# Insurer Competition in Health Care Markets*

Kate Ho† Robin S. Lee‡

*June 25, 2015*

**Abstract**

We analyze the impact of insurer competition on health care markets using a model of premium setting, hospital-insurer bargaining, household demand for insurance, and individual demand for hospitals. Increased insurer competition may lead to lower premiums; it may also increase health providers' leverage to negotiate higher prices, thereby mitigating premium reductions. We use detailed California admissions, claims, and enrollment data from a large benefits manager. We estimate our model and simulate the removal of an insurer from consumers' choice sets. Although premiums rise and annual consumer surplus falls by $50-120 per capita, hospital prices and spending fall in certain markets as remaining insurers negotiate lower rates. Overall, the impact on negotiated prices is heterogeneous, with increases or decreases of up to 15% across markets. We conclude that insurer competition can increase consumer surplus but also generate a redistribution of rents across hospitals and greater medical spending in certain markets.

Keywords: health insurance, insurer competition, hospital prices, bargaining, countervailing power
JEL: I11, L13, L40

*This paper replaces an earlier working paper titled "Insurer Competition and Negotiated Hospital Prices." We have benefited from helpful comments and suggestions from numerous individuals (including Cory Capps, Allan Collard-Wexler, Greg Crawford, Leemore Dafny, Jan De Loecker, David Dranove, Martin Gaynor, Gautam Gowrisankaran, Phil Leslie, Julie Mortimer, Aviv Nevo, Mike Riordan, Bob Town, Mike Whinston, and Ali Yurukoglu), and conference and seminar participants; and from exceptional research assistance from Patricia Foo. We acknowledge support from the NYU Stern Center for Global Economy and Business. All errors are our own.

†Columbia University and NBER, kh2214@columbia.edu.

‡Harvard University and NBER, robinlee@fas.harvard.edu.

# 1 Introduction

This paper examines the impact of insurance competition on premiums, negotiated hospital prices and welfare in the U.S. private health insurance market. In many markets, the number of insurance plans available to consumers has increased in recent years, facilitated by the creation of state and federal health insurance exchanges, movement of individuals away from employer-sponsored plans, and the emergence of new insurance products through integrated and joint ventures by health providers and insurers. In support of these trends is the widely held perception that increased insurer competition may lead to increased quality of care and help to contain health care expenditures by reducing premiums and costs.

However, the complex interactions between insurers and other players in oligopolistic health care markets imply that, in addition to these potential benefits of insurer competition, there are also indirect effects that may not be welfare-improving. In particular, the effect of insurer competition on medical provider prices, which are determined via bilateral bargaining, depends in part on the baseline level of competition in both "upstream" health provider and "downstream" insurance markets. Changes in market structure that make the insurance sector more competitive can be shown to have a theoretically ambiguous effect on hospital prices, and the effect can differ substantially both across markets and within markets across providers. If prices increase for some providers but decrease for others, there will be a redistribution of rents that may affect both the health insurance premiums paid by consumers and hospitals' investment incentives. The recent antitrust lawsuits brought by health providers and employers against Blue Cross and Blue Shield, alleging that these insurers conspire to avoid competing against one another in certain markets, are evidence that some market participants believe that an increase in insurer competition would lead to higher, rather than lower, provider prices.[1]

The complex market structure and institutional details of the private health care market in the U.S. make it difficult to generalize findings from varying insurer competition in one environment to another without identifying the mechanisms by which competition influences equilibrium market outcomes. Our paper addresses this challenge by providing a framework for analyzing insurer-hospital bargaining, insurer premium setting, household demand for insurers, and individual demand for hospitals. The framework can be used to address these and related issues, including the impact of horizontal mergers by insurers or health providers, introduction of vertically-integrated plans (e.g., Anthem Blue Cross Vivity in California) or non-compete agreements such as the one alleged between Blue Cross and Blue Shield. We estimate our model using 2004 California admissions, claims, and enrollment data from a large health benefits manager for over a million individuals, and information on insurer networks and negotiated hospital prices. Armed with our framework and estimates, we conduct simulations that alter the set of insurers made available to consumers across several markets within California and investigate the equilibrium impact of insurer competition on premiums, negotiated hospital prices and expenditures, and firm profits and consumer welfare. The

[1] See, for example, "Antitrust Lawsuits Target Blue Cross and Blue Shield," *Wall Street Journal*, May 27, 2015.

effects that we identify and measure are present not only when employers add or remove insurers from plan menus offered to employees, but also when insurers merge or enter and exit markets.

One of this paper's key contributions is identifying and quantifying the mechanisms through which insurer competition affects negotiated hospital prices. As these negotiated prices constitute a significant component of insurer costs, hospital profits and—at nearly $1 trillion annually—total health care expenditures, understanding factors determining their levels and rate of growth is also of independent interest.[2] We identify a trade-off between opposing effects of insurer competition on hospital prices. First, if increased insurer competition reduces industry surplus captured by insurers and hospitals by constraining premiums and insurers' ability to recoup rate increases, it may generate a downward pressure on hospital prices—a relationship we refer to as the "premium effect" of increased insurer competition.[3] However there are offsetting effects when, as is often the case, the input market for health services is imperfectly competitive. In particular, as hospitals (and other medical providers such as physician groups) leverage their market power when negotiating prices with insurers, increased insurer competition may allow hospitals to better "play" insurers off one another when bargaining. If one insurer drops a hospital it may lose enrollees to another competing insurer (the "enrollment effect"), while those enrollees may continue to access the same hospital from the rival insurer (the "recapture effect"). These additional effects are variants of *countervailing power*, in which greater downstream (insurer) concentration can lead to lower negotiated input prices from upstream (hospital) providers (Galbraith, 1952). Quantifying (and signing) the net impact of increased insurer competition on negotiated prices is ultimately an empirical question. We control for the offsetting effects in our model and empirical analyses, and since the relative strength of each effect varies significantly across settings, we also admit the possibility for a heterogeneous impact of insurer competition across hospitals and markets.

Our model has several components. The first is a structural model of individual demand for hospitals that conditions on hospital characteristics and each individual's location and diagnosis. The estimates are used to construct a measure of expected utility derived by households from an insurer's hospital network, which in turn is used in a structural model of household demand for insurance products. We extend methods developed in Town and Vistnes (2001), Capps, Dranove and Satterthwaite (2003), and Ho (2006, 2009) that estimate similar demand systems by using detailed information on household characteristics (including household income, and the age and sex of each individual within the household) to account for insurer choices by households that aggregate preferences of individual household members. We thus admit more realistic substitution patterns across insurers upon counterfactual network changes than in previous papers.[4] In addition, by allowing

[2] The increase in annual U.S. hospital spending, at $900 billion, accounted for over 30% of the $2.8 trillion in total national health care expenditures in 2012 (Cuckler et al., 2013).

[3] This is consistent with arguments such as: "...non-Kaiser [hospital] systems recognized the need to contain costs to compete with Kaiser [Permanente]—that is, the need to keep their own demands for rate increases reasonable enough that the premiums of non-Kaiser insurers can remain competitive with Kaiser." ("Sacramento," *CA Health Care Almanac*, July 2009 accessed at `http://www.chcf.org/~/media/MEDIA%20LIBRARY%20Files/PDF/A/PDF%20AlmanacRegMktBriefSacramento09.pdf`). See also arguments put forth by Sutter Health, a large hospital system based in Northern CA (`http://www.sutterhealth.org/about/healthcare_costs.html` accessed on July 29, 2013).

[4] To our knowledge, only Ho (2006, 2009) and Shepard (2015) are able to recover how the demand for competing

preferences and the probability of admission for various diagnoses to vary across individuals by age and gender, our analysis explicitly accounts for the selection of heterogeneous individuals across insurers as hospital networks change. We rely on these observable characteristics (which insurers cannot condition on when setting premiums) to control for individual and household selection across insurance plans and hospitals.

Accurate estimates of hospital and insurer demand are critical to capture "supply-side" incentives faced by insurers when setting premiums, and by both insurers and hospitals when engaging in bilateral bargaining over negotiated hospital prices. We assume that firms engage in static Bertrand-Nash premium setting, and use estimated price elasticities to estimate insurer non-hospital marginal costs (Bresnahan, 1987; Berry, Levinsohn and Pakes, 1995). We also assume that insurers and hospital systems engage in simultaneous bilateral Nash bargaining over input prices in each market (Horn and Wolinsky, 1988; Crawford and Yurukoglu, 2012), and derive a bargaining equation that specifies the equilibrium relationship between each negotiated price per-admission for a hospital system and insurer, and measurable objects related to the "gains-from-trade" created when these two parties come to an agreement. The estimates suggest that hospitals capture more than half of the gains-from-trade when bargaining with insurers, and that over 70% of negotiated hospital prices are determined by a combination of the prices of neighboring hospitals (a "price reinforcement" effect), and the loss in insurer premium revenues, net of non-hospital costs, upon losing a particular hospital (a "premium and enrollment" effect).

Our empirical analysis focuses on plans offered by three major health insurers—Blue Shield of California, Anthem Blue Cross, and Kaiser Permanente—through the California Public Employees' Retirement System (CalPERS) to California state and public agency employees, retirees (under age 65), and their families. We use estimates from our model to simulate the removal of one of these insurers (either Blue Cross or Kaiser) from CalPERS enrollees' choice sets, and examine the effect on equilibrium household choices of insurance plans, individual choices of hospitals, premiums set by insurers, and the prices negotiated between insurers and hospitals across different markets within California.[5] We hold fixed hospital and insurer non-price characteristics (including hospital networks) in these counterfactual exercises. We find that removing Blue Cross from the choice set leads to increased equilibrium premiums (4.4%) but reduced hospital prices (1.4%) for Blue Shield on average. There is substantial heterogeneity in hospital price effects across markets. In areas where Blue Cross represented a particularly good substitute for others in the choice set, removing it relaxes a constraint that prevented other plans from cutting hospital prices, and the result can be a substantial price reduction (as much as 15%), while in other areas prices increase by nearly 10%.

insurers varies as a function of their hospital networks; these papers assume that individuals (as opposed to households) choose both insurers and hospitals.

[5] Our analysis implicitly assumes that: (i) CalPERS's menu of insurance plans is chosen infrequently and can be held fixed while modeling the determination of hospital prices and premiums, and (ii) hospital prices are negotiated specifically for CalPERS by each insurer-hospital pair. We motivate these assumptions by noting that: CalPERS held fixed the set of insurers that were offered for several years both prior to and after our sample period; it offered plans from the three largest insurers in the market (who in turn covered more than two-thirds of privately insured individuals in CA); and its enrollees represent almost 10% of the commercially insured population in California.

We also consider the effect of removing Kaiser and again find that price effects vary across both insurers and markets. Overall there is a significant heterogeneous impact of insurer competition on hospital prices across markets. Consumer welfare is predicted to fall by approximately $50-120 per capita per year (depending on the insurer that is removed) due to the reduction of insurer choice sets and increased premiums.

Our analysis relies on several key assumptions. First, we assume that insurers engage in Nash Bertrand premium setting. Our main specification allows for the possibility that insurers face potentially larger-than-estimated demand elasticities when setting premiums. This captures external constraints on insurers' premiums, e.g., from competition by insurers for inclusion on an employer's plan menu, and allows the model to better match observed insurer price-cost margins. We also examine alternative premium setting regimes using fixed markups to capture the incentives faced by insurers offering self-insured products (and compensated via an administrative fee), or assuming that insurers face a probability of being removed from plan menus if premiums are too high. If there are significant constraints such as these on insurers' ability to increase premiums following a reduction in insurer competition, average premiums may actually *fall* as insurers are able to negotiate substantially lower hospital prices. Second, we identify household preferences for insurers from cross-household-type variation in premiums, and from cross-household and cross-zip code variation in the expected utility derived from each insurer's hospital network. We explore the robustness of our results to switching costs or other frictions that may prevent households from changing insurers following a premium or network change by repeating our analysis under perturbations of the estimated consumer preferences. We also provide additional evidence that households' plan choices are quite sensitive to network changes, suggesting that choice frictions are not too large. Ultimately, though our estimated demand elasticities, marginal costs, and other related objects may be affected by modifying these and other assumptions, we argue that our main findings—i.e., that the impact of reducing insurer competition on the distribution of rents between insurers and hospitals varies significantly across markets, and reducing competition can actually reduce negotiated prices in many cases—are robust.

Overall, our results suggest that although *adding* insurers in consumers' choice sets may lead to premium reductions, the resulting change in insurers' outside options when bargaining provides hospitals in many markets with the ability to negotiate higher prices. Furthermore, in the presence of premium setting constraints, intensifying insurer competition may actually yield premium *increases* and even higher negotiated prices. The welfare implications of this dynamic depend on the relative profit margins of insurers and hospitals, the heterogeneity of price effects across providers, and—to the extent that rents are redistributed across hospitals—the overall impact on investment, entry, and exit. Furthermore, as the benefits of encouraging insurer competition differ by market, a correct assessment of appropriate policy should take account of such long-run investment incentives as well as short-run premium effects.

**Related Literature and Contributions.** This paper makes a substantial contribution to the literature on vertical markets and bilateral oligopoly. In particular, it is the first paper to estimate a bargaining model between health providers and insurers and recompute counterfactual equilibrium negotiated prices when there are multiple competing firms on both sides of the market. Complementary to our paper is Gowrisankaran, Nevo and Town (2015) who, using a similar structural model of hospital-insurer bargaining, primarily estimate the impact of hospital mergers under the assumption that insurers do not compete with one another for enrollees.[6,7] Absent this form of insurer competition, the countervailing force by which insurers may negotiate lower prices with hospitals upon the removal of a competitor is not present. Thus, as we demonstrate, incorporating competition on both sides of the market—among hospitals and among insurers—is critical in order to capture the equilibrium responses of negotiated prices, premiums, and welfare to changes in market structure. Our framework can also be used to explore the effects of other changes to the structure of health care markets (e.g., mergers, integration, entry and exit, etc.).[8] To our knowledge, the only other papers that re-estimate negotiated input prices in an applied analysis of bilateral oligopoly with multiple competing upstream and downstream firms are Crawford and Yurukoglu (2012) and Crawford et al. (2015), both of which focus on the cable television industry; we rely on and build upon important contributions from these papers in our analysis.

This paper is related to the broader literature examining the relationship between market concentration and provider prices in health care markets (c.f. Gaynor and Town (2012)). One of the most recent of these papers, Moriya, Vogt and Gaynor (2010), uses a structure-conduct-performance approach with Medstat data to analyze the impact of both insurer and hospital market power on negotiated prices. The authors regress prices on hospital and insurer concentration (measured by Herfindahl indices) and market and firm fixed effects, and find that increases in insurer concentration are associated with decreases in hospital prices.[9] Melnick, Shen and Wu (2010) conduct a very similar analysis using estimated prices from hospital revenue data, with qualitatively similar results. We note that these and other papers using regression-based analyses have the limitation that the estimated results may mask heterogeneous effects. They also cannot be extrapolated out-of-sample to other settings or used to decompose the mechanisms behind the effects or conduct counterfactual simulations. Our approach complements these papers by admitting the possibility that varying concentration can have heterogeneous effects across providers and markets, and by imposing structure from a theoretical model to decompose these effects into distinct premium competition and bargaining mechanisms.

