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ABSTRACT

Specialty hospitals tend to negotiate higher commercial insurance payments, even for relatively routine procedures with comparable clinical quality across hospital types. How specialty hospitals can maintain such a price premium remains an open question. In this paper, we examine a potential (horizontal) differentiation effect in which patients perceive specialty hospitals as sufficiently distinct from other hospitals, so that specialty hospitals effectively compete in a separate market from general acute care hospitals. We estimate this effect in the context of routine pediatric procedures offered by both specialty children's hospitals as well as general acute care hospitals, and we find strong empirical evidence of a differentiation effect in which specialty children's hospitals appear largely immune to competitive forces from non-children's hospitals.

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A data appendix is available at http://www.nber.org/data-appendix/w30425
GitHub repository is available at https://github.com/imccart/ch-spillovers

1 Introduction

The growth of specialty hospitals in the U.S. has been a major concern to policy-makers, so much that the 2003 Medicare Modernization Act included a temporary federal moratorium on new physician-owned specialty hospitals (Government Accountability Office, 2003; Greenwald *et al.*, 2006). One concern that has not been fully assessed empirically is that specialty hospitals may negotiate higher payments from commercial insurers relative to their general acute care competitors (Raval *et al.*, 2022).[1] Such a price premium may be justified for highly specialized procedures for which speciality hospitals provide higher quality care or have few competitors; however, price differentials also persist for relatively routine procedures for which specialty and general acute care hospitals appear equivalent along many quality metrics. This begs the question — how do specialized hospitals negotiate higher commercial insurance payments even for relatively homogeneous and routine procedures?

We answer this question in the context of pediatric care at children's hospitals versus general acute care hospitals. We also focus on a set of standard procedures for which treatment and outcomes are largely homogeneous across different hospital types (e.g., routine appendectomy). Our analysis exploits compelling data on actual payments from private insurance firms to hospitals. Our data, maintained by the Health Care Cost Institute (HCCI), contain all hospital inpatient and outpatient claims to three national commercial insurers from 2010 to 2015. These unique data, also used by Cooper *et al.* (2019) to examine broad trends in hospital pricing from 2007 through 2011, capture the negotiated payment rates between hospitals and insurers, which may differ substantially from charge-based estimates of payments often used in the literature (Dafny, 2009; Dranove *et al.*, 2017). We also observe patient out-of-pocket spending, which provides a measure of price variation across choice sets that is often not available in the literature on hospital choice (Capps *et al.*, 2003; Gaynor & Town, 2012; Richards-Shubik *et al.*, 2021). In our setting of routine pediatric procedures, the modal U.S. family in our data has access to at least one stand-alone children's hospital or specialized children's unit in their market, along with several choices of general acute care hospitals with sufficient experience treating patients among the selected conditions.

Our analysis proceeds in two general steps. First, we provide descriptive statistics on the negotiated payments, quality, and market shares for a set of routine services provided by specialty children's hospitals (CH) relative to non-children's hospitals (NCH). We define CH as all hospitals with a designated children's unit within a larger hospital or a stand-alone structure, and we define NCH as a general acute care hospital without any physical space designated solely for pediatric care. With ad-

[1] In their comprehensive study of commercial insurance payment rates, Cooper *et al.* (2019) exclude specialty hospitals due to inherent differences between an average specialty hospital and a general acute care hospital.

justments for patient health, procedure, and location of service (inpatient or outpatient), we estimate an average price difference of $1,200 (around 20%) between CH and NCH. We also find no evidence that clinical quality is discernibly higher for CH relative to NCH. Despite higher prices and lack of clinical quality advantage, we observe meaningful increases in market shares of CH versus NCH over time, with CH capturing nearly 54% of the market in 2015 compared to 46% in 2010. Consistent with the observed pricing differences and increasing market share, we also estimate an *ex ante* willingness to pay (WTP) of around $2,500 per patient for CH compared to just under $1,000 for NCH, based on the WTP measure derived in Capps *et al.* (2003).

We then consider whether spillovers from specialization may explain the observed price differences. More specifically, we examine the presence of horizontal differentiation by which patients view CH to be sufficiently differentiated from NCH even for otherwise homogeneous products. Such a differentiation effect may be due to unobserved non-clinical factors such as a more kid-friendly environment or due to a *perceived* clinical quality advantage. We consider either case to be a spillover since they reflect a potential price premium conferred to routine procedures due to the hospital's specialty designation.

Since such horizontal differentiation is not directly observable, we consider indirect evidence based on how CH and NCH prices are affected by the entry of new hospitals or the expansion of existing hospitals into the pediatric space (e.g., the development of a designated pediatric unit within a general acute care hospital). This analysis exploits changes in within- versus across-segment competition. If, for example, the entry of a new CH has a large effect on other CH prices whereas entry of NCH has no such effect, then we can conclude that competition appears to be isolated within each market segment. This would be consistent with a differentiation effect, in which CH prices for routine procedures are buoyed by the hospital's specialty status rather than any discernible clinical quality differences. In the presence of such differentiation, CH are effectively immune to changes in competition from NCH.

Our identification strategy is that of a difference-in-differences (DD) design in which hospital entry or expansion acts as the treatment variable. Hospitals exposed to a new competitor in their market/service are the treated units. Our goal is to estimate the average treatment effect on the treated (ATT) with our preferred estimator being that proposed in Callaway & Sant'Anna (2021), which is robust to heterogeneity in the treatment effect across treated units and within treated units over time. We find strong empirical evidence of a differentiation effect on CH pricing, with entry of CH decreasing incumbent CH prices by 4.9% on average and with no meaningful effect on NCH prices. The entry of NCH has no meaningful effect on CH or NCH prices.

We also present two-way fixed effects and event study estimates in the supplemental appendix, as well as event study estimates based on the approach in Sun & Abraham (2021). Estimates from these alternative estimators are similar to those of our main results, although the parallel trends assumption is best satisfied with our preferred estimator. We also consider a variety of additional estimates to assess the sensitivity of our results. For example, our identification of an entry event is driven by observed claims in the data, and we consider increasing thresholds on the minimum count of claims in order to be treated as an entrant. As summarized in the supplemental appendix, our main results are not sensitive to these concerns.

Our analysis contributes to four related areas. First, we contribute to the empirical literature on multi-product firms and prices. This has been relatively well-studied in the marketing literature, where authors examine "umbrella branding" in which a subset of a firm's products may spur a broader brand loyalty that confers a price premium to the firms' other products (e.g., Erdem (1998), Anand & Shachar (2004), and Fazli & Shulman (2018)).[2] Garthwaite (2014) documents a similar demand spillover in the context of celebrity endorsements, where he finds that Oprah Winfrey's book club endorsements tend to increase not only the sales of the endorsed title but also the sales of non-endorsed titles by the same author. In our context, we view the Children's Hospital specialization as a form of umbrella branding that may create positive demand spillovers onto prices for other products. To our knowledge, we are the first to examine such spillovers in the health care setting and one of the few studies overall that attempts to quantify the magnitude of such a spillover.

Second, we contribute to the literature on hospital specialization, which is a growing area of concern among policy-makers and regulatory authorities given the high and increasing prices for U.S. hospital services. The central concern is that specialization may put general acute care hospitals at a financial disadvantage (Government Accountability Office, 2003). This may arise indirectly due to "cream-skimming," in which specialty centers work to attract only the most profitable patients for certain procedures, or increases in self-referrals, since many specialty centers are physician-owned.[3] A byproduct of such "cream-skimming" is that general hospitals may struggle to provide otherwise non-profitable services when exposed to additional competition from single-specialty hospitals. David *et al.* (2014) refer to this as "cross-subsidization," where the authors find evidence that entry of single-specialty hospitals tends to decrease offerings of otherwise non-profitable services from non-specialty hospitals.

[2]There is a large economics literature examining multi-product firms in the context of menu costs (e.g., Midrigan (2011), Alvarez & Lippi (2014), and Bhattarai & Schoenle (2014)). Luco & Marshall (2020) also consider multi-product firms in the context of vertical integration, where they find that vertical integration may eliminate double marginalization for one product and concurrently generate a positive spillover effect onto the prices of other products for the same firm.

[3]As per Government Accountability Office (2003), self-referrals to specialty hospitals that are jointly owned by the physician are often exempt from the Stark law. This falls under the "whole hospital" exemption, removed in 2010 for new hospitals, that exempts physicians and hospitals from the Stark law restrictions on self-referrals provided the physician owns some share of the entire hospital, rather than a subdivision such as an imaging or surgery center.

Our notion of pricing spillovers complements the idea of cross-subsidization in David *et al.* (2014). For example, David *et al.* (2014) examine spillovers in the context of services offered, while we consider spillovers in the context of pricing. Similarly, they exploit the fact that non-specialty hospitals may offer a wider range of services (some profitable and some unprofitable), while we exploit the fact that specialty hospitals also offer a wider range of services (some highly specialized and some more routine). Our contribution to this literature is to first document the large price differences among CH versus NCH, even among routine procedures with comparable clinical quality. To our knowledge, our focus on spillovers from specialization as a mechanism for the observed price differences is also novel.

