each provider-insurer combination for which data was available, resulting in a

total of 2,430 observations when including the uninsured and non-hospital providers. However, of this, I have only 773 observations of private insurer-hospital prices at hospitals within the state of New Hampshire.[4]

IV.II Medicare Prices

I standardize the private prices provided by NH HealthCost to be expressed as a percentage of the Medicare price using the 2018 physician fee schedule to calculate Medicare's fee-for-service (FFS) prices for the relevant outpatient procedures. Thus, in the analysis outlined in Section V, my outcome variable of interest is the percentage of the Medicare price that insurer i negotiates for a particular procedure j at a particular hospital h, denoted as y_{ijh}:

$$y_{ijh} = \frac{p_{ijh}}{p_{j,l(h)}^{Medicare}} * 100 \tag{1}$$

where p_{ijh} denotes the price a particular insurer pays for procedure j at hospital h, and $p_{j,l(h)}^{Medicare}$ denotes the price Medicare pays for the same service at the same at hospitals within hospital h's locality $l(h)$. Because Medicare FFS prices are designed to account for cost variation in providing each service across clinical settings and regions, standardizing my prices as a percentage of Medicare allows me to control for some of the costs associated with each procedure. However, the HealthCost prices are "bundled" and therefore are not perfectly comparable to the Medicare FFS prices because they may include more than just payments to the lead provider for the specific service while Medicare prices do not. I therefore deflate the NH HealthCost prices

[4] I do not observe prices for all three insurers at all 26 New Hampshire hospitals for all 33 procedures. Specifically, NH HealthCost does not list prices for Anthem at six hospitals (Wentworth-Douglass, Cheshire Medical Center, Upper Connecticut Valley Hospital, Franklin Regional Hospital, New London Hospital, and Frisbie Memorial Hospital), and for CIGNA, prices at Upper Connecticut Valley Hospital and Cottage Hospital are not listed. This indicates that these hospitals are likely outside of these insurers' networks.

by a certain factor per procedure such that the median price that the three major private insurers pay for the procedure is equivalent to 200% of the Medicare price for that procedure. This value is based on the results of prior literature on outpatient services which utilize direct claims data and have found to be the median percent of the Medicare price paid by private insurers for outpatient radiology services to be roughly 200% (Pelech, CBO, 2018). Deflating the prices in such a way does not affect the statistical significance or direction of my results but merely adjusts their magnitude to more conservative estimates. Further details on the unadjusted NH HealthCost prices and this standardization process are provided in Appendix A.

I calculate the Medicare FFS prices for each service using data from the 2018 physician fee schedule made publicly available by the Center for Medicaid and Medicare Services (CMS). The Medicare FFS prices are constructed using Relative Value Units (RVUs) and Geographic Practice Cost Indeces (GPCIs) to reflect the different intensities of providing different services and geographic variation in costs for providing the same service. Specifically, RVUs are intended vary according to the effort and resources required to perform those services and whether the service was provided in an office or a hospital facility, and they are each multiplied by GPCIs vary by locality.[5] Thus, the equation to calculate the Medicare price paid $p^{Med}_{j,l(h)}$ for each procedure j at the locality level $l(h)$ are calculated as using the following formula:

$$p^{Med}_{j,l(h)} = [(RVU^{work}_{j} * GPCI^{work}_{l(h)}) + (RVU^{PE}_{j} * GPCI^{PE}_{l(h)}) + (RVU^{MP}_{j} * GPCI^{MP}_{l(h)})] * CF_{2018}$$

where RVU^{work}_{j} denotes the RVU for the physician effort, RVU^{PE}_{j} denotes the RVU

[5]CMS defines 112 localities within the United States, which are often state-level definitions but for some larger states or major cities may be much smaller areas. For instance, a large state like California accounts for 31 of all localities, and Massachusetts is divided into "Metropolitan Boston, MA" and the "Rest of Massachusetts, MA." However, CMS considers all of New Hampshire one locality.

for the resource-based practice expense for the facility setting, and RVU_j^{MP} denotes the RVU for the malpractice expense associated with providing procedure j. Within hospital h's locality $l(h)$, $GPCI_{l(h)}^{work}$ denotes the GPCI corresponding to the work RVU, $GPCI_{l(h)}^{PE}$ corresponds to the practice expense RVU, and $GPCI_{l(h)}^{MP}$ corresponds to the malpractice RVU. CF_{2018} denotes the 2018 conversion factor ($35.996), which is updated annually to account for changes in the value of the dollar. For example to calculate the Medicare price for a foot x-ray versus an arthroscopic shoulder surgery in New Hampshire, the RVUs for arthroscopic shoulder surgery are significantly higher than for a foot x-ray, particularly for the work RVU and practice expense RVU to capture how the arthroscopic shoulder surgery is a much more technical, expensive, and high-risk procedure, so Medicare pays $30.90 for a foot x-ray and $677.26 for an arthroscopic shoulder surgery. However, in a different GPCI, such as the Boston Metropolitan Area, Medicare pays $34.25 for a foot x-ray and $729.84 for an arthroscopic shoulder surgery to reflect generally higher costs in Boston as compared to most of New Hampshire.

Medicare treats all of New Hampshire as one locality, meaning that all hospitals in New Hampshire that are reimbursed through prospective payments by Medicare Part A for inpatient services are reimbursed the same amounts for outpatient services through Medicare Part B. However, 13 out of the 32 hospitals in my dataset are Critical Access Hospitals (CAHs) that are eligible to receive cost-based reimbursements from Medicare. I was unable to obtain data on exactly how much these CAHs are reimbursed in the outpatient setting and therefore use the Medicare FFS rates paid at prospective payment hospitals as approximations for what they are reimbursed by Medicare. This should not have a major impact on the analysis as the focus is on variation in the prices for private insurers, and I primarily use Medicare prices for the purposes of standardization of the private insurer prices available through NH HealthCost.

IV.III Price Variation in the New Hampshire Market

Having constructed prices at the insurer-procedure-hospital level using both data sources outlined above, I find that large price variation exists in New Hampshire, and I present in Table 1 the price Medicare pays as well as the median adjusted prices for the three major private insurers (Anthem, Harvard Pilgrim, and CIGNA) and the uninsured for the 33 procedures included in my analysis. All prices reflect 2018 prices, and the raw unadjusted private prices can be found in Appedix A. Significant variation exists in the prices paid for the same procedure or service, not just between Medicare and the private payers but also when just considering the three major commercial insurers. This variation may be efficient if costs and quality vary across hospitals for complex procedures but may be inefficient for services where cost and quality are plausibly constant.