[6]See also Grennan (2013) (which models individual hospitals bargaining with medical device manufacturers), Dranove, Satterthwaite and Sfekas (2008) and Lewis and Pflum (2013).

[7]Ho (2006, 2009) relaxes this assumption and estimates a model of consumer demand for hospitals and insurers given the network of hospitals offered, as an input to a model of hospital network formation and contracting (assuming a take-it-or-leave-it offers model to determine hospital prices). Lee and Fong (2013) proposes a dynamic bargaining model of network formation and bargaining in a similar setting. However, these papers do not investigate the impact of insurer competition on input prices.

[8]Dafny, Ho and Lee (2015) use a version of this model to explore the price effects of cross-market hospital mergers.

[9]Recent work finding evidence that increased insurer concentration can lead to higher premiums is also relevant (Dafny (2010) and Dafny, Duggan and Ramanarayanan (2012).

Finally, our analysis contributes to the large literature in industrial organization on countervailing power and bargaining in bilateral oligopoly, and the impact of changes in concentration via merger or entry on negotiated prices (e.g., Horn and Wolinsky (1988), Stole and Zweibel (1996), Chipty and Snyder (1999), Inderst and Wey (2003)).[10]

## 2 Overview of Analysis

Our paper focuses on the large group commercial health insurance market in the U.S. Every year, non-elderly working consumers sign up with a health insurance plan that is offered by an insurer through their employer. In 2014, approximately 149 million non-elderly individuals were covered by an employer sponsored plan.[11] Commercial insurers typically charge a premium to consumers that varies according to the number of dependents that are covered, and provide access to hospitals contained in their plan's provider network. When an individual covered by a particular insurer visits a hospital, the insurer pays the hospital a negotiated price for the bundle of services that is provided. Such prices are determined by bilateral bargaining between insurers and hospitals and may vary (for the same bundle of services) within a given insurer across hospitals, and across insurers for a given hospital.

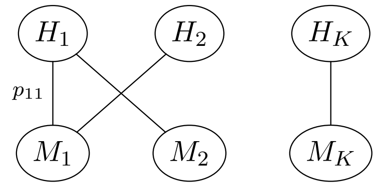
We investigate the impact of changes in the insurer choice set on the price bargaining process, and through it on prices, premiums, and consumer surplus in the California market. We consider in particular the three insurers that were offered to enrollees by CalPERS, a major benefits administrator, in 2004. The insurers were Blue Shield of California, Blue Cross of California and Kaiser Permanente. They represented over two-thirds of the entire California commercial health insurance market; in 2015, their combined market share increased to three-quarters.

The effect of insurer competition on hospital prices is difficult to isolate because it operates through multiple channels. Figure 1a provides a diagram of a hypothetical market to illustrate this point. The market contains 3 insurers or "managed care organizations" (MCOs) and 3 hospitals. Hospital $H_1$ contracts with both MCOs $M_1$ and $M_2$ while $H_2$ contracts only with MCO $M_1$. The third insurer $M_K$ is an integrated MCO which contracts exclusively with its own hospital $H_K$. We wish to understand how changing the degree of competition between insurers influences the prices negotiated between a particular hospital and a particular MCO. We focus on $p_{11}$, the price negotiated between $H_1$ and $M_1$.

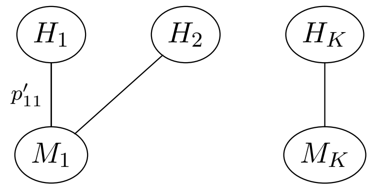
An increase in insurer competition affects $p_{11}$ through multiple channels. The first is a "premium effect": premium competition in the downstream market likely reduces industry surplus and therefore puts a downwards pressure on negotiated prices. However there are at least two offsetting effects that arise because prices are determined through bargaining. Relative bargaining leverage

[10] In a related industry, recent empirical work by Ellison and Snyder (2010) finds that larger drugstores secure lower prices from competing suppliers of antibiotics. Chipty and Snyder (1999) consider the effect of buyer mergers on negotiated upstream prices in the cable television industry, assuming the existence of just one supplier and multiple buyers. In that framework, which abstracts away from the upstream competition that is central to our paper, the curvature of the supplier's gross surplus function determines the effect of the merger on buyers' bargaining positions.

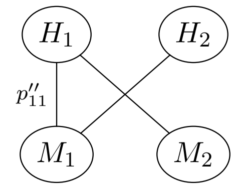
[11] Kaiser Family Foundation, *2014 Employer Heatlh Benefits Survey.*




(a) Baseline




(b) Exercise 1: Remove $M_2$




(c) Exercise 2: Remove $M_K$

Figure 1: Sub-figure (a) depicts a hypothetical market with 2 hospitals and 3 MCOs, where lines denote whether a hospital is on an MCO's network. Sub-figure (b) illustrates the removal of an existing insurer without removing any hospitals; and sub-figure (c) illustrates the removal of a vertically integrated insurer-hospital $M_K$ and $H_K$.

between the hospital $H_1$ and insurer $M_1$ depends crucially on consumer demand and the extent to which other insurers and/or hospitals in the market are good substitutes for the bargaining firms. For example, if $M_2$ is a close substitute for $M_1$, then consumers may be willing to switch to $M_2$ should $M_1$ drop $H_1$, and this reduces the insurer's bargaining outside option (an "enrollment effect"). In addition, if $H_1$ is very attractive to consumers (and has few close substitutes) so that consumers will switch to $M_2$ to continue to access $H_1$ if $H_1$ is dropped, this increases $H_1$'s outside option as well (a "recapture effect"). Both effects tend to lead to price increases as insurer competition increases. This trade-off between the premium effect and the enrollment and recapture effects, which would be difficult to capture through reduced form analysis, is explicitly detailed in our theoretical model of insurer-hospital bargaining and the empirical analysis that follows it.

Our counterfactual analyses simulate the equilibrium impact of removing an insurer from the choice set on premiums, negotiated prices, insurer enrollment and hospital utilization. Removing an insurer is illustrated in Figure 1b where insurer $M_2$ has been removed, and in Figure 1c where the integrated insurer $M_K$ is removed. An important limitation of our analysis, as highlighted in Figure 1, is that we hold fixed the hospital networks of (active) insurers in these counterfactual scenarios; ongoing and related work (e.g., Lee and Fong (2013)) examines the impact of such changes on equilibrium hospital networks.

The rest of this paper is organized as follows. In Section 3, we present a stylized theoretical model of how the U.S. private health insurance market operates, and derive a bargaining equation which relates negotiated prices to estimable objects related to insurer and hospital "gains-from-trade" from agreement. In Section 4, we describe the data used in our empirical analysis, and specify and estimate models of individual demand for hospitals and household demand for insurers that capture the extent to which each firm has close substitutes within the market. The estimates are then used as inputs to predict key terms in our model of premium setting and insurer-hospital price bargaining. In Section 5 we present results from our counterfactual simulations that remove an insurer from the market, and in Section 6 we discuss the assumptions underlying our analysis and accompanying robustness tests. Finally, we summarize our findings and conclude in Section 7.

# 3 Theoretical Framework

In this section we present a stylized theoretical model of how the insurers in an employer's choice set choose premiums and engage in bilateral bargaining with hospitals to determine negotiated prices. We do not explicitly model competition between insurers to be offered by the employer (although we examine alternative specifications which capture aspects of this competition in our empirical application); we thus condition on the set of insurers that are offered, and focus on price and premium-setting and consumer choices within that set.[12] The theoretical model highlights how particular objects of interest—notably demand by households for insurers and individuals for particular hospitals—serve as inputs into the determination of observed and counterfactual premiums and negotiated prices, and motivates their estimation. We also use the model's predictions to illustrate how the net effect of increased insurer competition on negotiated hospital prices can be theoretically ambiguous, thus both supporting and informing our subsequent empirical analyses.

## 3.1 Setup

For now, consider a single market that contains a set of hospitals $\mathcal{H}$ and insurers (also known as managed care organizations, or MCOs) $\mathcal{M}$; we later consider multiple markets in our empirical application. Let the current "network" of hospitals and MCOs be represented by $\mathcal{G} \subseteq \{0,1\}^{|\mathcal{H}| \times |\mathcal{M}|}$, where we denote by $ij \in \mathcal{G}$ that hospital $i$ is contained on MCO $j$'s network. We assume that a consumer who is enrolled in MCO $j \in \mathcal{M}$ can only visit hospitals in $j$'s network, denoted by $\mathcal{G}^M_j$; equivalently, we denote by $\mathcal{G}^H_i$ denote the set of insurers that have contracted with hospital $i$.

For our analysis, we take the network $\mathcal{G}$ as given—focusing primarily on the determination of premiums and negotiated prices—and assume the following timing in each period:

1a. MCOs set premiums $\boldsymbol{\phi} \equiv \{\boldsymbol{\phi}_j\}_{j \in \mathcal{M}}$ to downstream households, where $\boldsymbol{\phi}_j \equiv \{\phi_{j,\lambda}\}_{\forall \lambda}$ and $\phi_{j,\lambda}$ represents the premium charged by MCO $j$ for a household of "type" $\lambda \in \{\text{single}, \text{2-party}, \text{family}\}$.

1b. Simultaneously with premium setting, all insurers and hospitals $ij \in \mathcal{G}$ engage in simultaneous, bilateral bargaining to determine hospital prices $\boldsymbol{p} \equiv \{p_{i,j}\}$, where $p_{i,j}$ denotes the price paid to hospital $i$ by MCO $j$ for treating one of $j$'s patients.[13]

[12] CalPERS primarily only offered the three insurers that we focus on in our analysis as an option for the decade following 2003. Our approach also implies an assumption that separate prices for a particular insurer-hospital pair are negotiated across employers.

[13] For our simple theoretical model, we assume prices take this form. In reality hospital contracts are more complicated, with prices often being specific to the services provided or the patient's diagnosis, and taking several forms

2. Given hospital networks and premiums, every household $f \in \mathcal{F}$ enrolls in an insurance plan (where $\mathcal{F}$ denotes the set of all households). The insurance plan choice of all households in the market determines $\{\boldsymbol{D}_j(\mathcal{G}, \boldsymbol{\phi})\}_{\forall j}$ (where $\boldsymbol{D}_j(\cdot) \equiv \{D_{j,\lambda}(\cdot)\}_\lambda$ and $D_{j,\lambda}(\cdot)$ is the number of each type $\lambda$ households enrolled in MCO $j$) and $\{D^E_j(\cdot)\}_{\forall j}$ (where $D^E_j(\cdot)$ is the number of individual enrollees on MCO $j$).

3. After enrolling in a plan, each individual becomes sick with some probability; those that are sick visit some hospital in their network. This determines $D^H_{i,j}(\mathcal{G}, \boldsymbol{\phi}) \equiv \sum_{\forall \kappa} D^H_{i,j,\kappa}(\cdot)$, where $D^H_{i,j,\kappa}(\cdot)$ is the number of individuals of type $\kappa$ (representing an age-sex category) who visit each hospital $i$ through each insurer $j$.[14]

The distinction between *households* and choosing insurance plans (and paying premiums) and individual *consumers* choosing a hospitals—a feature that has not to our knowledge been accounted for in the prior literature—is an important instutitional feature of the private health insurance market, and integral for linking the theoretical analysis with our data and empirical application.

**Insurer and Hospital Profits.** We assume that insurers and hospitals, when setting premiums and bargaining over negotiated prices, seek to maximize profits. We assume that profits for an MCO $j$ are:

$$\pi^M_j(\mathcal{G}, \boldsymbol{p}, \boldsymbol{\phi}) = \big(\sum_{\lambda} D_{j,\lambda}(\cdot)\phi_{j,\lambda}\big) - D^E_j(\cdot)\eta_j - \sum_{h \in \mathcal{G}^M_j} D^H_{h,j}(\cdot) p_{h,j} \tag{1}$$

where the first term on the right-hand-side represents MCO $j$'s premium revenues that are paid per household (and sums over all household types), the second captures the MCO's non-hospital costs per *individual* enrolled (denoted $\eta_j$), and the third represents payments made to hospitals in MCO $j$'s network. This last term sums, over all hospitals in an insurer's network, the price per admission negotiated with each hospital multiplied by the number of patients admitted to that hospital. Any components of an insurer's profits that do not vary with its network (including fixed costs) do not affect the subsequent analysis and are omitted.

We assume that profits for a hospital $i$ are:

$$\pi^H_i(\mathcal{G}, \boldsymbol{p}, \boldsymbol{\phi}) = \sum_{n \in \mathcal{G}^H_i} D^H_{i,n}(\cdot)(p_{i,n} - c_i) \tag{2}$$

(e.g., case-rates, per-diems, or discounts off charges). In our empirical application we multiply a Medicare diagnosis-related group (DRG) adjusted price $p_{i,j}$ by the expected DRG weight for a given admission to control for variation in patient severity, and hence expected payments and costs, across different age-sex categories. This amounts to an assumption that hospitals negotiate a single price index (corresponding to an admission of DRG weight 1.0) with each insurer, which is then adjusted in accordance with the intensity (as measured by DRG weight) of treatment provided.

[14] In our empirical application, we will allow for heterogeneous consumers who become sick with different diagnoses with different probabilities. Consumers will also have different preferences for hospitals depending on their diagnosis and type. We also assume that consumers do not respond to negotiated prices when determining which hospital to visit; we provide further discussion of this assumption later.

which sums, over all insurers with which hospital $i$ contracts, the number of patients (of each type $\kappa$) it receives multiplied by an average margin per admission (where $c_i$ is hospital $i$'s average cost per admission for a patient).[15]

**Premium Setting.** We assume that each MCO sets premiums to maximize its profits:

$$\boldsymbol{\phi}_j = \arg\max_{\boldsymbol{\phi}} \pi_j^M(\mathcal{G}, \boldsymbol{p}, \{\boldsymbol{\phi}, \boldsymbol{\phi}_{-j}\}) \qquad \forall j \in \mathcal{M} \tag{3}$$

In our empirical application, each insurer's 2-party and family premiums are fixed multiples of the single (individual) premium; thus, we assume that insurers choose only the premium for a single household, and premiums for the other household types are determined as the same fixed multiples of this value.

**Bargaining.** Consider hospital $i \in \mathcal{H}$ bargaining with MCO $j \in \mathcal{M}$. We assume prices $p_{i,j} \in \boldsymbol{p}$ are negotiated for all $ij \in \mathcal{G}$ via simultaneous bilateral Nash bargaining, so that the negotiated price per-admission $p_{i,j}$ maximizes each pair's bilateral Nash product:

$$\begin{aligned} p_{i,j} = \arg\max_{p_{i,j}} & \Bigg[ \underbrace{\pi_j^M(\mathcal{G}, \boldsymbol{p}, \boldsymbol{\phi}) - \pi_j^M(\mathcal{G} \setminus ij, \boldsymbol{p}_{-ij}, \boldsymbol{\phi})}_{\text{MCO } j\text{'s ``gains from trade'' with hospital } i} \Bigg]^{\tau_j} \\ & \times \Bigg[ \underbrace{\pi_i^H(\mathcal{G}, \boldsymbol{p}, \boldsymbol{\phi}) - \pi_i^H(\mathcal{G} \setminus ij, \boldsymbol{p}_{-ij}, \boldsymbol{\phi})}_{\text{Hospital } i\text{'s ``gains from trade'' with MCO } j} \Bigg]^{(1-\tau_j)} \qquad \forall ij \in \mathcal{G} \end{aligned} \tag{4}$$

That is, each price $p_{i,j}$ maximizes the product of MCO $j$ and hospital $i$ "gains from trade" holding fixed all other negotiated prices $\boldsymbol{p}_{-ij} \equiv \boldsymbol{p} \setminus p_{i,j}$, where $\pi_j^M(\boldsymbol{p}_{-ij}, \boldsymbol{\phi}, \mathcal{G} \setminus ij)$ and $\pi_i^H(\boldsymbol{p}_{-ij}, \boldsymbol{\phi}, \mathcal{G} \setminus ij)$ represent MCO $j$ and hospital $i$'s disagreement payoffs (or outside options). As each bilateral bargain is assumed to occur simultaneously and concurrently with premium setting, we assume that if hospital $i$ comes to a disagreement with MCO $j$, the new network is $\mathcal{G} \setminus ij$, and all other prices $\boldsymbol{p}_{-ij}$ and premiums $\boldsymbol{\phi}$ remain fixed. We assume that Nash bargaining parameters $\tau_j \in [0, 1]$ $\forall j \in \mathcal{M}$, and vary across MCOs.