Third, we contribute to the literature on hospital choice. This literature typically considers a patient's utility over hospitals as a function of distance to the hospital and quality, as well as other observable patient and hospital characteristics, in a conditional logit model (Kessler & McClellan, 2000; Romley & Goldman, 2011; Gaynor & Town, 2012). Gaynor & Vogt (2003) also include the insurer's negotiated price as part of the patient utility function. More recently, Baker *et al.* (2016) and Gaynor *et al.* (2016) consider the physician's role on a patient's hospital choice, either due to restrictions on the physicians referrals as in Gaynor *et al.* (2016) or due hospital ownership of a physician's practice as in Baker *et al.* (2016). We build on this literature by including the patient's predicted out-of-pocket costs in their utility function over hospitals, thereby incorporating not only the negotiated price between an insurer and a hospital (as in Gaynor & Vogt (2003)) but also the terms of the patient's insurance contract at a given point in the year. Our hospital choice model is therefore akin to that of Gowrisankaran *et al.* (2015). By including predicted out-of-pocket expenses, our willingness to pay estimates more directly reflect consumer utility rather than a combined insurer/patient utility.[4]

Finally, we contribute to the literature on hospital pricing, much of which examines the effects of horizontal or vertical integration on hospital prices (Lin *et al.*, 2021; Schmitt, 2018; Lewis & Pflum, 2017; Dafny, 2009; Capps *et al.*, 2003; Gaynor & Vogt, 2003). We are one of the first studies to quantify price differentials between specialty versus non-specialty hospitals among overlapping products. We are also able to identify specific mechanisms underlying such a price premium.

[4] As Gaynor & Town (2012) note, the exclusion of price from patient utility, and therefore the assumption that out-of-pocket costs do not vary across hospitals, is "primarily for expositional ease....The advantage of allowing prices to enter patient utility is that recovering the utility parameter on price allows for the monetization of the patient's surplus from a given hospital network."

2 Children's Hospitals

Children in the U.S. receive acute inpatient care in one of three settings: freestanding CH, children's units nested within adult hospitals, or general hospitals that care for adults and children (Philipps & Trask, 2006). Freestanding CH are those that exclusively care for pediatric populations (typically children ages 0-18 years), are located in a separate facility from adults, and provide clinical and programmatic services dedicated to pediatric care (Philipps & Trask, 2006). Children's units within adult hospitals offer similarly dedicated services but within a larger hospital structure. We refer to both freestanding pediatric structures and hospitals with designated pediatric units as CH (Piper *et al.*, 2020; Raval *et al.*, 2022).[5] For all other hospitals in our analysis, pediatric care is delivered in a non-designated space used to treat a broader patient population. We classify all such hospitals as NCH.[6]

Among hospitals offering pediatric care, CH account for a disproportionate share of spending. For example, freestanding CH comprise less than 5% of all hospitals in the U.S., yet they account for 40% of pediatric inpatient days and 50% of costs for pediatric care.[7] In 2009 alone, 40 freestanding CH accounted for greater than $10 billion in U.S. health care expenditures.[8]

Disproportionate spending to CH derives from at least two factors. First, CH provide heavily specialized care to children who require highly trained providers and innovative technologies. One such example is surgery for congenital heart disease where mortality rates are lowest at high volume, specialized centers such as CH (Allen *et al.*, 2003; Chang & Klitzner, 2002). This type of care is inherently more expensive but largely justified by improved outcomes and quality relative to NCH (Porter, 2010; Raval *et al.*, 2010). Second, patients increasingly rely on CH even for relatively common procedures for which NCH are strong substitutes (Lorch *et al.*, 2010; Goldin *et al.*, 2014; Oldham, 2014; Salazar *et al.*, 2016; McAteer *et al.*, 2014; Cosper *et al.*, 2006). Yet even for such routine procedures, payments to CH remain much higher while quality is comparable to that of NCH (Raval *et al.*, 2010; Tian *et al.*, 2015; Raval *et al.*, 2022). These payment and quality comparisons also play out in our data, as summarized in Section 3. The goal of this paper is to understand how such a price premium exists in the absence of any clear clinical quality improvement.

[5]There are relatively few freestanding CH in the data, with almost no variation in freestanding CH over time. We therefore cannot provide an analysis specifically for freestanding CH compared to other hospital types. We instead argue that a designated pediatric wing is sufficiently equivalent to a freestanding CH from a patient's perspective, particularly for routine procedures considered in our analysis.

[6]Additional details on our classification of CH and NCH are provided in Piper *et al.* (2020). Based on the description in Piper *et al.* (2020), we define CH as all Tier A and Tier B hospitals (i.e., standalone Children's Hospitals as well as hospitals with a designated pediatric unit), and NCH reflects Tier C and Tier D hospitals (i.e., general acute care hospitals that treat pediatric patients but not in a designated pediatric structure or unit).

[7]*All Children Need Children's Hospitals*, National Association of Children's Hospitals and Related Institutions, 2007 Policy Brief. https://www.upstate.edu/gch/pdf/academics/allchildren.pdf.

[8]Kaiser Health News, *Growing Size And Wealth Of Children's Hospitals Fueling Questions About Spending*, 2011.

3 Data and Descriptive Statistics

Our primary data come from the Health Care Cost Institute (HCCI). The HCCI database consists of claims for over 10 million insured individuals with employer sponsored insurance each year.[9] We focus specifically on the pediatric population, where the HCCI data purportedly cover roughly 25% of all claims for privately insured children in the U.S.[10] After excluding newborns, our HCCI data consist of just over 112,000 unique inpatient stays and 2.4 million unique outpatient visits from 2010 through 2015.[11] To these data, we merge hospital-level characteristics such as bed count, for-profit status, and system membership from the American Hospital Association (AHA) annual surveys; data on a hospital's payer mix (i.e., the number and share of Medicare, Medicaid, or private insurance patients) from the Healthcare Cost Report Information System (HCRIS); and county-level demographic characteristics from the American Community Survey (ACS).

We restrict our sample to 13 common pediatric procedures, including routine appendectomies, tonsilectomies, and umbilical hernias. Table 1 presents the full list of procedures as well as summary statistics for negotiated payment rates and patient characteristics for each procedure.[12] We treat visits involving multiple procedures separately, indicated as "2+ procedures" in Table 1. Our final sample consists of around 32,000 inpatient stays and 337,000 outpatient visits. These visits are to 3,231 unique facilities (2,334 inpatient facilities and 3,119 unique outpatient facilities). For ease of exposition, we refer to all such facilities as "hospitals" throughout.

We list procedures in Table 1 in descending order based on the count of procedures observed. The most common procedures by far are tonsillectomy and tympanostomy (ear tubes), collectively accounting for over half of all observed procedures. We also see from Table 1 that the mean negotiated price for our selected procedures is around $5,400, with much higher negotiated rates for spine and esophageal (anti-reflux) surgery. Not surprisingly, procedures in these two areas are provided almost exclusively in an inpatient setting over our time period, and the patients receiving these surgeries overwhelmingly have one or more pediatric complex chronic conditions (CCC).[13] Anti-reflux surgery is also associated with a high readmission rate of 18%, whereas readmission rates for all other procedures are below 7.5% and often closer to 1%. Spine and anti-reflux surgery also have the

[9]Given recent changes in HCCI contributors and processes, there now exist two versions of the HCCI database available to researchers. Our analysis uses "HCCI version 1," which was the only version available as of the time we gained access to the data.

[10]*Children's Health Spending: 2010-2014*, Health Care Cost Institute, 2016. https://healthcostinstitute.org/.

[11]Since we rely in-part on AHA data to identify CH versus NCH status, we limit all outpatient visits to facilities that share an NPI with another inpatient facility. This excludes, for example, stand-alone surgery centers that have their own NPI; however, outpatient surgery centers attached to inpatient hospitals are generally captured in our data.

[12]Individual CPT and ICD-9 codes used to identify the relevant procedures in the data are provided in the supplemental appendix.

[13]See Feudtner *et al.* (2001) for additional discussion of pediatric CCC. This is the pediatric equivalent to common comorbidity indices in the adult population, such as the Charlson Comorbidity Index.

highest complication rates of 5% and 2%, respectively, compared to an overall complication rate of 0.4%, where a "complication" is defined as any instance of wound infection, surgical site infection, urinary tract infection, kidney failure, pneumonia, respiratory failure, sepsis, deep vein thrombosis, acute myocardial infarction, cerebrovascular infarction, hemorrhage or hematoma, or general complications not otherwise classified within 90 days of the procedure.[14]

Figure 1 presents the count of hospitals by CH and NCH in our data over time, limited to hospitals with at least 5 patients among our selected procedures in a year. Interestingly, we see an initial increase in the number of NCH, from 783 in 2010 to 960 in 2012, with a large decrease to 774 hospitals in 2015. Conversely, the number of CHs in our data increased, up from 179 in 2010 to 212 in 2015. In total, we observe 1,324 hospital-year observations for CH and 10,712 hospital-year observations for NCH.