However, this variation persists even when costs and quality are reasonably assumed to be fixed within the same hospital. Controlling for procedure, across hospital price variation accounts for 16.4% of the total variation but *within* hospital price variation accounts for a further 17.0% of the total variation in my data. For the same service at the same hospital, different payers are charged vastly different amounts. Figure 5 shows the different prices paid by the three major private payers in New Hampshire (Anthem, Harvard Pilgrim, and CIGNA) at the same hospital for spine x-rays (a common outpatient procedure). For all of the hospitals in Figure 5, there is a difference of at least $100 between what the highest and lowest payers pay.

It is unlikely that the cost of providing each of these services and the quality of each of these services within the same hospital should vary with patients' insurance coverage enough to account for the different prices observed. That is, while Anthem patients could potentially be healthier on average and therefore less expensive to treat than CIGNA patients, it is not very plausible that these differences in patient populations

Table 1: Median Hospital Prices for Radiology Services by Payer

Procedure	Medicare	Anthem	HP	CIGNA	Uninsured
Myocardial Imaging	$519.79	$964.25	$901.76	$1,265.12	$1,552.74
MRI - Pelvis	$449.82	$1,028.85	$829.60	$1,192.77	$1,637.16
MRI - Brain	$398.48	$698.92	$940.34	$1,062.96	$1,635.29
CT - Abdomen/Pelvis, with contrast	$328.29	$621.93	$793.12	$889.18	$1,426.38
MRI - Knee	$250.57	$432.41	$528.89	$580.45	$868.77
MRI - Shoulder, Elbow, or Wrist	$250.57	$423.08	$504.70	$599.41	$839.07
MRI - Back	$236.78	$320.58	$496.77	$518.01	$787.87
CT - Chest	$206.77	$367.01	$347.67	$445.00	$638.77
Ultrasound - Pregnancy	$150.83	$212.14	$216.33	$231.85	$420.51
Mammogram	$145.25	$332.64	$228.78	$297.02	$447.79
Ultrasound - Abdominal, Complete	$129.73	$243.13	$237.92	$224.46	$396.58
Ultrasound - Transvaginal	$129.58	$252.27	$242.05	$259.17	$455.56
Ultrasound - Head and Neck	$123.82	$279.23	$251.90	$233.11	$364.83
Ultrasound - Pregnancy follow-up	$122.51	$245.01	$229.27	$286.99	$358.86
CT - Head/Brain, without dye	$121.75	$172.25	$179.80	$349.16	$520.52
Ultrasound - Pelvic	$116.79	$233.59	$177.72	$165.35	$379.81
Ultrasound - Abdominal, Limited	$97.05	$192.68	$188.77	$186.11	$259.92
Ultrasound - Breast	$93.11	$186.22	$174.41	$191.70	$309.61
Bone Density Scan	$44.38	$71.85	$86.91	$97.28	$144.69
X-Ray - Hip	$43.59	$73.27	$81.58	$84.38	$117.49
X-Ray - Neck	$41.25	$72.07	$74.16	$91.05	$164.77
X-Ray - Middle Back	$37.70	$65.03	$86.42	$90.66	$141.55
X-Ray - Knee	$37.65	$70.35	$68.89	$80.98	$109.38
X-Ray - Wrist	$36.92	$67.30	$69.78	$79.97	$115.90
X-Ray - Spine	$36.82	$66.81	$74.66	$81.08	$116.48
X-Ray - Abdomen	$34.80	$58.79	$72.07	$81.87	$119.60
X-Ray - Chest	$34.33	$53.37	$59.81	$64.93	$99.52
X-Ray - Hand	$33.53	$59.34	$65.58	$67.23	$104.37
X-Ray - Pelvis	$33.53	$128.59	$103.01	$133.78	$146.57
X-Ray - Ankle	$33.15	$60.17	$63.19	$66.89	$97.90
X-Ray - Foot	$30.90	$52.30	$60.65	$66.89	$100.91
X-Ray - Shoulder	$30.88	$54.59	$60.31	$73.02	$104.06
Urine Capacity Measurement	$16.93	$32.32	$28.91	$38.81	$61.80

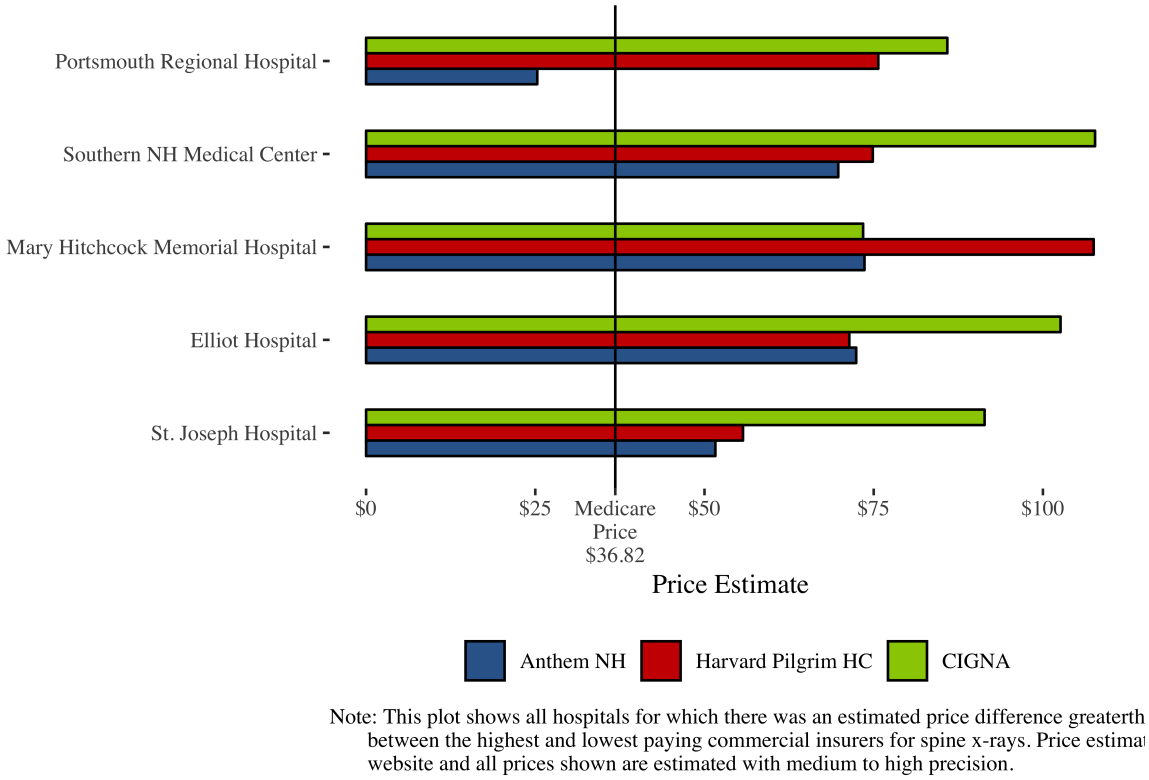


Figure 5: Prices Paid by Private Insurers for Spine X-Rays (Outpatient)

would be sufficiently large to account for much of the price variation, particularly for radiology services. Thus my analysis explores other potential sources of this variation, particularly the level of competition among insurers and hospitals that may allow each to exert certain levels of market power in the price bargaining scenario.