**Remarks.** Although we assume that premiums and hospital prices are simultaneously determined, premiums and negotiated prices will be "optimal" with respect to each other in equilibrium. This timing assumption implies that the level of premiums remains fixed when considering the disagreement payoffs in (4), and significantly simplifies the computation and estimation of our model.[16]

[15] In our empirical application we will construct an expected resource-intensity-adjusted price and cost per admission that varies for each individual-type $\kappa$ and across each insurer-hospital pair.

[16] Gal-Or (1999) uses a similar timing assumption to model negotiations between hospitals and insurers. See also Nocke and White (2007), Draganska, Klapper and Villas-Boas (2010), and Crawford et al. (2015).

The assumption that all bargains maximize bilateral Nash products, taking the outcomes of all other bilateral bargains as given, was proposed in Horn and Wolinsky (1988), and has been subsequently used in applied work (e.g., Crawford and Yurukoglu (2012), Grennan (2013), Gowrisankaran, Nevo and Town (2015)). Collard-Wexler, Gowrisankaran and Lee (2014) provide a non-cooperative extensive form that allows for firms to participate in multiple bargains which gives rise to this particular bargaining solution as an equilibrium outcome.

Finally, for now we ignore the presence of hospital systems for ease of exposition. However the full model presented at the end of this section and our empirical application allow insurers to bargain simultaneously with *hospital systems*, where a system removes all of its hospitals from an insurer's hospital network upon disagreement.

### 3.2 Simple Case: A Monopolist MCO

Before proceeding with our general analysis, we develop the intuition for how insurer competition affects negotiated prices in a simple setting with only a monopolist MCO $j$ and two hospitals, $A$ and $B$. In this environment, assume that insurer marginal costs $\eta_j = 0$, Nash bargaining parameters $\tau_j = .5$, and costs per admission are constant for each hospital (given by $c_A$ or $c_B$); we then re-express (4) for the bargain between $j$ and $A$ as:

$$p^*_{Aj} = \arg\max_p \left[[D_j\phi_j - D^H_{Aj}p - D^H_{Bj}p_{Bj}] - [\tilde{D}_{j\setminus A}\phi_j - \tilde{D}^H_{Bj\setminus A}p_{Bj}]\right] \times \left[D^H_{Aj}(p - c_A)\right] \quad (5)$$

where $\tilde{D}_{j\setminus A}$, $\tilde{\phi}_{j\setminus A}$, and $\tilde{D}^H_{Bj\setminus A}$ denote the values of these objects if MCO $j$ and hospital $A$ did not come to an agreement so that $A$ was no longer on $j$'s network. Since we have assumed MCO $j$ to be a monopolist insurer, $A$'s disagreement point (i.e., $\pi_{A,\mathcal{H}}(\boldsymbol{p}_{-Aj}, \boldsymbol{\phi}, \mathcal{G} \setminus Aj)$) is equal to 0. Nevertheless, we note that even with a monopolist insurer, $\tilde{D}_{j\setminus A} < D_j$ since more consumers may choose to remain uninsured if MCO $j$ drops hospital $A$.

For simplicity, consider the case where exactly one representative person per household visits a hospital, half of $j$'s enrolled households visit $A$ and the other half visit $B$, and upon disagreement between $j$ and $A$, all households enrolled in $j$ visit $B$. The first-order condition (FOC) of (5) can be written as:

$$p^*_{Aj}D_j = \underbrace{(D_j - \tilde{D}_{j\setminus A})\phi_j}_{\text{(i)}} - \underbrace{p^*_{Bj}(D_j/2 - \tilde{D}_{j\setminus A})}_{\text{(ii)}} + \underbrace{\frac{c_A D_j}{2}}_{\text{(iii)}} \quad (6)$$

where $p^*_{Aj}D_j$ represents *total payments made from MCO $j$ to hospital $A$*. There are three terms in (6) that affect total payments:

(i) The first term represents $j$'s changes in premium revenues upon losing hospital $A$: the greater this term, the higher is hospital $A$'s negotiated payment. We refer to this as the "premium and enrollment" effects. The impact of increasing insurer competition on this term is ambiguous: an additional insurer may increase the term $(D_j - \tilde{D}_{j\setminus A})$, as consumers may be more likely to switch away from $j$ upon disagreement with $A$; however, since insurer competition may increase premium competition, premiums $\phi_j$ may decrease.

(ii) The second term represents the change in payments made by $j$ to hospital $B$ as a result of losing $A$ from its network. Since it is likely that $\tilde{D}_{j\setminus A} > D_j/2$ (i.e., MCO $j$ does not lose all of the enrollees that used to visit hospital $A$), then $j$'s payments to $B$ increase upon disagreement with hospital $A$. This implies term (ii) is negative, which (given its negative sign in the equation) means hospital $A$ captures a higher negotiated price the greater is $p^*_{Bj}$. We thus refer to this as the "price reinforcement" effect, as it establishes the (complementary) equilibrium relationship between all hospital prices in the market.

Insurer competition will then have two effects on this term. The first is a direct effect due to its impact on $(D_j/2 - \tilde{D}_{j\setminus A})$: if $\tilde{D}_{j\setminus A}$ becomes smaller with insurer competition (so that this term becomes less negative or even positive), then insurer competition will have a negative effect on $p^*_{Aj}$. The second effect is an indirect effect through $p^*_{Bj}$: depending on whether $p^*_{Bj}$ increases or decreases due to insurer competition, it will have either a reinforcing or dampening effect on $p^*_{Aj}$ (and vice versa).

(iii) The third term notes that hospital $A$ will obtain higher total payments if it has higher realized costs (a "hospital cost" effect); insurer competition, by potentially reducing MCO $j$'s total demand, will tend to depress this term and hence total payments to $A$.

Finally, the impact of insurer competition on the negotiated price per-admission $p^*_{Aj}$ will also depend on how the total volume of enrollment $D_j$ changes as a new insurer enters the choice set. Thus, even in this simple setting, the introduction of insurer competition has the potential to either increase or decrease negotiated prices.

### 3.3 General Model

We now return to the general model with multiple MCOs and hospitals active in a given market. Following the previous analysis, we derive the FOC of the maximization problem given by (4) (for a given network $\mathcal{G}$, premiums $\boldsymbol{\phi}$, and negotiated prices $\boldsymbol{p}^*$):

$$\underbrace{p^*_{i,j} D^H_{i,j}}_{\text{total hospital payments}} = (1-\tau_j)\Bigg[\underbrace{\big([\Delta_{i,j} D_j]\phi_j - [\Delta_{i,j} D^E_j]\eta_j\big)}_{\text{(i) } \Delta \text{ MCO revenues net of non-hosp costs}} - \underbrace{\Bigg(\sum_{h \in \mathcal{G}^M_j \setminus ij} p^*_{hj}[\Delta_{i,j} D^H_{hj}]\Bigg)}_{\text{(ii) } \Delta \text{ MCO } j \text{ payments to other hospitals}}\Bigg]$$
$$+ \tau_j \Bigg[\underbrace{c_i D^H_{i,j}}_{\text{(iii) total hospital costs}} - \underbrace{\sum_{n \in \mathcal{G}^H_i \setminus ij} [\Delta_{i,j} D^H_{i,n}](p^*_{i,n} - c_i)}_{\text{(iv) } \Delta \text{ Hospital } i \text{ profits from other MCOs}}\Bigg] \qquad (7)$$

where we have dropped the arguments of all demand functions for expositional convenience, and $[\Delta_{i,j} D_j] \equiv D_j(\mathcal{G}, \cdot) - D_j(\mathcal{G} \setminus ij, \cdot)$, $[\Delta_{i,j} D_j^E] \equiv D_j^E(\mathcal{G}, \cdot) - D_j^E(\mathcal{G} \setminus ij, \cdot)$ and $[\Delta_{i,j} D_{h,j}^H] \equiv D_{h,j}^H(\mathcal{G}, \cdot) - D_{h,j}^H(\mathcal{G} \setminus ij, \cdot)$. These represent the changes in these functions when hospital $i$ and MCO $j$'s come to a disagreement, where we assume disagreement between hospital $i$ and insurer $j$ results in $i$'s removal from $j$'s network.[17]

Equation (7) represents the key equation for our analyses. As in the simple case discussed previously, the general model predicts that each MCO $j$ and hospital $i$ bargain over the "gains from trade" created when that hospital is onboard an MCO's network. These gains are primarily obtained by MCOs through higher premiums and additional enrollees; although these gains are shared with hospitals via negotiated per-admission prices, we use the *total hospital payment* used on the left-hand-side of (7) as a measure of hospital surplus that is comparable across hospitals for a particular MCO and is not dependent on the number of admissions that a hospital actually receives.[18]

The total hospital payment made from MCO $j$ to hospital $i$ depends on each firm's gains from trade. The first line, representing the MCO $j$'s gains from having hospital $i$ on its network, comprises two terms:

(i) *Premium and enrollment effects*: the first term represents $j$'s change in premium revenues (net of non-hospital costs) upon losing hospital $i$. It is a function of both the level of $j$'s premiums and the change in $j$'s enrollment if $i$ is no longer on its network.

(ii) *Price reinforcement effect*: this is the change in payments per enrollee that $j$ makes to other hospitals in its existing network upon losing $i$, and is a generalized version of term (ii) in equation (6) where we now allow the MCO to have additional hospitals on its network. It indicates that if $j$'s enrollees visit higher-cost hospitals in $j$'s network in the case where $i$ is dropped, then $p_{i,j}^*$ will be higher.

The second line of (7), representing hospital $i$'s gains from being on MCO $j$'s network, also comprises 2 terms:

(iii) *Hospital cost effect*: every unit increase in costs results in a $\tau_j$ unit increase in $p_{i,j}^*$.

(iv) *Recapture effect*: the final term, required when there is more than one insurer in a market, represents the change in hospital $i$'s reimbursements from insurers $n \neq j$ when $i$ is removed from $j$'s network. The more that consumers from other MCOs visit hospital $i$ if $j$ drops $i$ (which can occur if consumers switch away from $j$ to another MCO in order to access $i$), then the more negative is $\Delta_{i,j} D_{i,n}^H$ and hence the higher are negotiated prices $p_{i,j}^*$.

[17] In our empirical application, we assume that firms bargain over expected profits that are a function of expected demand,

[18] For example, consider two hospitals $A$ and $B$ that deliver the same "gains-from-trade" to MCO $j$, but $A$ serves fewer patients than $B$ (e.g., it is only valuable for a rare disease or diagnosis so that $D_{Aj}^H < D_{Bj}^H$). The model indicates that each hospital obtains the same absolute amount of surplus from MCO $j$ but focusing on a price-per-admission as opposed to total hospital payments will obscure this.

**Impact of a Change in Insurer Competition.** As in the simple case with a monopolist MCO, a change in insurer competition such as addition of a new insurer to the choice set affects hospital payments through multiple mechanisms. First, since the premium revenue term is a function of both demand and premiums, it allows the impact of insurer competition to have two offsetting effects. On one hand, the loss of a very attractive hospital can cause a larger change in an insurer's enrollment if there are alternative insurers present; this increases hospital prices (the enrollment effect). On the other hand, a competitive insurance market can reduce the loss in revenues faced by an insurer upon losing a hospital since premium markups are low, implying that losing a hospital leads to only a small adjustment in premiums (the premium effect). Adding an insurer affects the price reinforcement effect both by changing enrollment and, less directly, through its impact on the prices paid to other hospitals. Finally insurer competition may affect the recapture term through two routes. First, if the presence of other competing MCOs allows consumers to switch plans in order to retain access to hospital $i$, this will have a positive effect on price. Second, as for the reinforcement effect, there is an indirect effect through other prices in the market. One of the objectives of our counterfactual simulations is to decompose the overall price effect of insurer entry into these components.

**Hospital Systems.** In our main empirical application, we allow hospitals to jointly negotiate as part of a system. Let $\boldsymbol{\mathcal{S}}$ be a partition of the set of hospitals $\mathcal{H}$ into hospital systems (under the realistic assumption that hospitals can be part of only one system), and let $\mathcal{S} \in \boldsymbol{\mathcal{S}}$ represent the set of hospitals in a given system $\mathcal{S}$. A hospital system $\mathcal{S}$ can also represent a single hospital if $|\mathcal{S}| = 1$.

Let profits for a hospital system $\mathcal{S}$ be given by: $\pi_{\mathcal{S}}(\mathcal{G}, \boldsymbol{p}, \boldsymbol{\phi}) = \sum_{h \in \mathcal{S}} \pi_h^H(\mathcal{G}, \boldsymbol{p}, \boldsymbol{\phi})$ which sums over the profits of all hospitals $h \in \mathcal{S}$. We assume that each insurer must carry all or none of the hospitals in a system, but can negotiate a separate price for each hospital within the system. Every hospital system $\mathcal{S} \in \boldsymbol{\mathcal{S}}$ and insurer $j \in \mathcal{M}$ engages in simultaneous bilateral Nash bargaining over all prices for the given system so that each price $\{p_{i,j}\}_{i \in \mathcal{S}}$ maximizes the Nash product of the hospital system and insurer profits:

$$p_{i,j} = \arg\max_{p_{i,j}} \Bigg[ \underbrace{\pi_j^M(\mathcal{G}, \boldsymbol{p}, \boldsymbol{\phi}) - \pi_j^M(\mathcal{G} \setminus \mathcal{S}, \boldsymbol{p}_{-ij}, \boldsymbol{\phi})}_{\text{MCO } j\text{'s ``gains from trade'' with system } \mathcal{S}} \Bigg]^{\tau_j} \times \Bigg[ \underbrace{\pi_i^H(\mathcal{G}, \boldsymbol{p}, \boldsymbol{\phi}) - \pi_i^H(\mathcal{G} \setminus \mathcal{S}, \boldsymbol{p}_{-ij}, \boldsymbol{\phi})}_{\text{Hospital system } \mathcal{S}\text{'s ``gains from trade'' with MCO } j} \Bigg]^{(1-\tau_j)} \quad \forall i \in \mathcal{S}, \forall \mathcal{S} \in \boldsymbol{\mathcal{S}} \tag{8}$$

This is the corresponding bargain to (4), except that the disagreement point with hospital $i$ represents insurer $j$ losing all hospitals in $\mathcal{S}$. Every hospital in the same system has the same first-order-condition of (8):

$$\underbrace{\sum_{i\in\mathcal{S}} p^*_{i,j} D^H_{i,j}}_{\text{system payments}} = (1-\tau_j)\Bigg[ \underbrace{\big([\Delta_{\mathcal{S},j} D_j]\phi_j - [\Delta_{\mathcal{S},j} D^E_j]\eta_j)\big)}_{\text{(i) } \Delta \text{ MCO revenues net of non-hosp costs}} - \underbrace{\Big(\sum_{h\in\mathcal{G}^M_j\setminus\mathcal{S}} p^*_{hj}[\Delta_{\mathcal{S},j} D^H_{hj}]\Big)}_{\text{(ii) } \Delta \text{ MCO } j \text{ payments to other hospitals}} \Bigg]$$

$$+\tau_j\Bigg[ \underbrace{\sum_{i\in\mathcal{S}} c_i D^H_{i,j}}_{\text{(iii) system costs}} - \underbrace{\sum_{i\in\mathcal{S}} \sum_{n\in\mathcal{G}^H_{\mathcal{S}}, n\neq j} ([\Delta_{\mathcal{S},j} D^H_{i,n}](p^*_{i,n} - c_i)}_{\text{(iv) } \Delta \text{ system profits from other MCOs}} \Bigg] \quad \forall \mathcal{S} \in \boldsymbol{\mathcal{S}} \tag{9}$$

where $[\Delta_{\mathcal{S},j} D_j]$, $[\Delta_{\mathcal{S},j} D^E_j]$, and $[\Delta_{\mathcal{S},j} D^H_{hj}]$ represent changes in these objects when MCO $j$ and system $\mathcal{S}$ come to a disagreement. Note that (9) is equivalent to (7) if there are no hospital systems (or if hospitals in the same system bargain independently). As before, we refer to terms (i)-(iv) as the premium and enrollment, price reinforcement, hospital cost, and recapture effects.