3.1 Market Definition

Our identification strategy relies on entry and expansion of CH and NCH over time, which necessarily requires a construction of geographic markets. We construct hospital markets based on observed patient flows using community detection methods. As shown in Everson *et al.* (2019), such methods provide more reasonable measures of hospital markets than the commonly used Hospital Referral Regions (HRRs) or Hospital Service Areas (HSAs). Constructing our own markets is particularly important in our pediatric setting given that HSAs and HRRs derive from claims for Medicare beneficiaries.

Our pediatric market construction proceeds in essentially two steps. First, we collect the set of all county FIPS codes and hospitals. From this comes an adjacency matrix that captures the set of county FIPS codes and the different hospitals selected from patients in those FIPS codes.[15] Second, we employ the cluster walktrap algorithm to identify mutually exclusive sets of county codes, where each set defines a specific hospital market (Pons & Latapy, 2005).

The community detection algorithm yields 363 distinct hospital markets for pediatric care in our data, similar to the market construction in Everson *et al.* (2019). The median market includes 275 unique zip codes and accounts for 159 procedures in our data. Figure 2 presents information on the average market share of CH versus NCH over time, as well as market shares for selected markets with large changes in CH shares. From Figure 2, we see that CH maintained an average market share of 46% among our selected procedures in 2010, increasing to 54% by 2015. In markets with the largest

[14] ICD-9 diagnosis codes to identify each individual complication are listed in the supplemental appendix.

[15] In order to focus on counties with sufficient numbers of patients going to each hospital, we require that at least 10% of a hospital's procedures must come from patients in that county in order to qualify as a "connection" between a given hospital and county.

shift to CH, we see CH with just 25% market share in 2010 increasing to nearly 70% by 2015.

3.2 Hospital Prices and Quality

Although it is commonly understood that CH command a substantial price premium relative to NCH among commercial insurers (Raval *et al.*, 2022), this has not been well-documented among routine procedures in a large-scale empirical setting. In this section, we therefore briefly compare and discuss price and quality differences among CH versus NCH.

Table 3 presents procedure-level summary statistics for prices and quality, separately by CH and NCH. Mean commercial insurance payments among the set of routine procedures of interest are just over $6,200 for CH and around $4,800 for NCH. Table 3 also suggests comparable quality outcomes for CH and NCH, with mean complication rates of 0.4% for CH and 0.3% for NCH, as well as mean readmission rates of 1.7% for CH and 1.1% for NCH. Finally, we see from hospital-level summaries in Table 2 that CH are generally much larger than NCH, reflective of CH associations with academic medical centers (53% of CH are teaching hospitals compared to only 6% of NCH). Specifically among our HCCI claims data, CH account for about 141 patients per year while NCH account for less than 13 patients per year. Note, however, that because the total number of NCH far exceed that of CH across the U.S., the total number of procedures in our data are nearly equally split between the two hospital types.

While mean prices and quality outcomes are informative, CH also tend to attract less healthy patients relative to NCH. For example, the share of patients with at least one pediatric complex condition is 6% for CH compared to 1.7% for NCH. Similarly, patients going to CH are more likely to receive treatment in an inpatient setting, with 10.1% of all procedures being in an inpatient setting for CH compared to 7.1% for NCH. For a more appropriate comparison, we estimated by ordinary least squares (OLS) the following regression equation:

$$y_{it} = \beta x_{it} + \gamma z_{ht} + \lambda w_{mt} + \delta \text{CH}_i + \theta_g + \theta_t + \epsilon_{it}, \tag{1}$$

where y_{it} denotes the outcome (log price, 90-day readmission, or 90-day complication) for patient i in year/month t;[16] x_{it} denotes patient and procedure characteristics including an indicator for the procedure, an indicator for whether the patient has any CCC, an indicator for the procedure taking place in an inpatient setting, and an indicator for whether the patient is female; z_{ht} denotes hospital characteristics including bed size, number of nurse, physician, resident, and other FTEs, total hospital discharges, total hospital Medicare discharges, and total hospital Medicaid discharges; w_{mt} denotes

[16] Embedded in the i subscript is the patient's insurance product g, hospital h, and market m.

market-level variables including percentage of residents of different age categories, race, income, and education; CH denotes an indicator for whether the hospital is a children's hospital (either a free-standing structure or a designated pediatric wing of an otherwise general acute care hospital); θ_g and θ_t capture fixed effects for the patient's insurance product (the insurance group ID) and year/month fixed effects; and ϵ_{it} is an error term.

Figure 3 presents the estimated coefficient and 95% confidence interval for $\hat{\delta}$. We present these results overall and separately when estimating the regression only for inpatient or outpatient procedures. From Figure 3, we find point estimates reflecting between 12% and 27% higher prices among CH relative to NCH after adjusting for observable patient, hospital, and market characteristics, as well as adjusting for insurer and year fixed effects.[17] Conversely, we see no evidence of quality improvement among CH relative to NCH. Our estimates for inpatient readmissions and complications are noisy due to few instances of such events in our data, and as such, we cannot definitively rule out higher or lower quality inpatient care among CH relative to NCH. However, following outpatient procedures, we estimate economically meaningful and statistically significantly higher readmission rates for CH relative to NCH. This could be due to unexpected readmissions following a given procedure, which would arguably reflect lower quality, but it could also be due to additional procedures (arranged as separate outpatient/inpatient visits) at CH relative to NCH.

3.3 Willingness to Pay

Among our set of common and relatively homogeneous pediatric procedures, the results from Section 3.2 demonstrate higher prices among CH with no discernable improvement in clinical quality, even after adjusting for observable patient, hospital, and market factors. Combined with the observed trends in market share among CH relative to NCH, it appears that patients are simply willing to pay more for CH services compared to NCH. To quantify this willingness to pay (WTP), we follow Capps *et al.* (2003) in estimating the average *ex ante* WTP among patients for CH and NCH.

Denote the *ex post* expected utility for patient i, procedure j, and hospital h as

$$u_{ih(j)t} = \beta x_{iht} - \gamma p_{ih(j)t} + \epsilon_{iht}, \tag{2}$$

where x_{iht} includes hospital characteristics (bed size, system, teaching, and for-profit status), patient differential distance, and patient characteristics (interactions with gender and comorbidities index), and $p_{ih(j)t}$ denotes predicted out-of-pocket costs for patient i undergoing procedure j at hospital h during year t. We form these predicted out-of-pocket costs in two steps. First, we predict the negoti-

[17]We cannot adjust for hospital fixed effects since CH and NCH status is predominantly time-invariant.

ated price based on a linear regression of observed prices (allowed amounts) on patient characteristics and surgery indicators. Second, we apply the patient's observed cost sharing (as a percentage) to the predicted price under the assumption that the patient would incur the same co-insurance at any hospital in their choice set. This approach is relatively unique among the hospital WTP literature because, unlike most estimates, we directly observe patient cost-sharing and negotiated payment amounts in the data.

Denoting by $H_{i(j)t}$ the set of all hospitals in patient i's choice set (relevant for procedure j), patient i then selects hospital h for procedure j if, for all $k \neq h, (k,h) \in H_i$,

$$u_{ih(j)t} - u_{ik(j)t} > \epsilon_{iht} - \epsilon_{ikt}.$$

Assuming ϵ_{iht} and ϵ_{ikt} are independently and identically distributed with a Type 1 extreme value distribution yields the standard multinomial logit model with the probability of selecting hospital h given by

$$s_{ih(j)t} = \frac{\exp(u_{ih(j)t})}{\sum_{k \in H_{i(j)t}} \exp(u_{ik(j)t})}. \tag{3}$$

The choice sets, $H_{i(j)t}\ \forall i$, consist of all hospitals in patient i's geographic market that had at least five other pediatric patients undergoing procedure j in the same year t. Since some geographic markets are relatively large, we also exclude from each patient's choice set any hospital beyond 100 miles from the patient's residence (based on zip code centroids). As is standard in the hospital choice literature, we also assume that there exists no outside option so that patients must select one hospital from their choice set.

Following Capps *et al.* (2003), the *interim* expected utility for having access to the set of hospitals $H_{i(j)t}$ is

$$\begin{aligned} V_{it} &= \mathrm{E}\left\{ \max_{k \in H_{i(j)t}} \left[u\left(x_{iht}, p_{ih(j)t}\right) + \epsilon_{iht} \right] \right\} \\ &= \ln \left[\sum_{k \in H_{i(j)t}} \exp\left(u_{ik(j)t}\right) \right]. \end{aligned}$$

The gain in expected utility from hospital h being in the patient's network is then $\triangle V_{iht} = V_{it}(h) - V_{it}(h, -k)$, and the willingness to pay for hospital h to be in network is $\triangle W_{iht} = \frac{\triangle V_{iht}}{\hat{\gamma}}$. We then sum $\triangle W_{iht}$ across i for each h and year t, and we average by hospital type (CH and NCH). Intuitively, *ex ante* WTP is therefore a combination of each patient's expected maximum utility and the probabilities of requiring procedure j in the data.