IV.IV Additional Data

Lastly, to provide controls for quality and cost variation, I include quality information from CMS's Hospital Compare data and county-level information on income and population demographics from 2017 US Census Data. CMS's hospital overall ratings attempt to capture the quality of care a hospital may provide compared to other hospitals based on the quality measures reported on Hospital Compare, summarizing

into a single rating more than 60 measures in seven measure groups: mortality, safety of care, readmission, patient experience, effectiveness of care, timeliness of care, and efficient use of medical imaging. Hospitals are ranked out of five stars, and my dataset includes two hospitals with two stars, 11 hospitals with three stars, 16 hospitals with four stars, and three hospitals with five stars for their overall ratings. My primary analyses uses only the hospital's overall quality rating as a control. The US Census data I use are county level estimates of median household income, percentage of the population over 65, and population density.

In order to construct hospital markets and define hospital density therein, I use geographical information from Dartmouth Atlas of Health Care and Google Maps. Dartmouth Atlas defines and provides data for each hospital's Hospital Service Area (HSA) and Hospital Referral Region (HRR), and these definitions for hospitals' markets are commonly used throughout the literature. An HSA delineates a local market for hospital care, composed of a collection of zip codes whose residents receive most of their hospitalizations from the hospitals in that area. For the most part, this calculation is based on assigning each zip code to the area where the greatest proportion of its Medicare patients were hospitalized. Most HSAs contain only one hospital. An HRR delineates regional health care markets for tertiary medical care and each contains at least one hospital that performs major cardiovascular procedures and neurosurgery. HRRs were largely defined by assigning HSAs to the region where the greatest proportion of major cardiovascular procedures were performed. My dataset contains 29 unique HSAs and 4 unique HRRs, and I count both the total number of hospitals within each hospital's market and the number of hospitals that provide the same service/procedure within that market. My second set of market definitions simply uses coordinate information for each hospital from Google Maps to calculate the total number of hospitals and the number of hospitals offering the same procedure within a 15-mile and 25-mile radius of each hospital.

V Empirical Approach

My analysis seeks to identify whether the market share of hospitals and insurers is related to variation in the prices private insurers pay for hospital services and whether this effect is heterogeneous accross different insurers. The first set of regressions concern price variation across insurers, the second set evaluates price variation across hospitals, and the third set examines the interaction between the two. In performing these primary analyses, I restrict my dataset to contain only hospitals in New Hampshire,[6] and only the three major private insurers. This leaves me with 33 services, 26 hospitals, and 773 observations.[7]

In the first set of regressions, I estimate whether there is a statistical difference between the prices for Anthem, Harvard Pilgrim, and CIGNA *within the same hospital* for the same service, and whether there is a relationship between these differences and each insurer's market share. I first estimate what percentage of the Medicare price each insurer i pays on average for each service j at each hospital h using the following fixed effects linear model:

$$y_{ijh} = \gamma_i + \delta_j + \lambda_h + \varepsilon_{ijh} \tag{2}$$

where γ_i is the insurer fixed effects term, δ_j is the procedure fixed effects term, λ_h is the hospital fixed effects term, and the error term is denoted by ε_{ijh}. The omitted insurer dummy is Anthem such that the coefficients $\hat{\gamma}_i$ estimate the percentage of

[6] I exclude prices atambulatory surgical centers, clinics, specialist practices, and private physician practices in my primary.

[7] NH HealthCost does not list prices for all three insurers at all 26 New Hampshire Hospitals for all 33 radiology services considered either because a hospital is not included in a plan's network, the hospital does not offer that procedure, or the observation frequency of certain procedure-insurer-hospital-level prices are too low for accurate estimates. That is, if only two Anthem patients receive an outpatient brain MRI at St. Joseph's hospital during 2018, NH HealthCost does not list a price for this procedure at St. Joseph's for Anthem as estimation power for this procedure-insurer-hospital combination is too low.

the Medicare price above the Anthem price that Harvard Pilgrim or CIGNA pay on average and these are the primary coefficients of interest. By including procedure and hospital fixed effects, I am able to compare prices among the commercial insurers for the same procedure within the same hospital in a context where costs and quality are very plausibly constant. That is, there should be essentially no variation in costs or quality for each radiology service at the same hospital on average.

Equation (2) only estimates whether there are consistent differences between the prices each insurer pays, and the relative magnitudes of the estimated coefficients $\hat{\gamma}_i$ may suggest a possible direction to the association between insurer market share and negotiated prices. In order to investigate more closely the magnitude of this relationship, I also estimate the relationship between each insurer's statewide market share s_i and price using the following simple fixed effects regression, restricting my observations only to private insurer prices:

$$y_{ijh} = \theta_i s_i + \delta_j + \lambda_h + \varepsilon_{ijh} \tag{3}$$

Ideally, I would know the market power of each insurer within hospital h's market, and identify the relationship between the prices negotiated by insurer i and hospital h given insurer i's market share in hospital h's market to identify the price and market share relationship more precisely, but given the limitations of my dataset, I am only able to examine this relationship to statewide market shares. A negative correlation between the size of the insurer's statewide market share and the magnitude of $\hat{\gamma}_i$ would fit the narrative that larger insurers may be able to negotiate lower hospital prices.