# 4 Empirical Application and Estimation

In the previous section, we developed a theoretical framework for insurer competition and bargaining with hospital systems, and obtained a relationship between negotiated hospital prices and consumer demand for hospitals and insurance plans given by (9). In this section we discuss our empirical setting and estimate the parameters and components that enter into this equation. We first describe the data from which negotiated prices, average hospital costs, insurer-hospital networks, household insurance enrollment, and individual hospital demand can be inferred. We then present and estimate a model of individual demand for hospitals from which we can predict the number of individuals who visit any hospital $h$ from MCO $j$ for any potential set of hospital networks (i.e., $\{D^H_{h,j}(\cdot)\}_{\forall h,j}$), as well as the expected utility or *willingness-to-pay* (WTP) for an insurer's hospital network. Next, we present and estimate a model of household demand for insurance plans from which we can predict the number of each type of households ($\{D_{j,\lambda}(\cdot)\}_{\forall j,\lambda}$) and number of individuals ($\{D^E_j(\cdot)\}_{\forall j}$) that enroll on any insurance plan $j$ for any potential set of hospital networks. Finally we use these two demand systems to estimate a model of insurer premium setting and hospital-insurer bargaining.

## 4.1 Data and Setting

Our main dataset comprises 2004 enrollment, claims, and admissions information for over 1.2M enrollees covered by the California Public Employees' Retirement System (CalPERS), an agency that manages pension and health benefits for California public and state employees, retirees, and their families. In 2004, CalPERS offered access to an HMO plan from California Blue Shield (BS), a self-insured PPO plan administered by Anthem Blue Cross (BC), and an HMO plan offered by Kaiser Permanente, a vertically integrated insurer with its own set of physicians and hospitals. We base our market definition on the California Office of Statewide Health Planning and Development (OSHPD) health service area (HSA) definitions. There are 14 HSAs in California.

For enrollees in BS and BC, we observe hospital choice, diagnosis, and total prices paid by each insurer to a given medical provider for the admission. We have 37,570 inpatient admissions in 2004 for enrollees in BS and BC under the age of 65 that can be matched to an acute care hospital in our data; we do not observe prices or claims information for Kaiser enrollees. The claims data are aggregated into hospital admissions and assigned a Medicare diagnosis-related group (DRG) code; we use the admissions data to estimate a model of consumer demand for hospitals (described in the next section), conditional on the set of hospitals in the BS and BC networks.[19] We discuss our measure of a price per-admission negotiated between an insurer and hospital in Section 4.4.

We divide individuals into 5 different age groups (0-19, 20-34, 35-44, 45-54, 55-64) and omit individuals over 65 (as they likely qualify for Medicare); this defines 10 distinct age-sex categories. For each age-sex group, we compute the average DRG weight for an admission from our admissions data, and compute the probability of admission to a hospital by dividing the total number of admissions from commercial insurers, by age-sex, in California (from 2003 OSHPD discharge data) by Census data on the total population commercially insured.[20] We also compute the probability of an individual in each age-sex group of being admitted for particular diagnoses in a similar fashion.

For enrollment data we use information on the plan choices of state employee households in 2004. We focus on state employees and their dependents only, and have the age, sex, and zip code for each household member and salary information in \$10K bins for the primary household member.[21] We limit our attention to enrollees into either BS, BC, or Kaiser, which represents over 90% of state enrollees.[22] For estimating insurance demand, we focus on households where the primary enrollee is under the age of 65 and salary information is not missing, leaving us with 162,719 unique households representing 425,647 individuals. We supplement detailed information on plan premiums and hospital networks with information on plan availability, collected from plan evidence of coverage and disclosure forms; it provides the zip codes and markets in which Kaiser and BS are not available to enrollees as an option.[23]

In addition to our main dataset, we use hospital characteristics, including location and costs, for hospitals from the American Hospital Association (AHA) survey.[24] We use demographic information from the 2000 Census.[25]

[19]We obtain BC hospital network information directly from the insurer; for BS, we infer the hospital network by including all hospitals that admitted at least 10 BS enrollees, and had claims data indicating that the hospital was a "network provider."

[20]An alternative method, using CalPERS data to determine the probability of admission, generated similar results.

[21]We do not use enrollment information for public agency employees due to the lack of salary information, and unobserved variation across public agencies in the amount of employer premium contributions.

[22]Some employees (primarily members of law enforcement associations) had access to additional plans that we exclude from our analysis. For our sample of active state employees, total household enrollment in these other plans was below 8%, and no omitted plan had enrollment greater than 2.8%.

[23]Kaiser is not offered as an option in HSAs 1 and 8; it also has limited availability in other markets by zip code. BS is offered as an option in all markets, except in parts of HSAs 1, 6, 8 and 12.

[24] Our measure of costs is the average payroll cost per admission for a hospital divided by the average DRG weight of admissions at that hospital (observed in our data).

[25]Since the Census uses Zip Code Tabulation Areas (ZCTAs) as a geographic identifier, while our other data use

Table 1: Summary Statistics

| | | BS | BC | Kaiser |
|---|---|---|---|---|
| Premiums ($/yr) | Single | 3782.64 | 4192.92 | 3665.04 |
| | 2-Party | 7565.28 | 8385.84 | 7330.08 |
| | Family | 9834.84 | 10901.64 | 9529.08 |
| Insurer | # Hospitals in Network | 187 | 220 | 27 |
| Characteristics | # Hospital Systems in Network | 119 | 147 | - |
| | Avg. Hospital Prices | 6741.54 | 6085.64 | - |
| | Avg. Hospital Costs | 3181.95 | 3271.36 | - |
| Household | Single | 19313 | 8254 | 20319 |
| Enrollment | 2-Party | 16376 | 7199 | 15903 |
| | Family | 35058 | 11170 | 29127 |
| | Avg. # Individuals/Family | 3.97 | 3.99 | 3.94 |

Notes: Summary statistics by insurer. Hospitals and hospital systems in network for BS and BC determined by the number of in-network hospitals or systems with at least 10 admissions observed in our data. Avg. Hospital Prices and Costs are unit-DRG amounts per admission (averaged across hospitals within each insurer).

**Summary Statistics.** Summary statistics are provided in Table 1. In 2004, annual premiums for single households across BS, BC, and Kaiser were $3782, $4193, and $3665; premiums for 2-party and families across all plans were a strict 2x or 2.6x multiple of single household premiums. State employees received approximately an 80% contribution by their employer. We use total annual premiums received by insurers when computing firm profits, and we use household annual contributions (20% of premiums) when analyzing household demand for insurers.

Table 2 reports individual enrollment for our sample of state employees and dependents, and illustrates the considerable variation in insurer market shares across HSAs. In particular, although BC is a small player in most markets, it has the largest market share in two of the more rural markets—HSA 1 and 8—where Kaiser is not available, and BS has a limited presence. Our empirical work will control for cross-market variation in insurer attractiveness by admitting insurer-market specific fixed effects, controlling for each insurer's hospital network, and by varying the set of insurers available to each enrollee by zip code.

Table 3 provides average admission probabilities and DRG weights per admission by age-sex categories. Note that admission rates and DRG weights for each age-sex category are broadly similar across samples. Older patients are admitted more often and with higher weights; the exception are 20-34 year old females, who are admitted more often than any other age-sex category at lower average DRG weights (as they are primarily admitted for labor and delivery services).

## 4.2 Individual Demand for Hospitals

Our model of individual demand for hospitals and insurers follows Ho (2006), which uses a discrete choice model of hospital demand that allows preferences to vary with observed differences across consumers. The estimates are used to generate an expected utility from each insurer's network which is then included as a plan characteristic in a model of demand for insurers. Choices of both

USPS zip codes, we obtain the demographic information from an intermediary dataset available at zip-codes.com which re-categorizes the Census information by zip code.

Table 2: Individual Enrollment and Hospital System Concentration

| | Individual Plan Enrollment | | | | | | Hospital Concentration | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Enrollment | | | Market Share | | | # Systems | | HHI (Adm) | |
| HSA Market | BS | BC | Kaiser | BS | BC | Kaiser | BS | BC | BS | BC |
| 1. North | 5366 | 15143 | - | 0.26 | 0.74 | - | 5 | 17 | 3686 | 1489 |
| 2. Sacramento | 55732 | 6212 | 59772 | 0.46 | 0.05 | 0.49 | 6 | 8 | 4112 | 2628 |
| 3. Sonoma / Napa | 6826 | 955 | 13762 | 0.32 | 0.04 | 0.64 | 5 | 5 | 3489 | 3460 |
| 4. San Francisco Bay West | 6021 | 926 | 4839 | 0.51 | 0.08 | 0.41 | 4 | 4 | 4362 | 3054 |
| 5. East Bay Area | 7856 | 1200 | 10763 | 0.40 | 0.06 | 0.54 | 9 | 10 | 2560 | 2096 |
| 6. North San Joaquin | 9663 | 3979 | 4210 | 0.54 | 0.22 | 0.24 | 7 | 8 | 2482 | 1888 |
| 7. San Jose / South Bay | 2515 | 762 | 4725 | 0.31 | 0.10 | 0.59 | 5 | 6 | 3265 | 2628 |
| 8. Central Coast | 8028 | 13365 | - | 0.38 | 0.62 | - | 4 | 9 | 3431 | 2254 |
| 9. Central Valley | 27663 | 7613 | 10211 | 0.61 | 0.17 | 0.22 | 12 | 13 | 1863 | 1539 |
| 10. Santa Barbara | 3973 | 1416 | 658 | 0.66 | 0.23 | 0.11 | 7 | 7 | 2459 | 2863 |
| 11. Los Angeles | 18205 | 6731 | 23919 | 0.37 | 0.14 | 0.49 | 22 | 28 | 741 | 716 |
| 12. Inland Empire | 17499 | 2801 | 20690 | 0.43 | 0.07 | 0.50 | 15 | 15 | 1015 | 1034 |
| 13. Orange | 7836 | 2906 | 5430 | 0.48 | 0.18 | 0.34 | 8 | 9 | 2425 | 2250 |
| 14. San Diego | 14585 | 2298 | 8593 | 0.57 | 0.09 | 0.34 | 10 | 8 | 1708 | 2549 |
| Total[a] | 191768 | 66307 | 167572 | 0.45 | 0.16 | 0.39 | 119 | 147 | 1004 | 551 |

Notes: Individual enrollment and market shares (Kaiser was not an option for enrollees in HSAs 1 and 8) and hospital system membership and admission Herfindahl-Hirschman Index (HHI)—computed using the number of admissions for all hospital-insurer pairs in our sample—by insurer.

[a] Total (statewide) HHI accounts for hospital system membership across HSAs.

Table 3: Admission Probabilities and DRG Weights

| | Admission Probabilities | | | DRG Weights | | |
|---|---|---|---|---|---|---|
| | OSHPD | CalPERS | | CalPERS | | |
| Age-Sex Category | All | BS | BC | BS | BC | All |
| 0-19 Male | 2.05% | 1.78% | 2.08% | 1.78 | 1.49 | 1.70 |
| 20-34 Male | 2.07% | 1.66% | 2.07% | 1.99 | 1.77 | 1.92 |
| 35-44 Male | 3.11% | 2.79% | 3.21% | 1.95 | 1.89 | 1.93 |
| 45-54 Male | 5.58% | 5.29% | 5.32% | 2.07 | 2.05 | 2.07 |
| 55-64 Male | 10.49% | 10.13% | 9.70% | 2.25 | 2.25 | 2.25 |
| 0-19 Female | 2.28% | 1.95% | 2.04% | 1.31 | 1.39 | 1.32 |
| 20-34 Female | 11.19% | 11.75% | 10.22% | 0.84 | 0.87 | 0.85 |
| 35-44 Female | 7.91% | 7.31% | 7.73% | 1.32 | 1.33 | 1.32 |
| 45-54 Female | 6.87% | 6.16% | 6.82% | 1.90 | 1.83 | 1.87 |
| 55-64 Female | 9.74% | 9.01% | 9.26% | 2.03 | 2.02 | 2.03 |

Notes: Average admission probabilities and DRG weights per admission by age-sex category. OSHPD refers to estimates from 2003 OSHPD discharge data; CalPERS refers to estimates from CalPERS admissions data.

hospitals and insurance plans are assumed in that paper to be made separately by each consumer in the market. However, since we have access to household level plan choice data rather than just aggregate market shares, we can model plan choices at the household level rather than the individual level, and permit household characteristics (such as the number of children and household income) to affect choices. In addition, since our data come from a single benefits manager, we know exactly which insurers are in the choice set.[26]

We assume that individuals belong to one of 10 age-sex categories or "types" (described previously), and an individual of type $\kappa$ requires admission to a hospital with probability $\gamma^a_\kappa$; conditional on admission, the individual has one of six diagnoses $l \in \mathcal{L} \equiv${cardiac, cancer, neurological, digestive, labor, other} with probability (conditional on admission) $\gamma_{\kappa,l}$. Individuals can only visit a hospital in their market (HSA) $m$, and individual $k$ of type $\kappa(k)$ with diagnosis $l$ derives the following utility from visiting hospital $i$:

$$u^H_{k,i,l,m} = \delta_i + z_i \upsilon_{k,l}\beta^z + d_{i,k}\beta^d_m + \varepsilon^H_{k,i,l,m} \tag{10}$$

where $\delta_i$ are hospital fixed effects, $z_i$ are observed hospital characteristics (teaching status, a for-profit (FP) indicator, the number of beds and nurses per bed, and variables summarizing the cardiac, cancer, imaging and birth services provided by the hospital), $\upsilon_{k,l}$ are characteristics of the consumer (diagnosis, income, PPO enrollment), $d_{i,k}$ represents the distance between hospital $i$ and individual $k$'s zip code of residence (and has a market-specific coefficient), and $\varepsilon^H_{k,i,l,m}$ is an idiosyncratic error term assumed to be i.i.d. Type 1 extreme value. There is no outside option, since our data includes only patients who are sick enough to go to a hospital for a particular diagnosis. We observe the network of each insurer and, therefore, can accurately specify the choice set of each patient; we assume that the enrollee can choose any hospital in his HSA that is included in his insurer's network and within 100 miles of the enrollee's zip code. Importantly, we also assume that negotiated hospital prices do not influence individuals' choice of which hospital to visit.[27]

The model predicts that a individual $k$, who lives in market $m$, is enrolled in MCO $j$, and has diagnosis $l$, visits hospital $i$ with probability:

$$\sigma^H_{ijkm|l}(\mathcal{G}) = \frac{\exp(\delta_i + z_i\upsilon_{k,l}\beta^z + d_{i,k}\beta^d_m)}{\sum_{h\in\mathcal{G}^H_{jm}} \exp(\delta_h + z_h\upsilon_{k,l}\beta^z + d_{h,k}\beta^d_m)}$$

where $\mathcal{G}^M_{j,m}$ is the network of hospitals available on insurer $j$ in market $m$. The probability that a individual $k$ visits hospital $i$ given his insurer network is then given by:

$$\sigma^H_{ijkm}(\mathcal{G}_m) = \gamma^a_{\kappa(k)} \sum_{l\in\mathcal{L}} \gamma_{\kappa(k),l}\sigma^H_{kijm|l}(\mathcal{G}_m) \tag{11}$$

We estimate this model via maximum likelihood using our admission data. Further estimation details and estimates are provided in Appendix A.1.