The estimated *ex post* WTP value over time for CH and NCH types are presented in Figure 4, with

95% confidence intervals calculated using the bias-corrected percentile bootstrap (DiCiccio & Efron, 1996; Gatta *et al.*, 2015). Overall, we estimate an *ex post* WTP of around \$2,300 per person for CH (95% CI $[2,060, 2,600]$) compared to a WTP of \$870 per person for NCH (95% CI $[786, 979]$). As seen from Figure 4, this WTP differential is persistent over time. These results are also consistent with national trends discussed in Section 2 and our analysis is Section 3.2; however, these results do not explain *why* individuals are willing to pay so much more for access to a CH compared to an NCH. We turn to this question in the following sections.

4 Specialization and Differentiation

4.1 Identification and Estimation

Our identification strategy is to exploit entry or expansion of hospitals into pediatric care. For now, we simply refer to these events as "treatment," and we estimate the effects of treatment using a difference-in-differences (DD) design. We denote by $p_{i(jh)t}$ the negotiated payment relevant for patient i (receiving procedure j at hospital h) at year t. Adopting the standard potential outcomes notation (Rubin, 1974), we denote the (unobserved) negotiated payments for a patient exposed to treatment by $p^1_{i(jh)t}$, and we similarly denote the (unobserved) negotiated payments for the same patient not exposed to treatment by $p^0_{i(jh)t}$. Our goal is to estimate the average treatment effect on the treated (ATT),

$$ATT_\tau = \mathrm{E}[p^1_{i(jh)\tau} - p^0_{i(jh)\tau} | \text{Treated}, t = \tau],$$

where τ reflects each time period relative to treatment.

Our preferred approach is to estimate the ATT with a two-step process. First, we residualize our outcome based on the preliminary regression equation:

$$p_{it} = \beta_x x_{it} + \beta_z z_{ht} + \beta_w w_{jt} + \beta_g g_{mt} + \gamma_j + \gamma_h + \gamma_t + \varepsilon_{it}, \tag{4}$$

where p_{it} denotes the log negotiated payment (again with i also nesting procedure j, hospital h, and market m); x_{it} is a vector of patient characteristics such as the presence of childhood comorbidities and patient gender; z_{ht} denotes a vector of hospital characteristics including bed size, nurse and physician staffing levels, and total discharges by type of payer; w_{jt} denotes an indicator for whether procedure j was performed in an inpatient or outpatient setting; g_{mt} captures market-level variables including percentage of residents of different age categories, race, income, and education; γ_j, γ_h, and γ_t denote procedure, hospital, and year/month fixed effects, respectively; and ε_{it} is the error term.

We estimate Equation (4) using OLS, take the prediction $\hat{p}_{it}$, and form the residual, $\tilde{p}_{it} = p_{it} - \hat{p}_{it}$. Second, using the residualized outcome, $\tilde{p}_{it}$, we estimate the ATT using the estimator proposed in Callaway & Sant'Anna (2021). We treat the data as cross-sectional at the patient level, since we do not generally observe multiple procedures over time for the same patient.

This two-step process is our preferred estimation strategy as it accommodates an adjustment for a rich set of time-varying covariates; however, there remain several alternative estimators and specifications to consider, including standard event studies with two-way fixed effects or other recent estimators such as that proposed in Sun & Abraham (2021). As a sensitivity analysis, we therefore present results from these alternative estimators in the supplemental appendix. All such estimators tend to support the main findings, although the parallel trends assumption best holds under our preferred estimation strategy using Callaway & Sant'Anna (2021). We also present similar results from a simplified specification in which Equation 4 only includes fixed effects for procedure, hospital, time, and inpatient/outpatient setting, thereby avoiding any concerns from conditioning on time-varying covariates that may also be affected by treatment.

4.2 Market Entry and Expansion

We identify demand spillovers by exploiting the entry or expansion of different hospital types over time. This could derive from several different underlying events, such as the formation of an entirely new hospital or hospital system, expansion of new pediatric units among existing hospital structures, recent inclusion in an insurer's provider network (for insurers that contribute to the HCCI claims data), or in the case of NCH entry, an expansion into one or more of the common pediatric procedures considered in this paper. In all cases, a treated hospital is one that has been exposed to the emergence of a new hospital into the relevant payment negotiations for the set of procedures in question. Throughout the remainder of the paper, we refer to all such events simply as "entry" for brevity.

Treatment status inherently depends on the number of claims that we assume capture entry in the data. For example, if a hospital did not admit any pediatric patients in year t and admitted some positive number of pediatric patients for at least one of our procedures of interest in year $t + 1$, this would appear as an entry event in our baseline construction. In the appendix, we impose increasingly high thresholds for determining a new competitor in the data (i.e., hospitals with 0 routine pediatric procedures in year t and at least 5 or 10 routine pediatric procedures observed in year $t + 1$, respectively). Results based on these different thresholds reveal slightly larger point estimates but are nonetheless qualitatively similar.

Figures 5 and 6 present the baseline entry events for CH and NCH in our data, respectively. To aid in visualization, we limit these figures to markets with at least 50 observed procedures in each year. Each row in the figures reflects a market and each column reflects a year. The shaded markets in Figure 5 depict markets in which a new CH emerged in the data (i.e., the treated group), and similarly for NCH in Figure 6. We highlight two important points from these figures: 1) the figures reveal the staggered nature of treatment in our data, with different markets affected by entry at different times; and 2) a large number of markets are affected by CH and NCH entry at some point in our panel. This second point also helps to alleviate concerns regarding endogeneity of entry in our context. Entry events are relatively minor in our setting, typically reflecting a slight realignment of hospital services into pediatric care rather than an entirely new structure.

For estimation, the treatment indicator is set to one in the first period for which entry is observed and in all future periods. We therefore do not distinguish between markets exposed to entry in time t versus those exposed to entry at time t and again at time $t+1$ — in both cases, the treatment indicator takes its value at time t. Our control group in this analysis is any procedure not yet exposed to entry as of time t.

4.3 Results

In the current context, we have four ATTs in mind, one for each type of hospital exposed to the entry of each hospital type. For example, we aim to estimate the ATT for CH when exposed to entry of another CH and, separately, when exposed to entry of NCH. We similarly aim to estimate the ATT for NCH when exposed to entry of another NCH and, separately, when exposed to entry of CH. The estimands of interest are reflected more formally in Equations (5) - (8), where τ again reflects each time period relative to treatment.

$$ATT^{\text{CH}}_{\text{CH},\tau} = \text{E}[p^{\text{CH}_1}_{i(jh)\tau} - p^{\text{CH}_0}_{i(jh)\tau} | \text{CH Entry}, \quad h = \text{CH}, \quad t = \tau] \tag{5}$$

$$ATT^{\text{NCH}}_{\text{CH},\tau} = \text{E}[p^{\text{NCH}_1}_{i(jh)\tau} - p^{\text{NCH}_0}_{i(jh)\tau} | \text{NCH Entry}, h = \text{CH}, \quad t = \tau] \tag{6}$$

$$ATT^{\text{CH}}_{\text{NCH},\tau} = \text{E}[p^{\text{CH}_1}_{i(jh)\tau} - p^{\text{CH}_0}_{i(jh)\tau} | \text{CH Entry}, \quad h = \text{NCH}, t = \tau] \tag{7}$$

$$ATT^{\text{NCH}}_{\text{NCH},\tau} = \text{E}[p^{\text{NCH}_1}_{i(jh)\tau} - p^{\text{NCH}_0}_{i(jh)\tau} | \text{NCH Entry}, h = \text{NCH}, t = \tau] \tag{8}$$

The central estimands of interest are the "same-type" effects, $ATT^{\text{CH}}_{\text{CH}}$ and $ATT^{\text{NCH}}_{\text{NCH}}$. The "other-type" events serve as something of a falsification test to the hypothesis that specialization confers some form of demand spillover. If such a spillover does not exist, then we should estimate similar effects from same or other-type events. Results based on our preferred estimator are presented in Figures 7 and 8. In both figures, we present effects for all hospitals and separately for CH and NCH.

We also present the 95% confidence interval for the overall ATT (not specific to a given time period) in the upper-right portion of each figure.

With regard to CH entry in Figure 7, we estimate relatively large price reductions for CH, with an overall 95% confidence interval of between a 3.0% to 6.8% reduction. As would be expected given the timing of contract negotiations, these effects begin to arise 2 and 3 periods after an entry event. More importantly, we see from Figure 7 that the effects of CH entry are isolated almost entirely on prices of CH. While we do find a negative and statistically significant overall point estimate on prices for NCH, these effects are much smaller than those for CH, with insignificant and economically small effects in any given period.