In the second set of regressions, I estimate how hospital market shares relate to the prices each insurer is able to negotiate for each service *across hospitals*. However, as with the imperfect measure of insurer market share, I use an imperfect measure

of hospital market share as I am unable to obtain data on the precise outpatient volumes of each hospital for each service. Instead, I construct a measure of the number of other hospitals present in hospital h's market to serve as a proxy for market share and relative hospital concentration in it's inverse form. However, this measure provides only a proxy for hospital market share because while there may be several hospitals in the same market, one may perform significantly more outpatient radiology procedures than the others and therefore have greater market share in the market for that service. This may be due to this hospital having a greater capacity to provide that service or because it is preferred by patients for that service for some other reason. Nevertheless, I hypothesize that because there are so few hospitals present in each market,[8] the addition of a marginal hospital to hospital h's market will appreciably subtract from hospital h's market share and reduce hospital concentration. I estimate this relationship using roughly the same framework as Equation (2) except that the hospital fixed effects term λ_h is decomposed into various observable measures relating to a particular hospital and its market, resulting in the following linear model:

$$y_{ijh} = \gamma_i + \delta_j + \alpha n_h + \beta_1 p_{jh} + \beta_2 q_h + \beta_3 X_{c(h)} + \varepsilon_{ijh} \tag{4}$$

where n_h represents the number of hospitals in hospital h's market and can be thought of as hospital density; p_{jh} denotes the typical patient complexity for procedure j at hospital h; q_h denotes overall hospital quality at hospital h as provided through the CMS Hospital Compare data; and $X_{c(h)}$ is a vector of county-level characteristics for each hospital's county $c(h)$ that include the median household income, the percentage of people over 65 years of age, and population density. The primary coefficient of interest in this second set of regressions is $\hat{\alpha}$ which estimates how hospital competition may be related to prices. If $\hat{\alpha}$ is negative, this suggests that the more hospital

[8] At the broadest definitions of markets, the maximum number of hospitals in any one market is 13 total, but at the smaller market definitions, this number is often less than 5.

competition there is within a hospital's market, the lower the prices.

A hospital's market is defined differently across several specifications, resulting in different levels of hospital density n_h across different regressions. I first use Hospital Service Area (HSA) and Hospital Referral Region (HRR) definitions for hospitals' markets and count the total number of hospitals within each hospital's market. In another specification, I also count the number of hospitals that provide the same service/procedure within that market such that the market term in Equation (4) becomes n_{jh}. This attempts to isolate whether the hospital is truly competing with other hospitals in its market in providing procedure j or whether it may be the only hospital in its market providing that service and therefore faces no competitors. While the 33 radiology services I have restricted my analysis to are quite common, I do not observe prices for all service-hospital combinations in the HealthCost data because some hospitals provide certain services very infrequently or not at all. Thus, I restrict my estimates only to service-hospital combinations for which I observe at least one price as this signals the hospital does indeed provide the service in the outpatient setting. Most hospitals in the dataset do provide at least half of the relevant services and there does not appear to be a consistent set of services for which price data are missing.

The second set of market definitions I use are based on geographical radii drawn around each hospital. As with the HSA/HRR market definitions, I count the total number of hospitals as well as the number of hospitals that also provide the same service/procedure within a 5-mile radius (local market), 15-mile radius (broader market), and 25-mile radius (even broader market) of each hospital h. As the services being examined are all outpatient services, the HSA/HRR definitions may not truly capture the potential patient population and potential competitors because they are calculated on the basis of hospitalization (inpatient) events. For outpatient services,

patients may be able to "shop" more easily among different hospitals given their insurance plan. That is, potential patients may place greater weight on convenience and distance to the hospitals they can go to in the outpatient setting rather than the intensity of care they can receive there because their health status is often less acute in the outpatient setting as compared to the inpatient setting. Therefore, insurers may want to provide attractive plans that offer patients enough convenient choice in their relevant market but without facing high premiums or out-of-pocket costs. Thus, this radial measure of a hospital's market may be more applicable to consumers' choices in the outpatient setting.

The last set of regressions I perform investigate whether hospital density n_h is related to insurer's negotiated prices across hospitals differently for different insurers. That is, one insurer may be more sensitive to the number of hospitals present in hospital h's market because of their relative bargaining leverage in the price negotiation process. This bargaining leverage may be function of their own market share or something else. Thus, the final regression equation is otherwise the same as Equation (4) but includes an interaction between the number of hospitals in hospital h's market and an indicator for each insurer:

$$y_{ijh} = \gamma_i + \delta_j + \alpha n_h + (n_h * \gamma_i) + \beta_1 p_{jh} + \beta_2 q_h + \beta_3 X_{c(h)} + \varepsilon_{ijh} \tag{5}$$

The primary coefficients of interest are those on the interaction terms $(n_h * \gamma_i)$, which estimate how the addition of one additional hospital to hospital h's market affects the price negotiated with insurer i for procedure j. In order to test whether the magnitude of this relationship may be related to the insurer's statewide market share s_i, I also estimate the following:

$$y_{ijh} = \gamma_i + \delta_j + \alpha n_h + (n_h * s_i) + \beta_1 p_{jh} + \beta_2 q_h + \beta_3 X_{c(h)} + \varepsilon_{ijh} \quad (6)$$

where the insurer dummies in Equation (5) have been replaced with their statewide market shares to result in an interaction between hospital density and insurer market share ($n_h * s_i$). The significance of the coefficient on this term will test whether the negative effect on prices from hospital density is greater for insurers with greater market share.

VI Results

The first set of results presented in Table 2 demonstrate that there are statistically significant differences in the prices paid by each insurer for a particular service within each hospital and that prices are negatively associated with market power. Standard errors are clustered by procedure and hospital when procedure and hospital fixed effects are included, and the coefficients are presented as the percentage of the Medicare price *above* the Anthem price, which is also expressed as a percentage of the Medicare price when shown, for each service at each hospital as Anthem is the omitted insurer dummy variable. In the primary specification in Column 3, these positively estimated coefficients suggest that on average Anthem the lowest prices at roughly 180% of the Medicare price, Harvard Pilgrim pays more than Anthem by 26.2% the Medicare price, and CIGNA pays more than Anthem by 38.3% the Medicare price. That is, Harvard Pilgrim pays about 14% more than Anthem, and CIGNA pays about 21% more than Anthem on average. The basic fixed effects linear model of price on market share in Column 4 results in a negative and statistically significant coefficient on insurer statewide market share that estimates a 1% increase in insurer statewide market share is associated with a 2% decrease in prices. None of the results presented

have causal interpretations, but they do demonstrate strong associations between the insurer's statewide market share and price as all estimated coefficients are statistically significant at at least the 5% level.