[26] In contrast, in Ho (2006), the insurer utility equation was estimated from aggregate market share data. Individuals' employer-based choice sets were not observed so the estimates were interpreted as reflecting the joint preferences of the employers choosing the choice sets and the employees choosing their plans.

[27] We note that this is consistent with the non-observability of negotiated prices by consumers who may face coinsurance payments, and the inability of insurers to otherwise steer patients to cheaper hospitals. See further discussion of this assumption in Ho and Pakes (2014) and Gowrisankaran, Nevo and Town (2015).

**Identification.** Identification of individual preferences for hospitals relies on variation in hospital choice sets across markets and differences in choice probabilities for particular hospitals with certain characteristics both within and across diagnosis categories. The distance coefficient, which is assumed to be market-specific, is identified from within-market, across-zip code variation in choice probabilities as consumers live closer or further away from hospitals. We rely on the common assumption that unobservable hospital preference shocks are uncorrelated with observable hospital characteristics, including location. Furthermore, as in Ho (2006), we implicitly assume that there is no selection across insurance plans on unobservable consumer preferences for hospitals.

**Willingness-to-Pay (WTP).** The estimated demand model is valuable for this application for several reasons. First, it can be used to predict changes in hospital demand on any insurer following any hypothetical network change. Second, it allows us to construct a measure of ex-ante expected utility or "willingness-to-pay" ($WTP$) for an insurer's hospital network.

We follow an established literature in using the estimated hospital demand model to predict this $WTP$ measure for any insurer's hospital network (Town and Vistnes, 2001; Capps, Dranove and Satterthwaite, 2003; Ho, 2006; Farrell et al., 2011). This object will then be used as a plan characteristic in our subsequent insurer demand model. Given the assumption on the distribution of $\epsilon^H_{k,i,l,m}$, individual $k$'s expected utility or $WTP$ for the hospital network offered by plan $j$ can be expressed as:

$$WTP_{k,j,m}(\mathcal{G}_{j,m}) = \gamma^a_{\kappa(k)} \sum_{l \in \mathcal{L}} \gamma_{\kappa(k),l} [\underbrace{\log\left(\sum_{h \in \mathcal{G}_{j,m}} \exp(\hat{\delta}_h + z_h \upsilon_{k,l} \hat{\beta}^z + d_{h,k} \hat{\beta}^d)\right)}_{EU_{k,j,l,m}(G_{j,m})}]$$

where the expression is a weighted sum across diagnoses of the expected utility of a hospital network conditional on a given diagnosis ($EU_{k,j,l,m}(G_{j,m})$), scaled by the probability of admission to any hospital.[28] Note that this object varies explicitly by age and gender. The model will therefore be able to account for differential responses by particular types of patients (i.e., selection) across insurers and hospitals when an insurer's hospital network changes.

## 4.3 Household Demand for Insurance Plans

We next estimate a model of household demand for insurance plans using enrollment information for state employee households. We assume that each household chooses among three insurance plans (BS, BC, and Kaiser), and considers the preferences over hospital networks for all individuals within the household.

We assume that the utility a household or family $f$ receives from choosing insurance plan

[28] $EU_{k,j,l,m}(G_{j,m})$ is the expected value of the maximum of $\{u^H_{k,i,l,m}\}$ across all hospitals in $G_{j,m}$ before the realization of the (demeaned) error terms $\{\varepsilon^H_{k,i,d}\}$.

$j \in \{BS, BC\}$ in market $m$ is given by:

$$u^M_{f,j,m} = \underbrace{\delta_{j,m} + \alpha^\phi_f(.2 \times \phi_{\lambda(f),j}) + \sum_{\forall\kappa} \alpha^W_\kappa \sum_{k\in f,\kappa(k)=\kappa} WTP_{k,j,m}}_{\tilde{u}^M_{f,j,m}} + \varepsilon^M_{fjm} \qquad (12)$$

where $\delta_{j,m}$ is an insurer-market fixed effect that controls for physician networks, brand effects, and other insurer characteristics; $\phi_{\lambda(f),j,m}$ is the household type-insurer premium (scaled by the consumer contribution of 20%), where $\lambda(f)$ denotes the household-type of household $f$ (single, 2-party, family);[29] $\sum_\kappa \alpha^W_\kappa \sum_{k\in f,\kappa(k)=\kappa} WTP_{k,j,m}(\cdot)$ is the variable summarizing a household's WTP for the insurer's hospital network, which is constructed by summing over the value of the value of $WTP_{k,j,m}$ for each member of the household multiplied by a age-sex-category specific coefficient, $\alpha_\kappa$; and $\varepsilon^M_{fjm}$ is a Type 1 extreme value error term. This specification is consistent with households choosing an insurance product prior to the realization of their health shocks and aggregating the preferences of members when making the plan decision.[30,31] We assume that in markets where Kaiser is available, Kaiser is the "outside-option" and delivers utility $u^M_{f,Kaiser,m} = \tilde{u}^M_{f,Kaiser,m} + \varepsilon_{f,Kaiser,m}$, where $\tilde{u}^M_{f,Kaiser,m} \equiv \alpha^K_m d^K_f$ and $d^K_f$ is the (drive-time) distance between household $f$'s zip code and the closest Kaiser hospital. In two HSAs, Kaiser is not available; in these markets, we assume that $\delta_{BC,m} = 0$. We assume that each household chooses the utility maximizing insurance plan among those available to it.[32]

Thus, the predicted probability that a given family $f$ chooses an insurer $j$ is:

$$\hat{\sigma}_{f,j,m}(\boldsymbol{\phi}, \mathcal{G}) = \frac{\tilde{u}^M_{f,j,m}}{\sum_{n\in\mathcal{M}_{z(f)}}(\tilde{u}^M_{f,n,m})} \qquad j \in \mathcal{M}_{z(f)} \qquad (13)$$

where $\mathcal{M}_{z(f)}$ denotes the set of insurers available in $f$'s zip code of residence.

**Identification.** The coefficients $\{\alpha^W_\kappa\}_{\forall\kappa}$ are identified from variation in households' $WTP$ for an insurer's network, induced both through geographic variation within-market across zip-codes (e.g., some households are closer to hospitals included in an insurer's network than others), and through variation in the probabilities of experiencing different diagnoses (e.g., households vary in age and gender composition). The insurer-market fixed effects will absorb variation in plan benefits such as deductibles and coinsurance rates that do not vary within markets; we assume that they also

[29] We do not explicitly model household responsiveness to deductibles, copays, or—in the case of BC—coinsurance rates. As long as the financial generosity of plans (outside of premiums) does not vary when an insurer is added or removed from a market, the impact of deductibles and copays will be absorbed into plan-market fixed effects and not affect our analysis.

[30] For implementation, we group together male and female individuals between the ages of 0-19, yielding 9 different age-sex category coefficients for $WTP$.

[31] See also Crawford and Yurukoglu (2012) and Lee (2013) as examples of controlling for complementary good utility when estimating demand for an intermediary product.

[32] We also explicitly control for the unavailability of Kaiser in certain zip codes, detailed in the insurer evidence of coverage and disclosure form.

absorb any variation in unobserved plan quality that could be correlated with premiums or hospital networks and lead to biased estimates.

We parameterize the coefficient on premiums as $\alpha_f^\phi \equiv \alpha_0^\phi + \alpha_1^\phi \log(y_f)$, where $y_f$ is the income of the household's primary enrollee. The premium coefficient is identified from within-plan variation in the premiums charged across household types (which are observed) for a given market; concerns about endogeneity are mitigated by the use of exogenous fixed multiples to scale premiums across household types and the presence of insurer-market specific fixed effects. This identification strategy requires an assumption that, controlling for income, while premiums vary across family types, premium sensitivity does not. As premiums do not vary across markets and are common across the state, cross-market variation cannot be used to identify the premium coefficient.

**Estimates.** We estimate the model via maximum likelihood. Estimates from the insurer demand system are presented in Table 13 in the Appendix. All coefficients are significant at p=0.05 and of the expected sign, except for one coefficient on $WTP$ for young individuals (age 0-19), which is positive but insignificant. We find that households are less price sensitive the higher is their income, and that households are more likely to choose an insurance plan that delivers higher hospital network expected utility. The desirability of Kaiser as an insurer is decreasing in the distance to the closest Kaiser hospital.

Table 4 provides implied own-price elasticities for each plan and household type.[33] The magnitudes range from -1.20 for single-person households for Kaiser to -2.94 for families with children for BC. These numbers are well within the range estimated in the previous literature. For example Ho (2006) uses a similar model (although a different dataset) to generate an estimated elasticity of -1.24. Cutler and Reber (1996) and Royalty and Solomon (1998) use panel data on enrollee responses to observed plan premium changes in employer-sponsored large group settings to estimate elasticities of -2, and between -1.02 and -3.5, respectively. We note, however, that these estimates may potentially represent a lower bound on the true elasticity faced by insurers because they do not account for insurer competition to be included in the menu of plans offered by CalPERS.[34] If the employer (CalPERS) is more price-elastic than the consumer, which may plausibly be the case given the much larger amounts paid by the employer, then a model that included competition at the employer level would predict higher elasticities, and lower insurer markups, than our estimates. We allow for this possibility in our model of premium setting discussed below.

### 4.4 Insurer Premium Setting and Hospital-Insurer Bargaining

We now turn to the estimation of insurer (non-hospital) marginal costs $\{\eta_{BS}, \eta_{BC}, \eta_K\}$ and Nash bargaining parameters $\{\tau_{BS}, \tau_{BC}\}$. We first detail the construction of the objects (hospital-insurer

[33] We report elasticities based on the full premium rather than the out-of-pocket prices faced by enrollees; they are referred to in the previous health insurance literature as "insurer-perspective" elasticities.

[34] Town (2001) uses a logit demand model, estimated using cross-employer as well as within-employer data variation, to generate a higher range of elasticities from -3.5 to -5.6 for California small group plans in 1997.

Table 4: Estimates: Insurance Plan Household Price Elasticities

| | Single | 2-Party | Family |
|---|---|---|---|
| BS | -1.25 | -2.18 | -2.56 |
| BC | -1.62 | -2.50 | -2.94 |
| Kaiser | -1.20 | -2.04 | -2.41 |

Notes: Estimated own-price elasticities for each insurer using insurer demand estimates from Table 13.

prices, and insurer and hospital demand) required to estimate these parameters from our model of insurer premium setting and hospital-insurer bargaining.

**Construction of Hospital-Insurer Prices.** To construct a measure of the price negotiated between each insurer-hospital pair, we first divide the price associated with each admission by that admission's 2004 Medicare DRG weight to account for differences in relative values across diagnoses. We then take an average across admissions to find the average "DRG-adjusted price." We focus only on hospital-insurer price observations for which we observe 10 or more admissions from a given insurer. We assume that each hospital-insurer pair negotiates a single price index that is approximated by this DRG-adjusted average (representing the negotiated price for an admission with DRG weight of 1.0), and that this value is multiplied by the DRG severity of the relevant admission to determine the actual payment to the hospital.

Formally, let $\mathcal{A}_{ij}$ be the set of admissions that we observe between hospital $i$ and MCO $j$. We assume that for any admission $a \in A_{ij}$, the total observed payment made for that admission $p^o_a = p^*_{ij} DRG_a + \varepsilon_a$, where $p^*_{ij}$ is the price per-admission (for an admission of DRG weight 1.0) negotiated by $i$ and $j$ given by (9), $DRG_a$ is the observed DRG-weight for admission $a$, and $\varepsilon_a$ represents a mean-zero admission specific payment shock reflecting unanticipated procedures or costs (and is mean independent of all observable hospital and insurer characteristics). Our estimate of a hospital-insurer's negotiated DRG-weighted price per admission $p^*_{ij}$ is $\hat{p}_{ij} \equiv (1/\#A_{ij}) \sum_{\forall a \in A_{ij}} (p^o_a / DRG_a) = p^*_{ij} + \varepsilon^A_{ij}$, where $\varepsilon^A_{ij} \equiv \hat{p}_{ij} - p^*_{ij} = (1/\#A_{ij}) \sum_{\forall a \in A_{ij}} (\varepsilon_a / DRG_a)$ and, by assumption, is not known in advance to either hospitals or insurers.[35]

**Predicted and Counterfactual Hospital and Insurer Demand.** With estimates from the insurer and hospital demand systems in hand, the demand objects in our specification of insurer and hospital profits in (1) and (2) are computed by predicting the insurer and hospital demand choices for all households and individuals in our data, and aggregating as follows:

- *Insurer Demand:* For each insurer $j$ and household type $\lambda$ (single, two-party, or family), we predict expected insurer household demand: $\hat{D}_{j,\lambda,m}(\mathcal{G}, \boldsymbol{\phi}) \equiv \sum_{f \in \mathcal{F}_{\lambda,m}} \hat{\sigma}_{f,j,m}(\mathcal{G}, \boldsymbol{\phi})$, where $\mathcal{F}_{\lambda,m}$ is the set of households of type $\lambda$ in market $m$, and $\hat{\sigma}_{f,j,m}$ is the our predicted probability

[35] Hospital contracts with commercial insurers are typically negotiated as some combination of per-diem and case rates, and payments are not necessarily made at the DRG level. However, since Medicare DRG weights are designed to measure variation in resource utilization across diagnoses, we view them as appropriate inputs to control for differences in case-mix and resource use across hospitals. Hospitals are not paid on a capitation basis in our data.

that household $f$ chooses MCO $j$ given by (13). Similarly, for each insurer $j$, we form a prediction of the expected number of individual enrollees on each insurer by $\hat{D}^E_{j,m}(\mathcal{G},\boldsymbol{\phi}) \equiv \sum_{f\in\mathcal{F}_m} N_f \hat{\sigma}_{f,j,m}(\mathcal{G},\boldsymbol{\phi})$, where $N_f$ is the number individuals in household $f$.