Turning to NCH entry in Figure 8, we still estimate a statistically significant reduction in prices for CH when exposed to entry from NCH, but the point estimates are smaller in magnitude and insignificant in all but one time period. Conversely, we find insignificant and essentially null effects of NCH entry on prices for other NCH. This is consistent with the fact that the pediatric population, by construction, constitutes a small segment of patients at NCH. A marginal increase in competition among such procedures therefore has little effect on negotiated payments among NCH.

Collectively, we interpret these results as strongly supporting the presence of a demand spillover. Hospitals that are relatively more focused on pediatric care are significantly affected by the presence of a new competitor in that space. This effect is particularly pronounced when the new competitor is also focused on the pediatric population (e.g., the effect of CH entry on CH prices in Figure 7). Conversely, prices for pediatric procedures at NCH are generally unaffected by entry of other hospitals, which makes sense given the relatively infrequent occurrence of such procedures among an average NCH.

5 Discussion

Specialty hospitals have been and continue to be of interest to policy makers for several reasons. These concerns were originally laid out by the Government Accountability Office (GAO) in their 2003 report on the prevalence and effects of specialty hospitals (Government Accountability Office, 2003). The GAO, the Department of Health and Human Services (HHS), and the Medicare Payment Advisory Commissioned (MedPAC) subsequently issued five reports or testimonies to Congress regarding the role of specialty hospitals in U.S. health care. The primary concerns listed in these reports include (Government Accountability Office, 2003; Greenwald *et al.*, 2006): 1) "cream-skimming" of profitable patients, for which there is some empirical evidence; 2) self-referrals driven by financial incentives of physician-ownership, which has been found to be a relatively minor concern, if at all;

and 3) foreclosure of general hospitals, which has not been supported empirically.

In this paper, we first examine whether specialty hospitals negotiate higher prices even for routine procedures for which they face some level of competition. While other studies have *not* found evidence of improved financial performance for specialty hospitals based on Medicare data (Greenwald *et al.*, 2006), more recent literature also highlights that findings from Medicare claims may not extend to the commercial insurance market, particularly with regard to prices and profitability (Cooper *et al.*, 2019). Therefore, our analysis first establishes this key empirical fact — CH negotiate significantly higher commercial insurance payments compared to NCH for otherwise routine procedures offered by both hospital types.[18] These payment differences arise without any clear clinical quality improvement for CH relative to NCH among the routine procedures studied.

The question is then, how do CH negotiate higher commercial insurance payments for these procedures? We investigate a differentiation effect, whereby CH specialization confers a higher willingness-to-pay among patients either due to perceived quality differences or due to improved services in other, non-clinical dimensions such as amenities, a kid-friendly atmosphere, etc. We find relatively strong evidence that a differentiation effect exists, and we conclude that the price premium enjoyed by CH, even for routine procedures, arises because CH have sufficiently differentiated themselves so that they are largely immune from competitive pressures of NCH that also provide routine pediatric procedures. While our setting and empirical analysis is in the context of CH versus NCH, we suspect that these mechanisms also play a role in other specialty hospitals, provided there is a set of routine procedures offered by both the specialty hospital and nearby non-specialty hospitals. This is the case, for example, with many orthopedic and cardiac procedures.

We conclude with two general policy implications. First, our results highlight the need for granular (i.e., procedure-specific), actionable, and transparent quality information, from which patients and their physicians can make informed choices of hospitals for a given procedure. Such information may allow for patients to maintain access to highly specialized procedures for which specialty hospitals are the dominant choice, while also better facilitating informed choices for more routine procedures. Second, the strong presence of differentiation between CH and NCH suggests that specialty hospitals are able to absolve themselves somewhat from the competitive pressures of other non-specialty hospitals. Policies to encourage competition should therefore take into account the potential for hospitals to ease competitive pressure via a set of specialty hospitals that may collectively offer the same procedures as a general acute care hospital but at higher negotiated rates.

[18]This idea has been examined in the medical literature (Raval *et al.*, 2022) and appears to be somewhat common knowledge in the industry.

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Tables and Figures

Table 1: **Summary Statistics for Selected Procedures**[a]

Surgery	Mean Price	St. Dev. Price	Readmission	Complication	Inpatient	Female	CCC	Count
Tonsillectomy	4,851	3,529	0.012	0.001	0.022	0.500	0.020	104,163
Ear Tubes	3,514	3,077	0.011	0.000	0.012	0.408	0.033	99,254
2+ procedures	5,566	3,638	0.011	0.001	0.019	0.356	0.019	45,565
Appendectomy	12,473	8,378	0.033	0.026	0.510	0.408	0.031	35,471
Circumcision	4,544	5,303	0.015	0.001	0.049	0.008	0.041	16,666
Inguinal Hernia	6,011	3,791	0.010	n/a	0.001	0.187	0.022	16,273
Broken Arm	6,791	6,499	0.013	0.001	0.182	0.456	0.015	14,719
Strabismus	5,585	3,154	0.010	n/a	0.002	0.489	0.063	13,615
Umbilical Hernia	5,284	3,891	0.008	n/a	0.023	0.505	0.041	8,241
Orchiopexy	6,618	4,740	0.009	n/a	0.039	0.002	0.043	7,831
Spine	17,891	12,609	0.050	0.050	n/a	0.704	n/a	4,384
Anti-Reflux	12,413	9,920	0.183	0.022	0.855	0.490	0.745	876
Knee Arthroscopy	9,640	7,606	0.025	n/a	0.125	0.438	0.041	736
Gallbladder Removal	9,848	6,158	0.075	n/a	0.242	0.754	0.085	426
All	5,691	5,433	0.014	0.004	0.086	0.402	0.041	368,220

[a] Statistics based on inpatient and outpatient procedures for both CH and NCH. ICD-9 codes to identify each procedure are listed in the supplemental appendix. "n/a" reflects cell sizes of 10 or fewer patients, and "2+ procedures" denotes patients with more than one of the selected procedures in the same visit. Complication and readmission rates are defined for a 90-day period after the inpatient or outpatient visit.

Table 2: **Summary Statistics by Hospital Type**[a]

	Children's Hospitals					Non-Childen's Hospitals				
Variable	Mean	St. Dev.	10th Pctl	90th Pctl	Count	Mean	St. Dev.	10th Pctl	90th Pctl	Count
Bed Size	5.80	3.33	2.50	9.43	1,324	2.15	1.72	0.43	4.31	10,712
Nonprofit	0.77	0.42	0.00	1.00	1,324	0.73	0.44	0.00	1.00	10,712
Teaching Status	0.53	0.50	0.00	1.00	1,324	0.06	0.23	0.00	0.00	10,712
System Status	0.63	0.48	0.00	1.00	1,324	0.67	0.47	0.00	1.00	10,712
Nurse FTEs	1,370.80	840.01	530.20	2,393.80	1,324	393.81	386.89	79.00	818.00	10,712
Physician FTEs	149.08	292.23	0.00	407.00	1,324	27.40	93.50	0.00	63.00	10,712
Total Discharges	27,129.08	16,506.72	10,378.50	45,410.20	1,324	9,788.46	8,674.51	1,412.20	20,672.10	10,712
Medicare Discharges	6,739.01	5,400.95	58.00	12,704.70	1,324	3,311.90	2,799.23	529.00	6,968.60	10,712
Medicaid Discharges	4,636.37	3,628.39	945.00	9,603.00	1,324	1,217.61	1,567.17	86.00	2,937.00	10,712
HCCI Patients	141.33	265.38	5.00	331.70	1,324	12.44	21.64	1.00	31.00	10,712