Table 2:

	Dependent variable:			
	percent_medicare			
	(1)	(2)	(3)	(4)
Harvard_Pilgrim_HC	22.790***	22.313***	26.204**	
	(5.773)	(6.327)	(12.029)	
CIGNA	37.372***	37.448***	38.267***	
	(6.146)	(5.991)	(9.306)	
commercial_market_share				−2.022***
				(0.497)
Constant	184.189***			
	(4.541)			
Procedure Fixed Effects	No	Yes	Yes	Yes
Hospital Fixed Effects	No	No	Yes	Yes
Clustered Standard Errors	No	Yes	Yes	Yes
Observations	773	773	773	773
R^2	0.046	0.077	0.296	0.296
Note:				*p<0.1; **p<0.05; ***p<0.01

The second set of results presented in Tables 3-4 suggest that the number of hospitals in a hospital's market is negatively related to price at a statistically significant level across all definitions of a hospital's market and that the magnitude of this relationship decreases with distance.[9] Standard errors are clustered by procedure across all specifications presented. Table 3 presents the results where markets are defined at the hospital-level by HSA/HRR or radius, and Table 4 presents the results where markets are defined at the hospital-*procedure*-level by HSA/HRR or radius. These coefficients estimate that the addition of one hospital to a hospital's HSA definition is associated

[9]An HSA is the most local market (equivalent to drawing a 5-mile radius around each hospital), and an HRR is a broader market that the HSA or 15-mile radial markets but typically includes fewer hospitals than 25-mile radial markets.

with a decrease in prices equivalent to 21% of the Medicare price and 25% of the Medicare price if offering the same procedure. At the broadest definition, the addition of any hospital within a hospital's 25-mile radius is associated with a price decrease equivalent to 5-6% of the Medicare price. All coefficients on the included quality and cost control variables are statistically insignificant, but the coefficients on each insurer dummy remain similar to those in Table 1, indicating that both Harvard Pilgrim and CIGNA still pay higher prices than Anthem on average even when controlling for hospital density. On the whole, these results suggest that, controlling for typical patient complexity, hospital quality, and county level characteristics, the greater the number of hospitals in a hospital's market, the lower the prices at that hospital tend to be, and that this association is more intense the smaller geographical area defining the hospital's market.

The last set of primary results presented in Table 5 involve the interaction of hospital market density with each insurer as well as the interaction with insurer statewide market share. Within the 5-mile definition of a market shown in Column 1, the only a statistically significant relationship between hospital density and price is on the Harvard Pilgrim interaction term. Together the coefficients suggest that Harvard Pilgrim pays 31.7% of the Medicare price more than Anthem to have at least one hospital within each 5-mile radial market[10] and that CIGNA pays 43.1% of the Medicare price above Anthem's price to have at least one hospital within a 5-mile radial market. However, if a second hospital is introduced within a 5 mile radius, Harvard Pilgrim pays 4.2% of the Medicare price *less* than Anthem[11] while CIGNA continues to pay roughly 43.1% of the Medicare price above the Anthem price on average. This suggests that for local hospital market density, Anthem and CIGNA prices are not very sensitive, but for Harvard Pilgrim, prices do differ significantly

[10] 67.676 - 35.953 = 31.723

[11] 67.676 - 35.953(2) = -4.23

Table 3:

	Dependent variable:			
	percent_medicare			
	(1)	(2)	(3)	(4)
n_hosp_hsa_total	−21.128**			
	(8.640)			
n_hosp_15mi_total		−8.727***		
		(2.492)		
n_hosp_hrr_total			−7.031***	
			(1.488)	
n_hosp_25mi_total				−6.123**
				(2.655)
typical_patient_complexity_scale	11.858	10.194	10.825	9.326
	(7.918)	(7.862)	(8.281)	(7.990)
'Hospital Quality'	3.924	−3.091	−1.492	1.600
	(6.066)	(6.175)	(5.512)	(5.854)
median_household_income	−0.574	0.034	0.727	0.521
	(0.770)	(0.728)	(0.836)	(0.940)
percent_pop_over65	−0.670	−0.099	−0.580	−0.250
	(1.164)	(1.204)	(1.029)	(1.175)
pop_density	0.035	0.052	−0.006	0.029
	(0.048)	(0.050)	(0.046)	(0.045)
Harvard_Pilgrim_HC	19.677***	23.493***	20.514***	22.283***
	(7.318)	(7.187)	(7.068)	(7.123)
CIGNA	35.364***	38.446***	36.136***	37.107***
	(6.588)	(6.379)	(6.458)	(6.293)
Procedure Fixed Effects	Yes	Yes	Yes	Yes
Clustered Standard Errors	Yes	Yes	Yes	Yes
Observations	773	773	773	773
R^2	0.095	0.093	0.134	0.091

Note: *p<0.1; **p<0.05; ***p<0.01

Table 4:

	Dependent variable:			
	percent_medicare			
	(1)	(2)	(3)	(4)
n_hosp_hsa_p	−25.489***			
	(8.638)			
n_hosp_15mi_p		−6.832***		
		(2.518)		
n_hosp_hrr_p			−5.691***	
			(1.105)	
n_hosp_25mi_p				−5.105***
				(1.888)
typical_patient_complexity_scale	11.387	9.819	9.999	9.497
	(7.483)	(7.849)	(8.200)	(7.962)
'Hospital Quality'	4.191	−1.845	−1.863	1.005
	(6.205)	(6.309)	(5.577)	(5.902)
median_household_income	−0.645	−0.052	0.602	0.300
	(0.753)	(0.729)	(0.854)	(0.857)
percent_pop_over65	−0.659	−0.034	−0.113	−0.469
	(1.198)	(1.200)	(1.029)	(1.179)
pop_density	0.043	0.044	0.015	0.029
	(0.045)	(0.050)	(0.045)	(0.044)
Harvard_Pilgrim_HC	19.432***	23.269***	20.747***	22.541***
	(7.221)	(7.174)	(7.013)	(7.180)
CIGNA	34.989***	38.289***	36.451***	37.687***
	(6.632)	(6.432)	(6.420)	(6.480)
Procedure Fixed Effects	Yes	Yes	Yes	Yes
Clustered Standard Errors	Yes	Yes	Yes	Yes
Observations	773	773	773	773
R^2	0.101	0.088	0.123	0.089

Note: *p<0.1; **p<0.05; ***p<0.01

with density variation.

In the 25-mile radius market specification shown in Column 2, there are statistically significant coefficients for the 25-mile radial density, the Harvard Pilgrim dummy, the Harvard Pilgrim interaction, and the CIGNA interaction. Taken in combination, these coefficients suggest that if one additional hospital is placed within 25 miles of another hospital, Anthem prices decrease by 6.0% of the Medicare price on average, Harvard Pilgrim prices decrease by 10.2% of the Medicare price on average, and CIGNA prices decrease by only 0.62% of the Medicare price on average. However, because the coefficient on the CIGNA dummy is statistically insignificant, the estimates suggest that CIGNA only pays 5.4% of the Medicare price more than Anthem to include at least one hospital within a 25-mile radial market. For Harvard Pilgrim, on the other hand, the model estimates a willingness to pay 33.1% of the Medicare price more than Anthem[12] to include at least one hospital in a 25-mile radial market. If observations of Harvard Pilgrim are dropped from the dataset as shown in Columns 3 and 4, the relationship between price and hospital density at the 5-mile radius level is statistically equivalent to zero, but the hospital density relationship to price persists at the 25-mile radius level for both Anthem and CIGNA though it is smaller in magnitude (-8.1) than that for Harvard Pilgrim in the Column 2 (-10.2).