- *Hospital Demand:* For each hospital $i$ and MCO $j$, we predict the number of expected admissions from type-$\kappa$ individuals: $\hat{D}^H_{i,j,\kappa,m}(\mathcal{G},\boldsymbol{\phi}) \equiv \sum_{f\in\mathcal{F}_m} \hat{\sigma}_{f,j,m}(\mathcal{G},\boldsymbol{\phi}) \sum_{k\in f,\kappa(k)=\kappa} \hat{\sigma}^H_{ijkm}(\mathcal{G})$, where $\hat{\sigma}^H_{ijkm}(\cdot)$ is the predicted probability that individual $k$ of type $\kappa$ in family $f$ visits hospital $i$ on MCO $j$'s network given by (11) and our hospital demand estimates. We aggregate this value to the total predicted number of expected admissions across all individuals for hospital $i$ from MCO $j$, and scale by the expected admission DRG weight for patients of type $\kappa$ (given by $E[DRG_a|\kappa]$), as follows: $\hat{D}^H_{i,j,m}(\mathcal{G},\boldsymbol{\phi}) \equiv \sum_{\forall\kappa} E[DRG_a|\kappa] \times \hat{D}^H_{i,j,\kappa,m}(\cdot)$.

  As noted, weighting $\hat{D}^H_{i,j,\kappa,m}(\cdot)$ by the average admission DRG weight for a type-$\kappa$ individual accounts for potential differences in disease severity across admissions. Since this multiplies both hospital unit-DRG adjusted prices and costs, we capture the impact of selection of enrollees by age-sex categories and location across plans (e.g., as insurer hospital networks change) on expected reimbursements and costs in our bargaining equations.

These demand objects are computed for the observed network of hospitals and insurers, and for all potential "disagreement networks" involving a breakdown of agreement between any hospital and insurer pair. These allow for the construction of all demand terms in the bargaining first-order condition (7), which then allows us to estimate the remaining parameters in this equation—i.e., insurer non-hospital marginal costs of each enrollee $\{\eta_j\}$, and Nash bargaining parameters $\{\tau_j\}$.

**Estimation of Insurer Marginal Costs and Nash Bargaining Parameters.** We jointly estimate $\boldsymbol{\theta} \equiv \{\boldsymbol{\eta},\boldsymbol{\tau},\rho\}$ using 2-step GMM under the assumption that $E[\boldsymbol{\omega}^n(\boldsymbol{\theta})\boldsymbol{Z}^n] = 0$ for $n \in \{1,2,3\}$, where we define our error terms $\{\boldsymbol{\omega}^n\}_{n\in\{1,2,3\}}$, sets of instruments $\{\boldsymbol{Z}^n\}_{n\in\{1,2,3\}}$, and parameter $\rho$ below.

1. *Premium Setting.* We assume that all MCOs maximize profits and are constrained to set premiums for different household types at the multiples observed in the data (2x and 2.6x for two-party and family) and to be the same across the entire state (a constraint that holds in our data). Denoting the premium for a single household charged by MCO $j$ as $\phi_j$, the first-order condition of (1) can be expressed as:

$$\frac{\partial\pi^M_j(\cdot)}{\partial\phi_j} = \sum_m \Bigg( [1,2,2.6]\times\hat{\boldsymbol{D}}_{j,m}(\cdot) \qquad (14)$$
$$+\rho\times\Bigg(\phi_j[1,2,2.6]\times\frac{\partial\hat{\boldsymbol{D}}_{j,m}(\cdot)}{\partial\phi_j} - \frac{\partial\hat{D}^E_{j,m}(\cdot)}{\partial\phi_j}\eta_j - \sum_{h\in\mathcal{G}^H_{j,m}} \frac{\partial\hat{D}^H_{h,j,m}(\cdot)}{\partial\phi_j}\hat{p}_{h,j}\Bigg)\Bigg) + \omega^1_j \qquad \forall j$$

where $\hat{\boldsymbol{D}}_{j,m}$ and $\partial\hat{\boldsymbol{D}}_{j,m}/\partial\phi_j$ are vectors for each of these objects (the levels and derivatives with respect to premiums of insurer demand) for all three household types.

We introduce the "elasticity scaling" parameter $\rho > 0$ in (14) to allow insurers to perceive that the derivative of household demand with respect to premiums (which enters into the derivative terms in (14)) may differ from that estimated from our insurer demand model. Explicitly modeling the competition between insurers to be included on the CalPERS plan menu is beyond the scope of this paper. However, to the extent that employers have different premium elasticities from their employees, failing to account for this difference may bias our estimates of insurer marginal costs even if our household premium elasticities are accurately estimated. We thus use the parameter $\rho$ as a way of capturing standard Nash Bertrand premium setting behavior while also allowing us to better match observed insurer price-cost margins (the next set of moments). We also report estimates and results when we impose $\rho = 1$ (i.e., insurers, when setting premiums, perceive that premium elasticities are the same as those estimated from our insurer demand model); our substantive counterfactual predictions are similar. Additionally, in Section 6, we detail and discuss results from two alternative premium setting specifications.

For BS and BC, as we are explicitly controlling for prices paid to hospitals, the estimated cost parameters $\{\eta_j\}_{j\in\{BS,BC\}}$ represent non-hospital marginal costs per enrollee, which may include physician, pharmaceutical, and other fees. Since we do not observe hospital prices for Kaiser, $\eta_{Kaiser}$ will also include Kaiser's hospital costs. With the exception of $\eta_j$ and $\rho$, all objects on the right-hand-side of (14) are computable from the hospital and insurer demand systems estimated in the previous subsections. We assume that our estimates of all demand terms in (14) (including expected DRG weights) condition on exactly the set of observables in firms' information sets so that they are optimal predictors of these terms and equal to firms' expectations for these objects.

The term $\omega_j^1$ is mean zero; we recover it by setting $\partial\pi_j^M(\cdot)/\partial\phi_j$ in (14) equal to 0, and use a constant and the number of hospital systems onboard each insurer as instruments in $\boldsymbol{Z}^1$ to form two moment conditions.[36]

2. *Insurer Margins.* We use 2004 financial reports for each of our three insurers from the California Department of Managed Health Care to compute medical loss ratios (MLR) by dividing total medical and hospital costs costs by total revenues. Obtained ratios are $\{0.82, 0.79, 0.91\}$ for BS, BC, and K. We define:

$$\omega_j^2 = MLR_j^o - \underbrace{\sum_m \frac{D_{j,m}^E(\cdot)\eta_j + \sum_{h\in\mathcal{G}_{j,m}} \hat{D}_{h,j,m}^H(\cdot)\hat{p}_{h,j}}{\phi_j[1,2,2.6]\times\hat{\boldsymbol{D}}_{j,m}(\cdot)}}_{\text{Predicted MLR}} \qquad \forall j \tag{15}$$

where $MLR_j^o$ represents the obtained values for each insurer's MLR. We use the same instruments as for the premium setting moments ($\boldsymbol{Z}^2 = \boldsymbol{Z}^1$), providing two additional moments.

[36]By assumption, $E[\omega_j^1] = E[\sum_m \sum_{h\in\mathcal{G}_{j,m}} (\partial\hat{D}_{h,j,m}^H(\cdot)/\partial\phi_j)\varepsilon_{h,j}^A] = 0$.

3. *Hospital-Insurer Bargaining.* We derive the following equation from (9):

$$\sum_{i\in\mathcal{S}} \hat{p}_{ij}\hat{D}^H_{ij} = (1-\tau_j)\underbrace{\left[\left([\Delta_{\mathcal{S},j}\hat{D}_j]\phi_j\right) - \sum_{h\in\mathcal{G}^M_j\setminus\mathcal{S}} \hat{p}_{h,j}[\Delta_{\mathcal{S},j}\hat{D}^H_{h,j}]\right]}_{\tilde{Z}^3_{1;\mathcal{S},j}} - (1-\tau_j)\eta_j \underbrace{\left[\Delta_{\mathcal{S},j}\hat{D}^E_j\right]}_{Z^3_{2;\mathcal{S},j}}$$

$$+\tau_j \underbrace{\left[\sum_{i\in\mathcal{S}} c_i\hat{D}^H_{i,j} - \sum_{i\in\mathcal{S}}\sum_{n\in\mathcal{G}^H_{\mathcal{S}},n\neq j}[\Delta_{\mathcal{S},j}\hat{D}^H_{i,n}](\hat{p}_{i,n}-c_i)\right]}_{\tilde{Z}^3_{3;\mathcal{S},j}} + \omega^3_{\mathcal{S},j} \qquad \forall\mathcal{S} \tag{16}$$

where we assume that all hospitals in a system bargain jointly within a market, and the term $\omega^3_{\mathcal{S},j}$ is generated by MCO-hospital system specific differences between predicted and observed total hospital payments, resulting from our use of estimated prices per-admission as opposed to firms' actual expected prices.[37] As discussed above, we assume that our estimates of all demand terms in (16) are equal to firms' expectations for these objects. We use the following instruments in $\boldsymbol{Z}^3$ to address the endogeneity of negotiated prices on the right hand side of (16) with respect to $\omega^3_{\mathcal{S}j}$:

- We use two instruments for the term $\tilde{Z}^3_{1;\mathcal{S}j}$ in (16), where each is constructed by replacing $\hat{p}_{hj}$ for each hospital $h$ in the expression by either the hospitals per-admission cost $c_h$, or by a weighted average of $\Delta WTP_{h,j,k,m} \equiv WTP_{k,j,m}(\mathcal{G},\cdot) - WTP_{k,j,m}(\mathcal{G}\setminus\mathcal{S}_h, j,\cdot)$ across all individuals onboard MCO $j$ (where $\Delta WTP_{h,j,k,m}$ represents the change in expected utility for an individual $k$ when hospital $h$'s system is dropped from MCO $j$'s network);
- We use the term $Z^3_{2;\mathcal{S},j}$ in (16), which is the predicted change in individual enrollment on MCO $j$ upon losing system $\mathcal{S}$;
- We use two instruments for the term $\tilde{Z}^3_{3;\mathcal{S}j}$ in (16), where similar to above, we construct each instrument by replacing the term $(\hat{p}_{in} - c_i)$ with either $c_i$ or with $\Delta WTP_{i,n,k,m}$.

We construct these 5 instruments separately for BS and for BC (we do not estimate for Kaiser, as we do not observe its hospital prices), yielding 10 total instruments in $\boldsymbol{Z}^3$. These instruments rely on the positive correlation between hospital prices and both hospital costs and the constructed $\Delta WTP_{i,j,k,m}$ measure. These are valid instruments as we have assumed that unanticipated admission price shocks $\{\varepsilon^A_{ij}\}$ (which comprise $\omega^3_{\mathcal{S}j}$) are mean-zero and mean-independent of firm and hospital observable characteristics.[38]

[37] $\omega^3_{\mathcal{S}j} = \sum_{i\in\mathcal{S}}\left[\varepsilon^A_{ij}D^H_{ij} + (1-\tau_j)\sum_{h\in\mathcal{G}^M_j\setminus ij}\varepsilon^A_{hj}[\Delta_{ij}D^H_{hj}] + \tau_j\sum_{n\in\mathcal{G}^H_i\setminus ij}\varepsilon^A_{in}[\Delta_{ij}D^H_{in}]\right]$.

[38] The hospital and insurer-market fixed effects included in the demand equations (10) and (12) control for a substantial amount of variation in preferences that might otherwise generate endogeneity issues in the bargaining equation. We have explicitly ruled out one additional source of bias: the correlation between unobservable hospital preference shocks with observable hospital characteristics. For example, we do not allow unobserved preferences for hospitals to be correlated with individuals' zip codes and conditioned upon when either households choose among insurers or insurers contract with hospitals (thus generating a correlation across zip codes between household unobservable

Due to the simultaneous determination of premiums and negotiated prices in our model, the value of $\rho$ does not enter into the computation of these sets of moments.

We obtain bootstrapped estimates of standard errors by resampling the set of admissions within each hospital-insurer pair to construct new estimates for each pair's DRG-weighted price per admission, $\hat{p}_{ij}$, and re-estimating marginal costs and Nash bargaining parameters. We recover $\tilde{\omega}_{\mathcal{S}j} \equiv \hat{\omega}^3_{\mathcal{S}j}/(\sum_{i\in\mathcal{S}} \hat{D}^H_{ij})$, and hold its value fixed in our counterfactual simulations.

**Identification.** The premium setting and margin moments are the primary source of identification for non-hospital marginal costs and our elasticity scaling parameter, $\rho$. Intuitively, the margin moments constructed from (15) closely pin down the values for non-hospital marginal costs for BS and BC and the total medical marginal costs for Kaiser. The assumed form of premium competition governed by (14) that relates estimated premium elasticities, observed premiums, and marginal costs helps to identify $\rho$. There is also additional information on insurer marginal costs contained within the bargaining first-order condition in (16), as marginal costs for BS and BC affect the correlation between hospital price and changes in the number of *individual enrollees* for the insurer upon disagreement with a given hospital.[39]

Identification of the bargaining parameter $\tau_j$ for BS and BC leverages the bargaining moments constructed from (16). Several sources of variation in negotiated hospital prices are relevant. One example is the extent to which cross-hospital variation in hospital costs, $c_i$, is reflected in prices; another is the correlation between a hospital's price and the predicted effect of dropping that hospital (or its system) on the number of *households* enrolled in the insurer. For example, if the hospital price is highly correlated with the loss of household enrollment when it is dropped from the network ($[\Delta_{\mathcal{S}j} D_j]$ ), this suggests that the hospital is able to capture a substantial proportion of the gains from trade (i.e. that $\tau_j$ is low).

**Estimates.** Table 5 contains estimates for insurers' non-hospital marginal costs, Nash bargaining parameters, and our elasticity scaling parameter for four specifications. The first two assume that insurers bargain with each hospital separately, and the last two assume that they bargain with all hospitals in a system in each market jointly. Odd numbered specifications assume that insurers use estimated household premium elasticities when choosing premiums (setting $\rho = 1$), and do not employ insurer margin data as moments. Even numbered specifications estimate $\rho$, and use the insurer margin moments. For discussion, we focus on specifications (iii) and (iv) (system

preferences for insurers and computed households' WTP for an insurer's network). Given these assumptions, the use of objects related to household and insurer demand in our instruments is valid. One additional possibility ruled out by our assumptions is the presence of heterogeneous Nash bargaining parameters that differ within an insurer across hospital systems in a way that is correlated with systems' attractiveness to consumers. Rather than allowing for bargaining parameters to be pair-specific, our model primarily rationalizes observed price variation through predicted differences in insurer and hospital system gains-from-trade.

[39] When we estimate the model without using the margin moments (and assume that $\rho = 1$), marginal costs are still identified from the premium setting moments; however, as we do not observe negotiated prices for Kaiser, we assume that $\omega^1_{Kaiser} = 0$ and directly recover our estimate of $\hat{\eta}_{Kaiser}$ from (14).