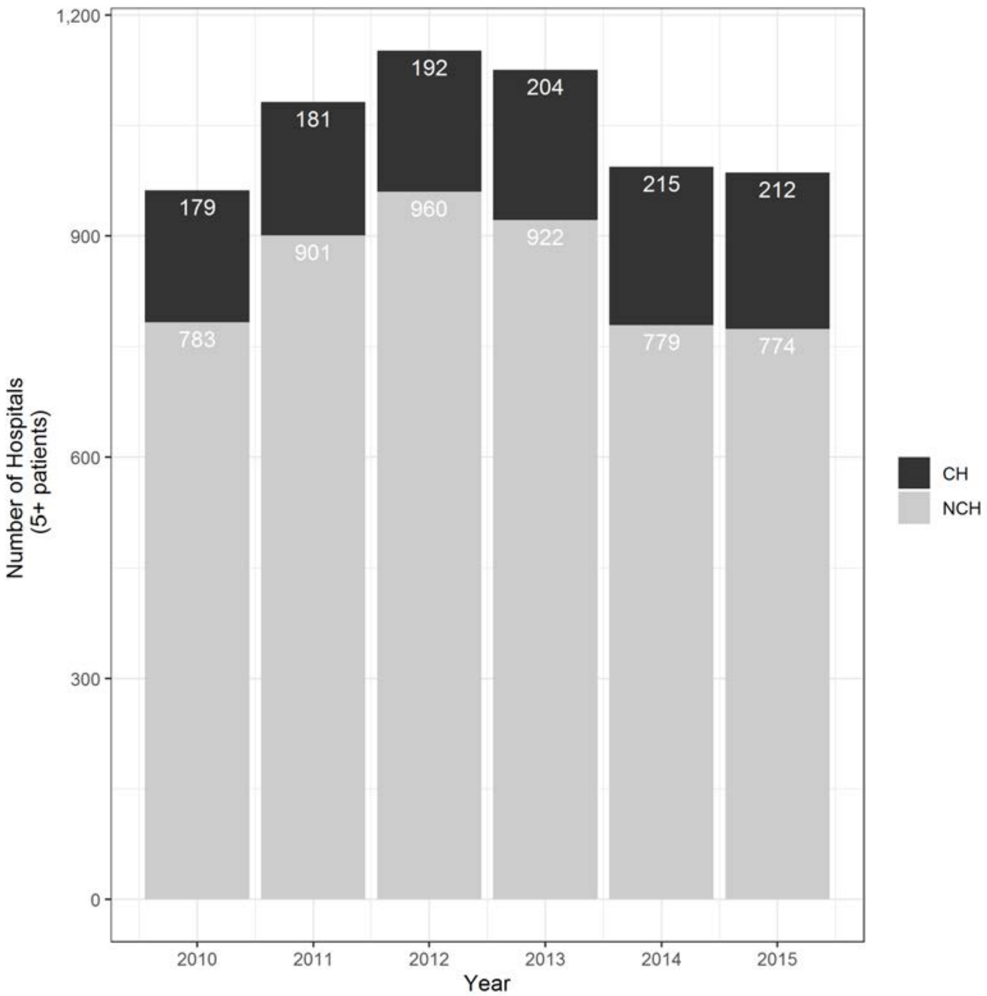
[a] Mean, standard deviation, and percentiles for selected hospital variables. All statistics are based on hospital-year level observations (e.g., HCCI patients is the number of patients per year, per hospital).

Table 3: **Summary Statistics for Selected Procedures by Hospital Type**[a]

Surgery	Mean Price	St. Dev. Price	Readmission	Complication	Inpatient	Female	CCC	Count
Children's Hospitals								
Ear Tubes	3,899	3,654	0.014	0.000	0.020	0.407	0.052	48,722
Tonsillectomy	5,474	3,920	0.016	0.001	0.035	0.476	0.034	46,942
2+ procedures	5,943	3,601	0.014	0.001	0.026	0.327	0.028	23,653
Appendectomy	14,033	9,333	0.037	0.027	0.558	0.409	0.039	17,209
Inguinal Hernia	6,027	3,671	0.011	n/a	0.001	0.191	0.026	11,764
Circumcision	4,942	5,607	0.016	0.002	0.039	0.004	0.050	10,721
Strabismus	5,808	3,062	0.013	n/a	0.002	0.486	0.074	9,571
Broken Arm	7,408	6,256	0.011	n/a	0.200	0.468	0.017	9,229
Umbilical Hernia	5,314	3,886	0.009	n/a	0.025	0.504	0.046	6,217
Orchiopexy	6,621	4,599	0.010	n/a	0.034	n/a	0.049	5,804
Spine	17,645	11,758	0.053	0.051	n/a	0.707	n/a	3,309
Anti-Reflux	12,357	9,911	0.189	0.022	0.870	0.478	0.750	699
Knee Arthroscopy	11,406	8,609	0.054	n/a	0.317	0.417	0.087	230
Gallbladder Removal	11,391	6,598	0.123	n/a	0.399	0.656	0.160	163
All	6,280	5,890	0.017	0.004	0.101	0.382	0.060	194,233
Non-Children's Hospitals								
Tonsillectomy	4,218	2,687	0.008	0.001	0.010	0.523	0.008	44,064
Ear Tubes	3,045	2,054	0.007	n/a	0.003	0.407	0.012	38,908
2+ procedures	4,925	3,050	0.007	0.001	0.010	0.390	0.007	16,285
Appendectomy	10,733	6,676	0.028	0.024	0.468	0.407	0.024	15,105
Circumcision	3,516	3,995	0.014	n/a	0.072	0.017	0.020	4,579
Broken Arm	5,558	6,823	0.020	n/a	0.158	0.428	0.010	4,060
Inguinal Hernia	5,711	3,494	0.007	n/a	n/a	0.169	0.012	3,366
Strabismus	4,891	2,939	0.004	n/a	n/a	0.495	0.036	2,729
Umbilical Hernia	4,658	2,815	n/a	n/a	0.019	0.506	0.025	1,488
Orchiopexy	6,344	4,283	n/a	n/a	0.063	n/a	0.022	1,469
Spine	17,641	15,818	0.042	0.056	n/a	0.654	n/a	503
Knee Arthroscopy	8,583	6,844	n/a	n/a	0.036	0.409	n/a	364
Gallbladder Removal	8,439	5,116	n/a	n/a	0.152	0.806	n/a	217
Anti-Reflux	12,724	10,507	0.145	n/a	0.780	0.569	0.732	123
All	4,874	4,430	0.011	0.003	0.071	0.425	0.017	133,260

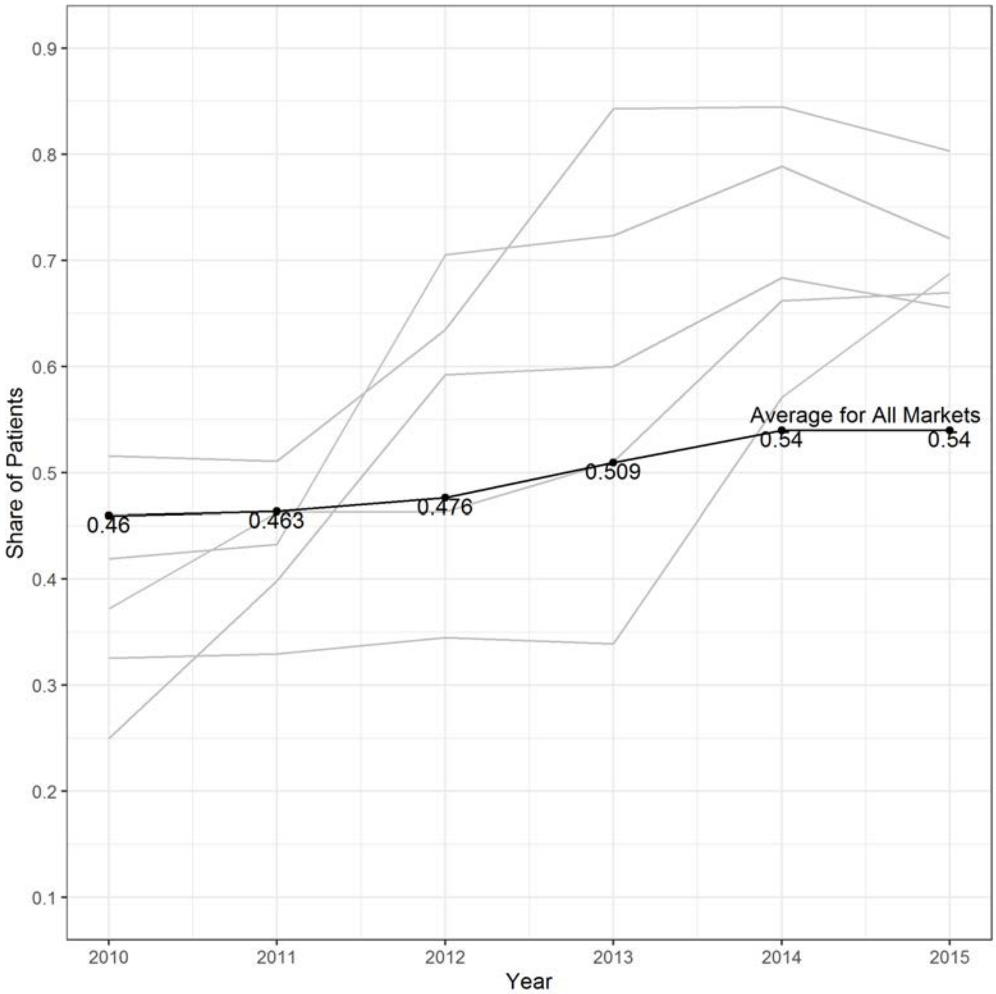
[a]Statistics based on inpatient and outpatient procedures, separately by CH and NCH. ICD-9 codes to identify each procedure are listed in the supplemental appendix. "n/a" reflects cell sizes of 10 or fewer patients, and "2+ procedures" denotes patients with more than one of the selected procedures in the same visit. Complication and readmission rates are defined for a 90-day period after the inpatient or outpatient visit.