The last two columns of Table 5 synthesize the analyses performed above. That is, the coefficients on the hospital density and insurer market share terms are statistically insignificant in both the HSA and HRR market definitions, suggesting that there is no relationship between the insurer's statewide market share and how the prices it negotiates with hospitals respond to more or less dense markets. This merely confirms the results presented in Columns 1-4 that demonstrate that Anthem and CIGNA prices are related similarly to hospital density despite their very different statewide market shares.

[12] 43.340 - 6.068 - 4.206 = 33.066

Table 5:

	Dependent variable:					
	percent_medicare					
	(1)	(2)	(3)	(4)	(5)	(6)
n_hosp_5mi_total	−6.010		−8.337		−36.327**	
	(10.324)		(10.567)		(16.172)	
n_hosp_25mi_total		−6.068**		−8.073**		−0.830
		(2.636)		(3.273)		(3.638)
Harvard_Pilgrim_HC	67.676***	43.340***				
	(14.585)	(11.803)				
CIGNA	43.121***	9.342	42.021**	3.769		
	(16.129)	(10.991)	(16.663)	(11.164)		
commercial_market_share					−2.605***	−0.920
					(0.862)	(0.584)
typical_patient_complexity_scale	11.805	9.547	14.226	11.890	11.935	9.138
	(7.913)	(8.053)	(8.875)	(8.958)	(7.922)	(7.989)
‘Hospital Quality‘	4.645	1.826	6.855	6.638	4.023	1.581
	(6.024)	(5.845)	(6.762)	(6.852)	(6.031)	(5.745)
median_household_income	−0.388	0.716	−0.150	0.621	−0.489	0.512
	(0.760)	(0.934)	(0.979)	(1.191)	(0.736)	(0.913)
percent_pop_over65	−0.600	−0.544	−0.847	−1.067	−0.612	−0.361
	(1.207)	(1.185)	(1.075)	(1.073)	(1.187)	(1.175)
pop_density	0.028	0.018	0.039	0.035	0.032	0.030
	(0.047)	(0.044)	(0.056)	(0.052)	(0.046)	(0.044)
n_hosp_5mi_total:Harvard_Pilgrim_HC	−35.953***					
	(8.195)					
n_hosp_5mi_total:CIGNA	−4.436		−2.085			
	(9.262)		(9.724)			
n_hosp_25mi_total:Harvard_Pilgrim_HC		−4.206***				
		(1.506)				
n_hosp_25mi_total:CIGNA		5.426***		6.684***		
		(1.594)		(1.615)		
n_hosp_5mi_total:commercial_market_share					0.551	
					(0.503)	
n_hosp_25mi_total:commercial_market_share						−0.189**
						(0.080)
Procedure Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Clustered Standard Errors	Yes	Yes	Yes	Yes	Yes	Yes
Observations	773	773	445	445	773	773
R^2	0.108	0.106	0.170	0.185	0.096	0.093
Note:						*p<0.1; **p<0.05; ***p<0.01

VI.I Secondary Analyses

I perform two secondary analyses to provide a more complete background to the results of the primary analysis. First, I examine whether the relationships found in the second step of my primary analysis investigating hospital density remain the same if I instead regress on *provider* density, which may include clinics, physician groups, and ambulatory surgery centers that also provide a particular service. I evaluate this association between prices and provider density for the prices at all providers in the dataset (Columns 1-3) and for prices at hospitals only (Columns 4-6) in Table 6. I find that, similar to my primary analysis, the negative relationships to price persist and continue to decrease as the radial definition of the market increases for provider density, although they are somewhat smaller in magnitude than for hospital density.

Table 6:

	Dependent variable:					
	percent_medicare					
	(1)	(2)	(3)	(4)	(5)	(6)
n_provider_5mi_p	−11.909***			−7.461**		
	(2.181)			(3.351)		
n_provider_15mi_p		−5.583***			−4.389***	
		(1.408)			(1.099)	
n_provider_25mi_p			−2.616***			−2.620***
			(0.716)			(0.808)
typical_patient_complexity_scale	16.890	17.602*	15.602	11.445	11.371	9.786
	(10.609)	(10.393)	(10.589)	(8.069)	(7.928)	(8.001)
'Hospital Quality'				2.830	−0.277	1.455
				(6.000)	(6.010)	(5.704)
median_household_income	−1.533***	−0.934**	−1.000**	−0.188	0.178	0.153
	(0.445)	(0.402)	(0.431)	(0.773)	(0.689)	(0.727)
percent_pop_over65	0.422	2.134	1.772	−0.618	0.013	−0.262
	(1.640)	(1.600)	(1.554)	(1.183)	(1.214)	(1.173)
pop_density	0.078**	0.102***	0.090***	0.027	0.049	0.054
	(0.033)	(0.034)	(0.031)	(0.050)	(0.052)	(0.051)
Harvard_Pilgrim_HC	18.798***	21.714***	21.208***	21.099***	22.628***	21.718***
	(4.154)	(4.367)	(4.298)	(7.245)	(7.150)	(7.111)
CIGNA	31.675***	33.856***	33.854***	36.366***	36.923***	36.549***
	(4.019)	(3.937)	(3.986)	(6.551)	(6.429)	(6.405)
Procedure Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Clustered Standard Errors	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1,118	1,118	1,118	773	773	773
R^2	0.215	0.211	0.195	0.092	0.099	0.095
Note:						*p<0.1; **p<0.05; ***p<0.01

Next, I evaluate the relationship between hospital density and price again, but this

time, restrict my observations to prices for the uninsured. The results demonstrate that in HSAs that include more than one hospital, prices faced by the uninsured tend to be roughly equivalent or more closely related to variation in the controls. The coefficient on hospital density is oddly positive and statistically significant in the 15-mile radial market but then becomes small, negative, and statistically significant at the broader market definitions. The explanation for the 15-mile result may have to do with the fact that all five hospitals that have more than three hospitals in their 15-mile radius[13] also happen to be located within seven miles of a state or county border. This means my county-level controls may not be as effective in accounting for the demographics of the population contained within the 15-mile radius as the broader market definitions of HRR and 25-mile radius perhaps capture a greater proportion of the hospital's county than the 15-mile radius definition does. In all specifications, the coefficients on the controls are statistically significant. Typical patient complexity is strongly and positively associated with higher prices, as is hospital quality and the median household income in the hospital's county, and the percentage of the population 65 and older and population density are both negatively associated with price, also with statitical significance at the 1% level.