Table 5: Estimates: Insurer Marginal Costs and Nash Bargaining Parameters

| | | (i) | (ii) | (iii) | (iv) |
|---|---|---|---|---|---|
| Insurer | $\eta_{BS}$ | 916.14 | 1,588.10 | 912.06 | 1,645.18 |
| Marginal Costs | | (13.24) | (87.88) | (13.17) | (94.13) |
| | $\eta_{BC}$ | 1404.14 | 2,284.63 | 1404.21 | 2,113.84 |
| | | (4.76) | (67.41) | (4.93) | (69.36) |
| | $\eta_K$ | 1442.00 | 2,556.41 | 1442.00 | 2,507.22 |
| | | - | (43.63) | - | (46.09) |
| Nash Bargaining | $\tau_{BS}$ | 0.30 | 0.14 | 0.40 | 0.13 |
| Parameters | | (0.01) | (0.03) | (0.02) | (0.03) |
| | $\tau_{BC}$ | 0.50 | 0.12 | 0.48 | 0.17 |
| | | (0.01) | (0.05) | (0.02) | (0.04) |
| Elasticity Scaling | $\rho$ | 1.00 | 3.28 | 1.00 | 2.85 |
| | | - | (0.17) | - | (0.20) |
| System Bargaining | | N | N | Y | Y |
| Use Margin Moments | | N | Y | N | Y |
| Number of Observations | | 407 | 407 | 266 | 266 |

Notes: 2-step GMM estimates of marginal costs for each insurer (which do not include hospital payments for BS and BC), Nash bargaining parameters, and elasticity scaling parameter. When "margin moments" are not used, we set $\rho = 1.00$, and Kaiser marginal costs are directly obtained from (14). Standard errors are computed using 80 bootstrap samples of admissions within each hospital-insurer pair to re-estimate hospital-insurer DRG weighted admission prices and re-estimating these parameters.

bargaining), as results and implications from assuming that insurers bargain with each hospital separately are broadly similar.

In specification (iii), we find that non-hospital per enrollee per year marginal costs are estimated to range from approximately \$900 for BS to \$1,400 for BC; total (including hospital) marginal costs are estimated to be \$1,442 per enrollee per year for Kaiser. As noted above, these non-hospital marginal costs may be under-estimated: in particular, if employers have a higher price elasticity of demand than consumers, then the true elasticities are higher than our estimates, and the costs estimated through the premium first-order condition will be biased down. Consistent with this, predicted average insurer margins under specification (iii) are over 40%, which are larger than those recovered from insurer financial reports.

Specification (iv) estimates the elasticity scaling parameter $\rho$ to help match reported margins. Non-hospital marginal cost estimates are larger, ranging from \$1,645 for BS to \$2,114 for BC; total (including hospital) marginal costs are estimated to be \$2,507 for Kaiser. These estimates are closer to those reported in outside sources. For example the Kaiser Family Foundation reports a cross-insurer average of \$1,836 spending per person per year on physician and clinical services, for California in 2014; data from the Massachusetts Center for Health Information and Analysis indicates average spending of \$1,644 per person per year on professional services for the three largest commercial insurers in the years 2010-12.[40]

[40] Kaiser data accessed from `http://kff.org/other/state-indicator/health-spending-per-capita-by-service/` on February 25, 2015. Massachusetts data were taken from the report "Massachusetts Commercial Medical Care Spending: Findings from the All-Payer Claims Database 2010-12," published by the Center for Health Information and Analysis in partnership with the Health Policy Commission. Both of these figures include member out-of-pocket spending, which is excluded from our estimates; the California data also include the higher-cost Medicare population

Table 6: Estimates: Negotiated Hospital Price Decomposition

| | Price | (i) Premium & Enrollment | (ii) Price Reinforcement | (iii) Hospital Costs | (iv) Recapture Effect |
|---|---|---|---|---|---|
| BS | 7417.17 | 31.9% | 50.3% | 17.3% | 0.5% |
| | | [28.2%, 32.7%] | [45.0%, 51.3%] | [14.4%, 18.3%] | [0.4%, 0.5%] |
| BC | 6235.84 | 34.4% | 38.2% | 24.6% | 2.7% |
| | | [30.9%, 35.8%] | [34.5%, 39.5%] | [22.3%, 26.5%] | [2.4%, 3.0%] |

Notes: Weighted average (by hospital admissions) decomposition of negotiated hospital prices into the components described in equation (9) for each insurer and hospital system (omitting residuals). Confidence intervals are constructed using 80 bootstrap samples of admissions within each hospital-insurer pair to re-estimate hospital-insurer DRG weighted admission prices, re-estimate insurer marginal costs and Nash Bargaining parameters, and re-compute price decompositions.

To rationalize the higher estimated marginal costs in (iv), we obtain an estimate of $\rho = 2.85$: i.e., insurers are estimated to perceive that their effective demand elasticity when setting premiums is nearly three times larger than the estimated household premium elasticity.

Estimated Nash bargaining parameters are between $0.4 - 0.5$ for BS and BC when margin moments are not used in (iii), but are lower (0.13 and 0.17) when using margin moments in (iv). To understand this difference, note that (iv) implies that insurers, with higher estimated marginal costs, have lower surplus created when contracting with hospitals. Thus, to rationalize the given level of hospital prices observed in the data, the model requires that hospitals capture more of these "gains from trade" under (iv) than in (iii).

For all subsequent analyses, we use estimates from specification (iv). Although the estimated parameters in Table 5 do differ between (iii) and (iv), the counterfactual results under the two models are substantively similar (see Section 6 for discussion).

**Implied Price Decomposition.** Table 6 presents the average of negotiated hospital prices for BS and BC, weighted by the predicted number of hospital admissions within each insurer. These figures are higher than the unweighted average hospital prices reported in Table 1, indicating that individuals tend to be admitted to relatively expensive hospitals. Table 6 also reports the weighted average decomposition of hospital prices into the different components predicted by our bargaining model in (9). That is, for each insurer, we report the average fraction of hospital prices that are determined by each term (i)-(iv).[41] We predict that the largest determinants of hospital prices are the prices of neighboring hospitals (the "price reinforcement" effect)—i.e., if hospital $i$ and MCO $j$ come to a disagreement, the more that MCO $j$ has to reimburse the hospitals that enrollees on $j$ substitute towards, the greater is $i$'s negotiated price. This effect combined with the "premium and enrollment effect"—the losses in MCO $j$'s premium revenues net of non-hospital costs upon disagreement with hospital $i$—determine over 70% of hospital prices across both insurers. The

in addition to the commercially insured enrollees in our sample.

[41] We exclude the residual $\omega^2_{\mathcal{S}j}$ in (16) from this calculation; when included, the residuals constitute less than 0.5%, on average, of BS and BC hospital prices. We use the negative of terms (ii) and (iv) when computing this decomposition.

other effects are predicted to have a smaller, but still significant, effect on hospital prices.[42]

# 5 The Equilibrium Effects of Insurer Competition

In this section we use the estimated model of hospital and insurer demand, price negotiations, and premium setting to simulate the impact of removing an insurer from enrollees' choice sets.

**Setup.** Our model considers the price-setting behavior of plans and hospitals offered by a single benefits manager; our counterfactuals should be interpreted as assessing the impact of that organization removing one insurer from its menu of plans. We assume that the hospital prices we observe are negotiated specifically for this population. We note that CalPERS is the nation's second largest employer purchaser of health benefits (after the federal government) and that the 1.2M covered lives in our data represent approximately 8% of commercially insured individuals in California in 2004. Given this scale, it is certainly feasible that insurers would be willing to negotiate prices specifically for CalPERS. In addition the insurers we observe are three of the five largest in the state, covering over two-thirds of the full commercially insured population. Thus we believe that analysis based on a setting with these three commercial insurers and the hospitals in their networks, along with the population of CalPERS enrollees, is reasonably representative of other employers in the large group insurance market.

For all counterfactual exercises, we hold fixed hospital characteristics and insurers' hospital networks (for all remaining insurers), and compute a new equilibrium in insurer premiums, negotiated hospital prices, household demand for insurers, and individual demand for hospitals. We ignore hospital capacity constraints and entry or exit choices since our simulations affect only part of the commercial insurance market (that for CalPERS enrollees) and therefore impact only a relatively small portion of hospitals' total admissions. We assume that hospitals bargain jointly as part of systems in each market.[43] We compute an equilibrium using an iterative algorithm that alternates between adjusting premiums, prices and enrollment until the process converges. The process is similar to that used in Crawford et al. (2015); additional implementation and computational details are provided in the Appendix.

## 5.1 Removing an Insurer from Employees' Choice Sets: Overview of Results

Table 7 reports the changes in premiums, enrollment, insurer payments to hospitals, and average hospital prices when either Blue Cross or Kaiser is removed from enrollees' choice sets. The baseline numbers, set out in the first column, are simulated using the model estimates. Columns 2-3 and

[42] The recapture effect, in particular, is small relative to the premium and enrollment effects. This is unsurprising given that, for every enrollee lost by the insurer if it comes to a disagreement with hospital $i$, the hospital will recapture a patient *only* if the enrollee becomes sick enough to be admitted, *and* moves to an insurer from which she can access $i$, *and* chooses to do so. The presence of Kaiser—a vertically integrated insurer from which non-Kaiser hospitals cannot be accessed—together with the low average probability of admission to hospital (under 5 percent in our population), explain the relatively small magnitude of the effect.

[43] Assuming that hospitals bargain independently yields similar results.

Table 7: Removing an Insurer: Summary Results

| | | Baseline | (i) Remove BC | | (ii) Remove Kaiser | |
|---|---|---|---|---|---|---|
| | | Amount | Amount | % Change | Amount | % Change |
| Premiums | BS | 3.69 | 3.85 | 4.35% | 4.09 | 10.77% |
| | | [3.49, 4.02] | [3.62, 4.27] | [3.6%, 6.2%] | [3.93, 4.41] | [8.4%, 13.0%] |
| (Single, $000/yr) | BC | 3.99 | - | - | 3.95 | -1.17% |
| | | [3.74, 4.15] | | | [3.79, 4.07] | [-2.4%, 2.5%] |
| | Kaiser | 3.90 | 3.97 | 1.65% | - | - |
| | | [3.87, 3.93] | [3.95, 4.04] | [.9%, 4.4%] | | |
| Enrollment | BS | 80.33 | 91.50 | 13.91% | 109.14 | 35.86% |
| | | [62.93, 90.13] | [78.21, 99.66] | [10.3%, 26.1%] | [94.66, 117.58] | [29.6%, 51.0%] |
| (Total HHs, 000s) | BC | 30.48 | - | - | 53.58 | 75.82% |
| | | [25.35, 41.95] | | | [45.14, 68.06] | [64.5%, 83.9%] |
| | Kaiser | 51.92 | 61.97 | 19.36% | - | - |
| | | [46.83, 60.20] | [54.84, 73.84] | [16.6%, 24.6%] | | |
| Avg Hosp Pmts | BS | 0.63 | 0.63 | -0.63% | 0.67 | 6.39% |
| | | [.53, .81] | [.52, .82] | [-2.5%, .8%] | [.55, .90] | [3.0%, 10.2%] |
| ($000 / Enrollee) | BC | 0.50 | - | - | 0.44 | -12.14% |
| | | [.39, .57] | | | [.38, .49] | [-18.6%, -2.4%] |
| Avg Hosp Prices | BS | 6.87 | 6.78 | -1.37% | 7.22 | 4.99% |
| | | [5.76, 8.80] | [5.58, 8.92] | [-3.9%, 1.7%] | [5.84, 9.56] | [1.8%, 8.6%] |
| ($000 / Admission) | BC | 5.39 | - | - | 4.80 | -10.92% |
| | | [4.86, 6.69] | | | [4.18, 5.31] | [-17.5%, -1.7%] |
| Surplus | Insurer | 0.48 | 0.59 | 22.91% | 0.67 | 38.75% |
| | | [.42, .54] | [.54, .66] | [18.5%, 35.2%] | [.53, .80] | [26.4%, 52.3%] |
| ($000 / Capita) | Hospitals | 0.21 | 0.23 | 5.36% | 0.30 | 40.45% |
| | (Non-K) | [.18, .23] | [.18, .29] | [-4.3%, 24.5%] | [.23, .39] | [27.9%, 66.1%] |
| | $\Delta$ Cons. | - | -0.05 | - | -0.12 | - |
| | | | [-.07, -.04] | | [-.14, -.12] | |

Notes: Results from simulating removal of Blue Cross (from all markets except HSAs 1 and 8) or removing Kaiser from all markets using estimates from specification (iv) in Table 5. Baseline numbers (including premiums, hospital prices, and enrollment) are recomputed from model estimates. Average insurer payments to hospitals and average (DRG-adjusted) hospital prices are weighted by the number of admissions each hospital receives from each insurer under each scenario. Surplus figures represent total insurer, hospital, and changes to consumer surplus per insured individual. 95% confidence intervals, reported below estimates, are constructed by using 80 bootstrap samples of admissions within each hospital-insurer pair to re-estimate hospital-insurer DRG weighted admission prices, re-estimate insurer marginal costs and Nash bargaining parameters, and re-compute counterfactual simulations.

4-5 show levels and percent changes when Blue Cross and Kaiser are removed from the choice set, respectively.

**Removing Blue Cross.** Premiums increase (by 4.4% for BS and 1.7% for Kaiser) when Blue Cross is removed from the choice set.[44] However, on average hospital payments per enrollee and hospital (unit-DRG) prices per admission fall slightly for BS. Thus, although Blue Shield is charging higher premiums (and thereby obtaining higher markups), these gains do not lead to higher hospital prices; this suggests there may be offsetting bargaining effects. We explore this further below.

Table 7 also reports the surplus that accrues to insurers and hospitals, and the change in consumer welfare on a per-capita basis (where the total insured population does not change across

[44] As Kaiser is not offered as an option to enrollees in HSAs 1 and 8, we retain BC in these two markets since removing it would leave BS as a monopolist in the CalPERS choice set, a scenario which seems unrealistic.

baseline and counterfactual scenarios). We note that total insurer surplus (across all insurers that are present) increases when BC is removed; this is primarily due to the increase in premiums charged by BS and Kaiser.[45] Non-Kaiser hospital profits change very little, while consumer welfare is predicted to fall by approximately \$50 per capita per year due to an increase in premiums and a reduction in the number of insurers in the choice set.[46]

**Removing Kaiser Permanente.** Table 7 also reports the effect of removing Kaiser from the choice set. Kaiser has a much greater market share than BC in California, so not surprisingly, its removal has a larger effect on Blue Shield's equilibrium premiums and enrollment. BS's premiums increase by 11% when Kaiser is removed. However, BS's payments to hospitals now rise on average (by 6.4%), implying that the premium effect now outweighs other offsetting bargaining effects. The effect of removing Kaiser on BC looks quite different, with BC premiums falling by 1.2% and its average hospital prices also falling. We return to these heterogeneous effects when we use our model to decompose the different components of the impact insurer competition below.

The increase in insurer surplus when Kaiser is removed is very similar to that when BC is removed. However, non-Kaiser hospitals' surplus increases by nearly 40%, largely due to their new admissions of former Kaiser enrollees. Consumer surplus falls by approximately \$120 per capita, a larger reduction than when BC is removed due to the larger increase in BS premiums and removal of a larger insurer from the choice set.