Figure 1: **Count of CH and NCH**[a]



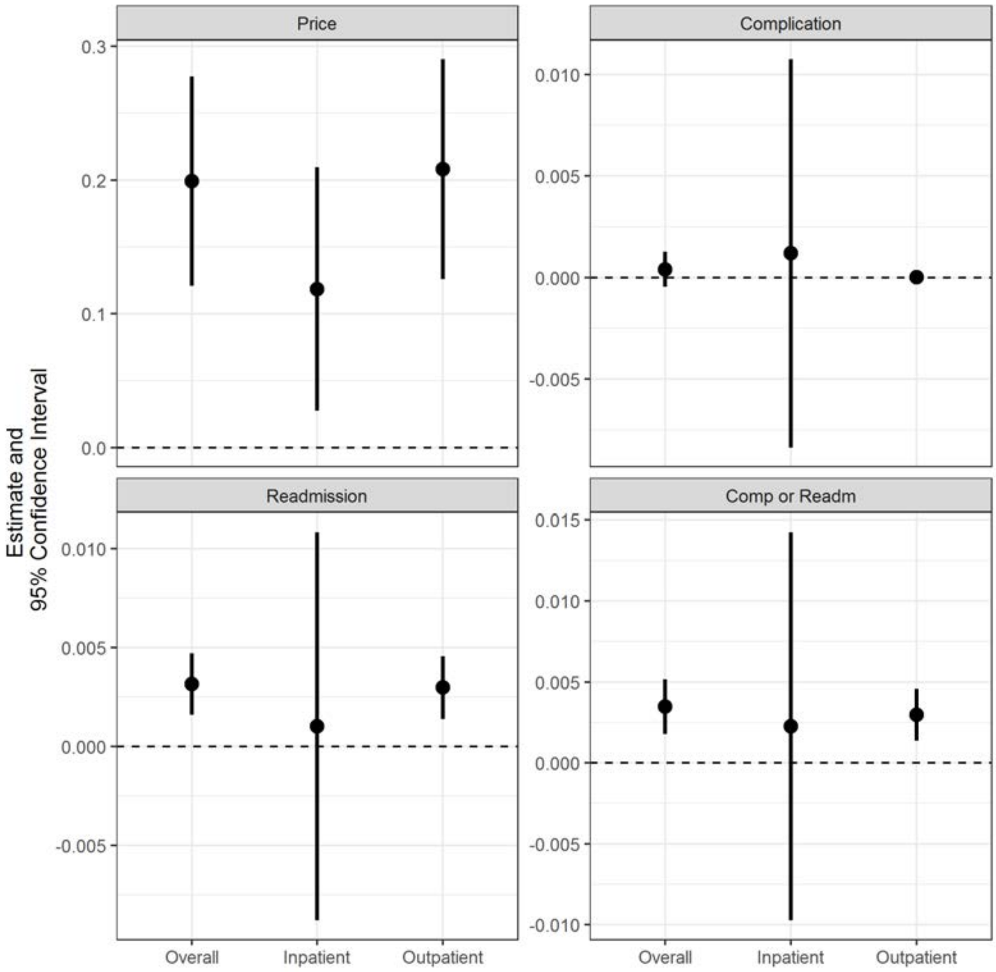
[a]Children's Hospital (CH) versus Non-Children's Hospital (NCH) designation based on tiers described in Piper *et al.* (2020) and discussed in Section 2.

Figure 2: **CH Market Shares**[a]



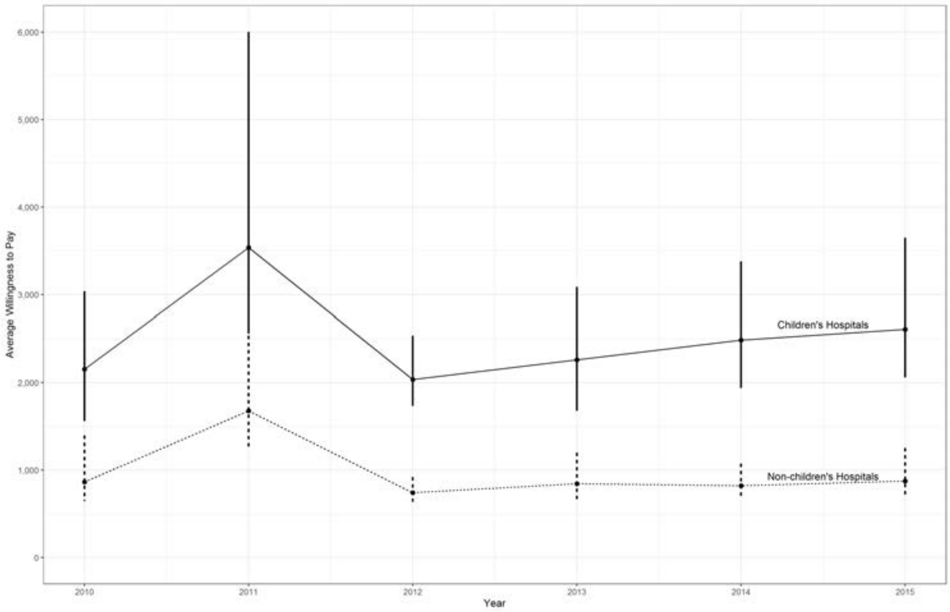
[a]Children's Hospital (CH) market shares based on CH designation described in Piper *et al.* (2020) and discussed in Section 2. Hospital markets are defined by community detection using the cluster walktrap algorithm as described in Section 3.1 (Pons & Latapy, 2005; Everson *et al.*, 2019).

Figure 3: **Price and Quality Differences by CH and NCH**[a]



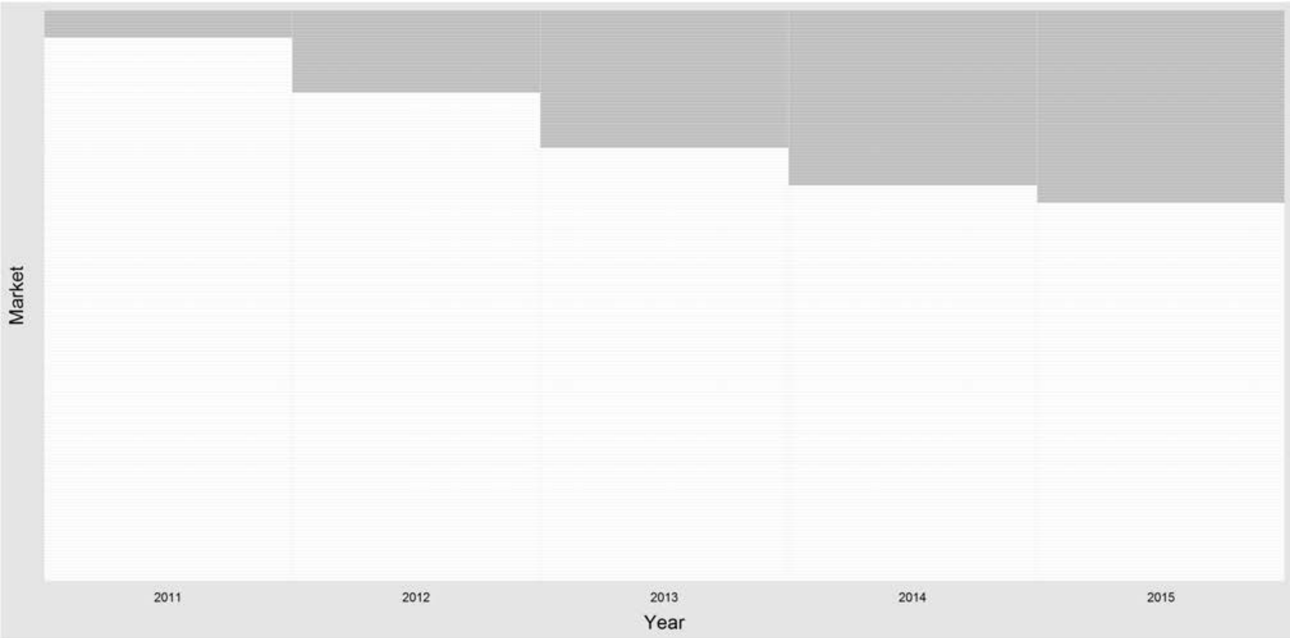
[a]Estimated coefficients for the Children's Hospital (CH) indicator as reflected in Equation 1.