VII Discussion

The results as a whole suggest that the market power of insurers and hospitals is related to the prices hospitals and insurers negotiate as the theoretical framework would predict and as is consistent with prior literature. That is, the insurers and hospitals with the greatest market shares or least competition are able to negotiate the most favorable prices; for the insurers, this translates into negotiating lower prices,

[13]These five hospitals are Parkland Medical Center, Portsmouth Regional Hospital, Southern New Hampshire Medical Center, St. Joseph Hospital, and Wentworth-Douglass Hospital

Table 7:

	Dependent variable:			
	percent_medicare			
	(1)	(2)	(3)	(4)
n_hosp_hsa_total	5.449			
	(7.021)			
n_hosp_15mi_total		18.406***		
		(3.757)		
n_hosp_hrr_total			−6.163***	
			(1.656)	
n_hosp_25mi_total				−5.769**
				(2.680)
typical_patient_complexity_scale	32.888***	31.753***	32.614***	33.262***
	(10.201)	(9.611)	(9.769)	(10.133)
'Hospital Quality'	12.100**	20.633***	11.143**	14.332***
	(5.417)	(5.678)	(5.373)	(5.268)
median_household_income	3.237***	2.763***	3.970***	3.839***
	(0.700)	(0.620)	(0.651)	(0.710)
percent_pop_over65	−4.816***	−5.756***	−4.208***	−4.794***
	(1.108)	(1.143)	(0.984)	(1.106)
pop_density	−0.154***	−0.252***	−0.159***	−0.134***
	(0.039)	(0.048)	(0.035)	(0.038)
Procedure Fixed Effects	Yes	Yes	Yes	Yes
Clustered Standard Errors	Yes	Yes	Yes	Yes
Observations	700	700	700	700
R^2	0.286	0.307	0.303	0.289

Note: *p<0.1; **p<0.05; ***p<0.01

and for hospitals, this results in successfully negotiating higher prices. In my primary results (Tables 2-5), I find that Anthem, the largest insurer, consistently pays the lowest prices on average and that CIGNA, the smallest insurer, tends to pay the highest prices. I also find that hospitals with more hospitals nearby tend to negotiate lower prices with private insurers, and this relationship is stronger the closer the other hospitals are as it is easier for insurers to threaten not to include that hospital in-netwok if there is a close substitute.

However, I also find that market share cannot be the sole source of market power as the relationship of market share to negotiated prices is heterogeneous across insurers. Specifically, I find that Harvard Pilgrim is most price sensitive to hospital concentration than either Anthem or CIGNA. This discrepancy may be explained by the differences in company structure between Harvard Pilgrim and the other two insurers in that Harvard Pilgrim is a small, private, non-profit health insurance company active mainly in the Northeast United States whereas Anthem and CIGNA are both massive, publicly traded companies that provide insurance nationally. As a result, New Hampshire residents constitute less than 1% of total members for Anthem and CIGNA but constitute over 12% of membership for Harvard Pilgrim. Thus, in each hospital negotiation with New Hampshire hospitals, Harvard Pilgrim stands to lose or gain much more revenue based on bargaining outcomes than Anthem and CIGNA do. That is, the marginal benefit of negotiating lower prices may be greater for Harvard Pilgrim but the marginal cost of not including a hospital in its network may also be greater for Harvard Pilgrim than the other two insurers, so that Harvard Pilgrim's price elasticity is greater. The coefficient on the Harvard Pilgrim dummy (not the interaction) in Column 2 demonstrate that Harvard Pilgrim is estimated to be willing to pay a significantly higher price to successfully negotiate a contract with at least one hospital in an HRR, perhaps because having no contracts with any hospital in an HRR would make its plans sufficiently unattractive to a large proportion of its plan

enrollees to harm revenues. Indeed, Harvard Pilgrim is the only insurer for which the dataset contains at least one price observation at all 26 New Hampshire hospitals. In contrast, no prices are observed for CIGNA at Upper Connecticut Valley Hospital or Cottage Hospital, and for Anthem, no prices are observed at Upper Connecticut Valley Hospital, Franklin Regional Hospital, New London Hospital, Frisbie Memorial Hospital, Wentworth-Douglass Hospital, or Cheshire Medical Center, so it appears these hospitals have been excluded from Anthem and CIGNA's networks.[14] The nature of these exclusions may be indcative of Anthem and CIGNA being able to make more credible threats not to include certain hospitals in their network; because they are such large national insurers, the potential impact on their total enrollment from not including one small New Hampshire hospital is likely very small. Additionally, they appear to best leverage this threat in the context of HRR markets rather than HSA markets, and seem to be especially willing to exclude small Critical Access Hospitals, which presumably attract a very minor portion of their enrollees.

While both CIGNA and Anthem have many similarities in terms of national presence and for-profit status compared to Harvard Pilgrim, the two have different approaches to health management as highlighted by their rejected merger in 2017. As David Dranove argued before the Department of Justice while the merger was being considered, CIGNA is a somewhat smaller national insurer that has focused on reducing costs through innovation like its Collaborative Accountable Care (CAC) arrangements with providers, but this results in often paying somewhat higher prices to providers to incentivize high quality and coordinated care, which may require additional investment on the providers' part. Anthem, on the other hand, tends to rely more heavily on its sheer size to negotiate low prices with providers and therefore generate savings for its enrollees (Dranove 2017). Thus, the different prices observed by Anthem and CIGNA

[14]All hospitals excluded by Anthem or CIGNA are CAHs except for Wentworth-Douglass and Frisbie Memorial, which are both located near each other in Southeastern New Hampshire.

in New Hampshire may not be so much a function of their relative market shares but also a matter of their different approaches to cost saving. This is not to say that each insurer's market share does not have any effect on negotiated prices, although I cannot say it does from my simple regression estimates, but merely suggests that there are many possible omitted variables from my analysis.

My secondary analyses in Tables 6 and 7 also provide some interesting results that suggest that hospitals also face some competition from non-hospital providers that can also provide the same services and that the prices for the uninsured are much more explained by the cost and quality variables I include in my regressions than the prices for the privately insured are. The magnitude of the relationship of price to the number of non-hospital providers in the market is somewhat smaller than the relationship when considering only hospitals, which may be due to the non-hospital providers being subsitutes but not perfect subsitutes for hospitals, even in the outpatient setting. For most of the analyses, the coefficients on the controls are statistically insignificant but in the provider analysis where provider prices are included, the coefficients on median household income and population density do become statistically significant although their directionality is somewhat odd especially given the results for the uninsured in Table 7. For the uninsured, price is statistically positively related to typical patient complexity and hospital quality, which suggests that higher quality hospitals or those more specialized in providing a particular service are able to charge higher prices for that service to the uninsured. In addition, higher median household incomes are associated with higher prices for the uninsured, which may reflect labor costs and real estate prices, and older populations and more dense populations are associated negatively with prices. This roughly means that hospitals that serve a higher number of Medicare patients generally charge somewhat lower prices to the uninsured. One possible explanation for this is that rather than cost-shifting,[15] hospitals that serve

[15]Cost-shifting is the idea that hospitals may charge private payers and individuals more to make

more Medicare patients may perhaps face incentives to provide more cost-efficient care as Medicare pays such low prices. Therefore, these hospitals are willing to charge uninsured payers less because their per-unit costs for providing each service are lower.

There are several key limitations of this analysis in addition to the few that have been mentioned above. Namely, the analysis is limited by the lack of granularity of the data. First, the insurers' market share is only available at the state-level and therefore it cannot be explored whether the market power of each insurer within each hospital's market affects negotiated prices. Next, the hospital's true market share is also unknown as I do not have volume data for each hospital for each service, and I also do not have data on the variation of this volume across different insurers. One hospital may serve many more Medicare patients or Anthem patients than another, but this cannot be accounted for in my analysis. Lastly, the availability of price data is very limited and somewhat aggregated. I restrict my analysis only to outpatient radiology services in order to plausibly control for cost and quality both within and across hospitals, but the results may not extend to other forms of hospital care.

VIII Conclusion

Despite the limitations of this analysis, the results as a whole suggest that private insurers and hospitals with greater market shares are able to negotiate more favorable prices for themselves but that market share may not be the sole source of market power in price negotiations. While greater market share for insurers would provide them with better bargaining leverage, this may have harmful affects on welfare through higher premiums. However, policies that could afford insurers greater bargaining power without affecting their market share could potentially be beneficial. For example,

up for financial losses on Medicare patients, but there is little evidence supporting that this does indeed occur.

Medicare Advantage plans are allowed to negotiate with hospitals on the basis of the statute that if an agreement on prices is not reached, the insurer of the Medicare Advantage plan simply pays the Medicare rate. This leads most Medicare Advantage payments to be 100-105% of the Medicare price (Berenson et al., 2015) as insurers are able to leverage this significant threat quite effectively. If the statutes that allow for this to take place for Medicare Advantage plans could be expanded to all private insurer plans, this could significantly increase the market power of insurers in the hospital price negotiation process without impacting their market power with consumers or employers, and therefore competitive pressures would continue to hold premiums low.

The other mechanism through which hospital prices may become more efficient is through increasing hospital competition or at least not reducing it. My analysis echoes what many prior studies have also found that hospitals with fewer competitors tend to charge higher prices. Thus, mergers that allow hospital systems to control greater market shares and therefore face less competition are potentially leading hospital prices in the wrong direction, and claims of cost reductions from consolidation should be treated with some skepticism.

This paper builds on a tremendous amount of prior research and still more research needs to be done to develop better models of the relationship between hospital and insurer market share and their interaction in the bargaining process.

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X Appendix A

The first table shows the unadjusted mean prices paid by each insurer for each procedure within the state of New Hampshire.

Table 8: Median Hospital Prices for Radiology Services by Payer

Procedure	Medicare	Anthem	HP	CIGNA	Uninsured
Myocardial Imaging	$519.79	$964.25	$901.76	$1,265.12	$1,552.74
MRI - Pelvis	$449.82	$1,028.85	$829.60	$1,192.77	$1,637.16
MRI - Brain	$398.48	$698.92	$940.34	$1,062.96	$1,635.29
CT - Abdomen/Pelvis, with contrast	$328.29	$621.93	$793.12	$889.18	$1,426.38
MRI - Knee	$250.57	$432.41	$528.89	$580.45	$868.77
MRI - Shoulder, Elbow, or Wrist	$250.57	$423.08	$504.70	$599.41	$839.07
MRI - Back	$236.78	$320.58	$496.77	$518.01	$787.87
CT - Chest	$206.77	$367.01	$347.67	$445.00	$638.77
Ultrasound - Pregnancy	$150.83	$212.14	$216.33	$231.85	$420.51
Mammogram	$145.25	$332.64	$228.78	$297.02	$447.79
Ultrasound - Abdominal, Complete	$129.73	$243.13	$237.92	$224.46	$396.58
Ultrasound - Transvaginal	$129.58	$252.27	$242.05	$259.17	$455.56
Ultrasound - Head and Neck	$123.82	$279.23	$251.90	$233.11	$364.83
Ultrasound - Pregnancy follow-up	$122.51	$245.01	$229.27	$286.99	$358.86
CT - Head/Brain, without dye	$121.75	$172.25	$179.80	$349.16	$520.52
Ultrasound - Pelvic	$116.79	$233.59	$177.72	$165.35	$379.81
Ultrasound - Abdominal, Limited	$97.05	$192.68	$188.77	$186.11	$259.92
Ultrasound - Breast	$93.11	$186.22	$174.41	$191.70	$309.61
Bone Density Scan	$44.38	$71.85	$86.91	$97.28	$144.69
X-Ray - Hip	$43.59	$73.27	$81.58	$84.38	$117.49
X-Ray - Neck	$41.25	$72.07	$74.16	$91.05	$164.77
X-Ray - Middle Back	$37.70	$65.03	$86.42	$90.66	$141.55
X-Ray - Knee	$37.65	$70.35	$68.89	$80.98	$109.38
X-Ray - Wrist	$36.92	$67.30	$69.78	$79.97	$115.90
X-Ray - Spine	$36.82	$66.81	$74.66	$81.08	$116.48
X-Ray - Abdomen	$34.80	$58.79	$72.07	$81.87	$119.60
X-Ray - Chest	$34.33	$53.37	$59.81	$64.93	$99.52
X-Ray - Hand	$33.53	$59.34	$65.58	$67.23	$104.37
X-Ray - Pelvis	$33.53	$128.59	$103.01	$133.78	$146.57
X-Ray - Ankle	$33.15	$60.17	$63.19	$66.89	$97.90
X-Ray - Foot	$30.90	$52.30	$60.65	$66.89	$100.91
X-Ray - Shoulder	$30.88	$54.59	$60.31	$73.02	$104.06
Urine Capacity Measurement	$16.93	$32.32	$28.91	$38.81	$61.80