Figure 4: ***Ex post* WTP for CH and NCH**[a]



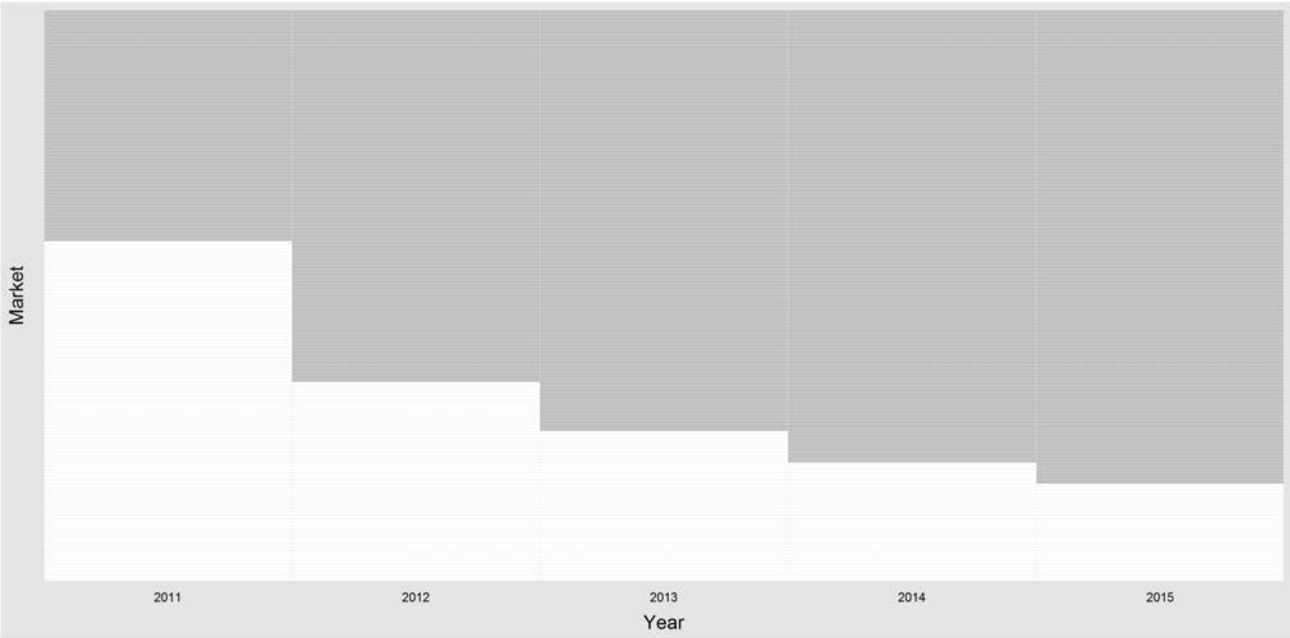
[a]Estimated *ex post* willingness-to-pay (WTP) for Children's Hospitals (CH) and Non-Children's Hospitals (NCH) as described in Section 3.3, estimated separately by year with bias-corrected percentile confidence intervals calculated from 250 bootstrap replications (DiCiccio & Efron, 1996; Gatta *et al.*, 2015).

Figure 5: **Entry of Children's Hospitals** [a]



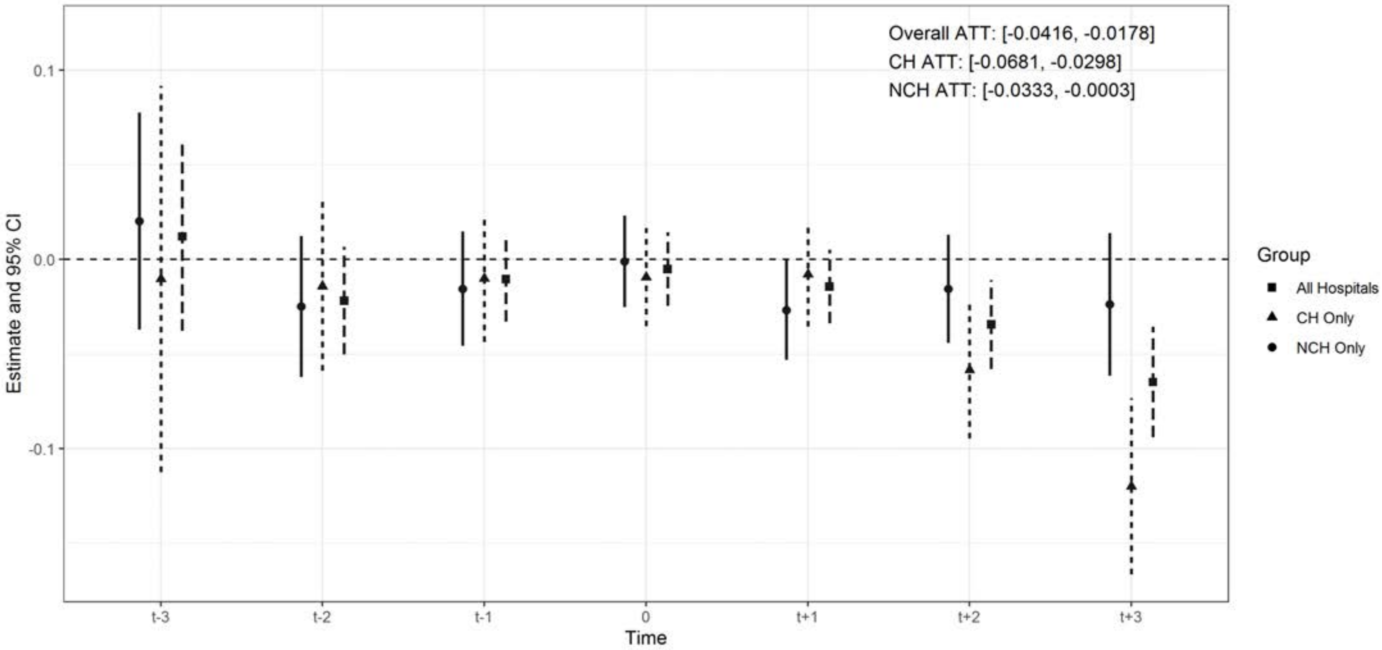
[a]Shaded markets reflect those experiencing entry of a Children's Hospital (CH) in the data, as defined and discussed in Section 4.2.

Figure 6: **Entry of Non-Children's Hospitals** [a]



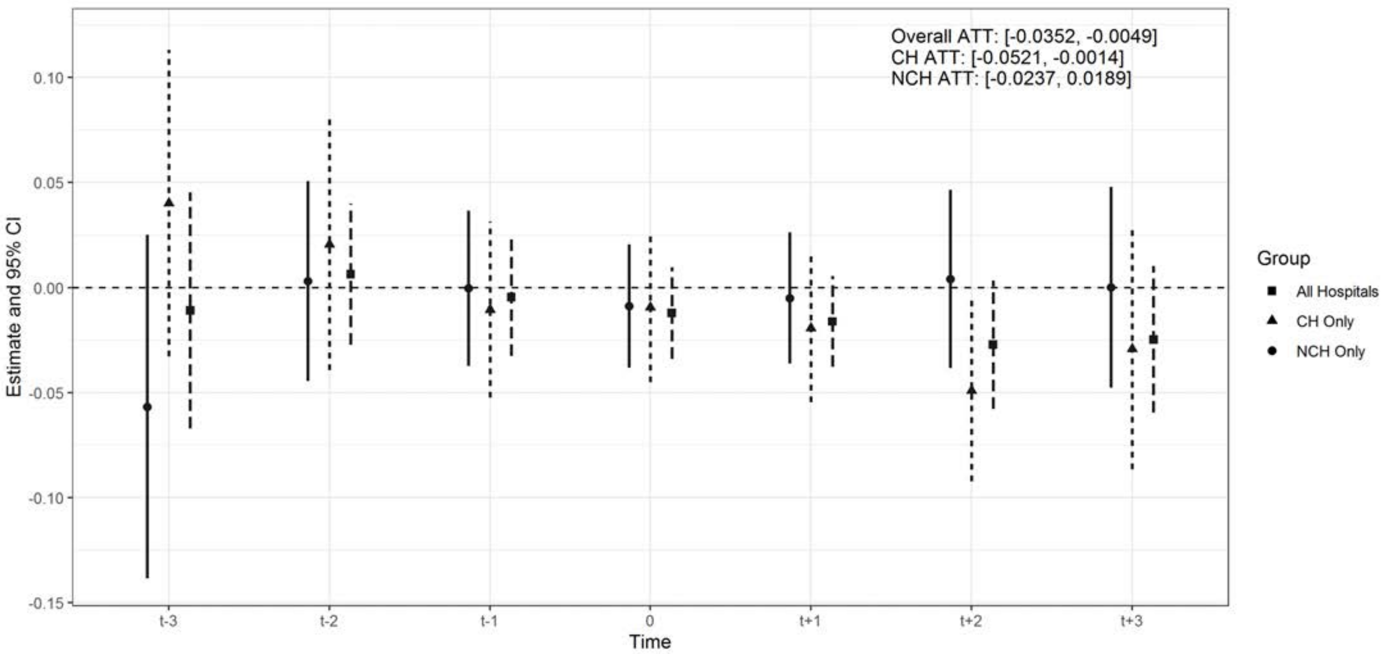
[a]Shaded markets reflect those experiencing entry of a Non-Children's Hospital (NCH) in the data, as defined and discussed in Section 4.2.

Figure 7: **Effect of Entry of Children's Hospitals**[a]



[a]Dynamic treatment effects estimated based on Callaway & Sant'Anna (2021), as described in Section 4.1.

Figure 8: **Effect of Entry of Non-Children's Hospitals**[a]



[a]Dynamic treatment effects estimated based on Callaway & Sant'Anna (2021), as described in Section 4.1.