## 5.2 Heterogeneity in Price Effects

Table 8 reports DRG-adjusted hospital prices, on average across all markets (repeated from Table 7) and separately for a subset of HSAs for both counterfactuals. We report results when premiums are fixed (but hospital prices are renegotiated), and when premiums are allowed to adjust. Note first that with fixed premiums, negotiated hospital prices tend to fall across all markets.

We now focus on results when premiums are allowed to adjust. There is substantial heterogeneity. While on average Blue Shield's hospital prices fall by 1.4% when BC is removed, there are very large reductions in some markets (as high as 16%) and substantial price *increases* (up to 9%) in others. Similarly, when Kaiser is removed, BS's prices fall in some markets and increase in others; average price changes range from a 14% reduction to a 27% increase. BC's prices always fall when Kaiser is removed, but the magnitudes vary from a 4% to an 18% reduction.

As a preliminary analysis to investigate the causes of the heterogeneity, we correlate BS hospital price changes under both counterfactuals with the market share of the insurer that is removed. Both correlations are negative. That is, in markets where the insurer that is removed (BC or Kaiser) has a greater market share, the predicted impact on BS's negotiated hospital prices is more negative. An analogous correlation between the price effect and the hospital Hirschman-Herfindahl Index (HHI)

[45] As there is no outside option, there is no loss of insured enrollees.

[46] We compute (expected) total consumer welfare as $\sum_m \sum_{f \in \mathcal{F}_m} \log(\sum_{j \in \mathcal{M}_m} \exp(\hat{\tilde{u}}^M_{f,j,m}))/\hat{\alpha}^\phi_f$, where expected utilities for each insurer $\hat{\tilde{u}}^M_{f,j,m}$ and premium coefficients $\hat{\alpha}^\phi_f$ are estimates from our insurer demand model.

in the market shows less consistency across counterfactuals: whereas in the Kaiser counterfactual, the price change is negatively correlated with the hospital HHI, this is not the case in the BC counterfactual. Given the bargaining model above, we would expect removing an insurer to result in a larger reduction in prices when the hospital HHI is high, since in those markets, hospitals should have a particular ability to leverage insurer competition to increase prices. The Kaiser correlation is consistent with this but the BC correlation is not.

**Understanding the Mechanisms Behind the Price Changes.** We investigate the causes of the heterogeneity we have identified by decomposing the change in negotiated prices into changes of the components introduced earlier in Sections 3.2 and 3.3.

Beginning with equation (9), we divide through by the number of admissions from insurer $j$ to hospital system $\mathcal{S}$ to obtain an equation for the average negotiated price per admission within each system. The difference between counterfactual and observed prices can be written as:

$$
\begin{aligned}
\bar{p}^{CF}_{\mathcal{S}j} - \bar{p}^{o}_{\mathcal{S}j} = & \underbrace{(1-\tau_j)\left[\frac{[\Delta_{\mathcal{S},j}\hat{D}^{o}_{j}]}{\hat{D}^{H,o}_{\mathcal{S}j}}(\phi^{CF}_{j}-\phi^{o}_{j})\right]}_{\text{(ia) } \Delta \text{ Premium Effect}} \\
& \underbrace{+(1-\tau_j)\left[\left(\frac{[\Delta_{\mathcal{S},j}\hat{D}^{CF}_{j}]}{\hat{D}^{H,CF}_{\mathcal{S},j}} - \frac{[\Delta_{\mathcal{S},j}\hat{D}^{o}_{j}]}{\hat{D}^{H,o}_{\mathcal{S},j}}\right)(\phi^{CF}_{j}) - \left(\frac{[\Delta_{\mathcal{S},j}\hat{D}^{E,CF}_{j}]}{\hat{D}^{H,CF}_{\mathcal{S},j}} - \frac{[\Delta_{\mathcal{S},j}\hat{D}^{E,o}_{j}]}{\hat{D}^{H,o}_{\mathcal{S},j}}\right)(\eta_j)\right]}_{\text{(ib) } \Delta \text{ Enrollment Effect}} \\
& \underbrace{-(1-\tau_j)\left[\left(\frac{\sum_{h\in\mathcal{G}^M_j\setminus\mathcal{S}} p^{CF}_{h,j}[\Delta_{\mathcal{S}j}\hat{D}^{H,CF}_{h,j}]}{\hat{D}^{H,CF}_{\mathcal{S},j}}\right) - \left(\frac{\sum_{h\in\mathcal{G}^M_j\setminus\mathcal{S}} p^{o}_{h,j}[\Delta_{\mathcal{S},j}\hat{D}^{H,o}_{h,j}]}{\hat{D}^{H,o}_{\mathcal{S},j}}\right)\right]}_{\text{(ii) } \Delta \text{ Price Reinforcement Effect}} \\
& \underbrace{+\tau_j\left[\frac{\sum_{i\in\mathcal{S}} c_i\hat{D}^{H,CF}_{i,j}}{\hat{D}^{H,CF}_{\mathcal{S},j}} - \frac{\sum_{i\in\mathcal{S}} c_i\hat{D}^{H,o}_{i,j}}{\hat{D}^{H,o}_{\mathcal{S},j}}\right]}_{\text{(iii) } \Delta \text{ Hospital Cost Effect}} \\
& \underbrace{-\tau_j\left[\sum_{n\in\mathcal{G}^H_{\mathcal{S}},n\neq j}\frac{\sum_{i\in\mathcal{S}}(p^{CF}_{i,n}-c_i)\Delta_{\mathcal{S},j}\hat{D}^{H,CF}_{i,n}}{\hat{D}^{H,CF}_{\mathcal{S}j}} - \frac{\sum_{i\in\mathcal{S}}(p^{o}_{in}-c_i)\Delta_{\mathcal{S},j}\hat{D}^{H,o}_{i,n}}{\hat{D}^{H,o}_{\mathcal{S}j}}\right]}_{\text{(iv) } \Delta \text{ Recapture Effect}}
\end{aligned}
\tag{17}
$$

where terms with a "o" and "CF" superscript denote observed "baseline" (before the removal or addition of an insurer) and counterfactual values respectively; other terms are the recomputed equilibrium values (at new premiums and prices) after the insurer has been removed; and for each hospital system $\mathcal{S}$, $\hat{D}^H_{\mathcal{S},j} \equiv \sum_{i\in\mathcal{S}}\hat{D}^H_{i,j}$, and $\bar{p}_{\mathcal{S},j} \equiv \sum_{i\in\mathcal{S}}(p_{i,j}\hat{D}^H_{i,j})/\sum_{i\in\mathcal{S}}(\hat{D}^H_{i,j})$. We discuss each effect briefly in turn, using the example of removing BC from the market for clarity.

We first decompose the change in term (i) from equation (9) (premium and enrollment effects) into the following two components:

Table 8: Removing an Insurer: Hospital Price Changes Across Markets

| | Baseline | (i) Remove BC | | | | (ii) Remove Kaiser | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Fix Premiums | | Adjust Premiums | | Fix Premiums | | Adjust Premiums | |
| | Amount | Amount | % Chg | Amount | % Chg | Amount | % Chg | Amount | % Chg |
| **BLUE SHIELD** | | | | | | | | | |
| All Mkts | 6,873.35 | 6,172.40 | -10.20% | 6,779.43 | -1.37% | 5,371.42 | -21.85% | 7,216.56 | 4.99% |
| 2. Sacramento | 7,868.21 | 7,700.49 | -2.13% | 8,420.88 | 7.02% | 5,945.68 | -24.43% | 7,355.82 | -6.51% |
| 4. SF Bay W. | 8,932.39 | 8,684.27 | -2.78% | 9,320.55 | 4.35% | 7,278.24 | -18.52% | 8,733.49 | -2.23% |
| 5. E. Bay | 7,125.87 | 6,935.03 | -2.68% | 7,731.84 | 8.50% | 4,299.67 | -39.66% | 6,118.76 | -14.13% |
| 9. C. Valley | 6,313.49 | 4,883.61 | -22.65% | 5,317.27 | -15.78% | 5,956.51 | -5.65% | 7,998.49 | 26.69% |
| 10. S. Barbara | 7,917.27 | 6,537.78 | -17.42% | 6,767.77 | -14.52% | 7,618.65 | -3.77% | 9,430.58 | 19.11% |
| 11. LA | 5,430.24 | 4,825.64 | -11.13% | 5,583.65 | 2.82% | 3,756.54 | -30.82% | 6,039.30 | 11.22% |
| 14. SD | 6,400.68 | 5,750.46 | -10.16% | 6,318.57 | -1.28% | 4,901.37 | -23.42% | 6,703.75 | 4.74% |
| **BLUE CROSS** | | | | | | | | | |
| All Mkts | 5,388.34 | - | | - | | 5,236.40 | -2.82% | 4,799.88 | -10.92% |
| 2. Sacramento | 5,682.80 | - | | - | | 5,587.40 | -1.68% | 5,318.23 | -6.42% |
| 4. SF Bay W. | 6,376.72 | - | | - | | 6,264.87 | -1.75% | 5,981.18 | -6.20% |
| 5. E. Bay | 6,582.49 | - | | - | | 6,311.45 | -4.12% | 6,017.81 | -8.58% |
| 9. C. Valley | 4,323.89 | - | | - | | 4,262.45 | -1.42% | 3,918.64 | -9.37% |
| 10. S. Barbara | 4,038.15 | - | | - | | 4,017.98 | -0.50% | 3,521.89 | -12.78% |
| 11. LA | 5,258.29 | - | | - | | 4,832.76 | -8.09% | 4,328.67 | -17.68% |
| 14. SD | 4,728.64 | - | | - | | 4,833.29 | 2.21% | 4,523.59 | -4.34% |

Notes: Average (DRG-adjusted) hospital prices from simulating the removal of Blue Cross or Kaiser across all HSAs, or within a selected sample of HSAs, using estimates from specification (iv) in Table 5. Baseline numbers are recomputed from model estimates. Average hospital prices are weighted by the number of admissions each hospital receives from each insurer under each scenario.

(ia) *Premium effect*: This is the increase in insurer $j$'s premium when BC is removed from the market, multiplied by the baseline change in number of enrollees when the hospital system is dropped (scaled by the number of admissions system $\mathcal{S}$ received from $j$). The larger the premium increase when the insurer is removed from the market, the higher the price increase for system $\mathcal{S}$.

(ib) *Enrollment effect*: The change in insurer $j$'s profit reduction (net of non-hospital costs) from losing system $\mathcal{S}$ when BC is removed from the market. The first term of (ib) represents this change-in-change in premium revenues (holding fixed premiums), and the second term represents the change-in-change in insurer non-hospital marginal costs. Since the loss in insurer $j$'s enrollment when system $\mathcal{S}$ is removed from the network is smaller when BC is not present, and since premium revenues exceed non-hospital marginal costs, we expect this overall term to be negative—i.e., that insurer $j$'s outside option should improve when BC is removed. The more negative the effect, the more negative the price increase for system $\mathcal{S}$.

Changes in terms (ii) - (iv) in (9) upon removal of an insurer are:

(ii) *Price reinforcement effect*: When BC is removed from the market, we expect a reduction in $j$'s loss in demand upon losing system $\mathcal{S}$, but an indeterminate overall effect on other-hospital prices. Thus, the direction of this overall effect is indeterminate.

(iii) *Hospital cost effect*: If system $\mathcal{S}$ contains a single hospital this term will equal zero. For multiple-hospital systems there may be a small change in average cost per admission when BC exits the market due to a re-allocation of differentially sick enrollees across plans and hospitals.

(iv) *Recapture effect*: The change in the contribution to profits that system $\mathcal{S}$ can recapture from other insurers if removed from $j$'s network, when BC is removed from the market. We expect the first term (recapture after BC is removed) to be smaller in magnitude than the second, because consumers have fewer other plans to which they can switch. In fact when we remove BC the first term goes to zero because the only remaining insurer choice is Kaiser, which as a vertically integrated plan, will not allow consumers to retain access to system $\mathcal{S}$. Thus the system's outside option is weakened when BC exits the market, implying a negative effect on the price increase through this term.

As discussed previously, we hold fixed the hospital-insurer specific per-admission residual in the price bargaining equation throughout our counterfactual exercises, and thus (17) will hold exactly.

In summary the premium effect tends to lead to a price increase when an insurer is removed from the market, due to a softening of premium competition, while the enrollment and recapture effects work in the opposite direction through the bargaining game. We now consider the extent to which this decomposition can explain the estimated heterogeneity in insurer competition effects.

**Decomposing the Price Effects of Removing BC.** Consider first the counterfactual that removes Blue Cross. Recall that BS state-wide premiums increase in this counterfactual but average hospital prices fall slightly. Table 9 decomposes the hospital price changes for BS into their component terms from equation (17) and also provides results for the individual markets covered in Table 8. To clarify the decomposition, we hold fixed the weights used when averaging across hospitals to be equal to baseline admission probabilities. For this reason counterfactual BS prices in Table 9 do not correspond exactly to those reported in the previous tables.

We begin with the bottom panel of the table which presents the predicted price changes in the simpler scenario where premiums are held fixed. Here we see that prices fall in every market: on average the reduction is 8.6%, though there is substantial variation across markets, with some having small price drops of approximately 2%, and others experiencing price drops as large as 22%. That prices always fall is unsurprising given that the premium effect is constrained to be zero; the enrollment and recapture effects both push prices downward when insurer competition is reduced. Note that the change in the recapture effect is much smaller in magnitude than changes in the enrollment effect (generating reductions in price per admission of approximately \$5 compared to \$300 on average, respectively).[47] The hospital cost effect is also very small.

[47]The intuition is that the loss of a single enrollee to the insurer implies a revenue loss of the order of \$4000 per year for certain, while that change is recaptured by the hospital system only if the enrollee switches to a plan from which it can access the system (relatively unlikely given the popularity of Kaiser in these areas) *and* gets sick enough to be admitted to hospital *and also* chooses system $\mathcal{S}$ in particular.

Table 9: Remove BC Counterfactual: Blue Shield Hospital Price Changes & Decomposition

| | Avg. Hospital Price ($ / admission) | | | Decomposition of Change ($ / admission) | | | | |
|---|---|---|---|---|---|---|---|---|
| | Baseline | Remove BC | % Change | (ia) Prem Effect | (ib) Enroll Effect | (ii) Price Reinforce | (iii) Cost Effect | (iv) Re-Capture |
| **ADJUSTING PREMIUMS** | | | | | | | | |
| All Mkts | 6,873.35 | 6,913.26 | 0.58% | 190.15 | -302.91 | 156.11 | 0.06 | -3.49 |
| 2. Sacramento | 7,868.21 | 8,415.18 | 6.95% | 178.12 | -73.12 | 445.14 | 0.05 | -3.23 |
| 4. SF Bay W. | 8,932.39 | 9,320.72 | 4.35% | 178.57 | -155.32 | 365.79 | 0.82 | -1.54 |
| 5. E. Bay | 7,125.87 | 7,716.08 | 8.28% | 209.42 | -41.08 | 427.26 | 0.24 | -5.64 |
| 9. C. Valley | 6,313.49 | 5,357.35 | -15.14% | 178.57 | -744.53 | -378.64 | 0.16 | -11.70 |
| 10. S. Barbara | 7,917.27 | 6,756.13 | -14.67% | 134.56 | -965.57 | -320.48 | -0.19 | -9.46 |
| 11. LA | 5,430.24 | 5,580.30 | 2.76% | 192.46 | -243.63 | 206.29 | 0.06 | -5.11 |
| 14. SD | 6,400.68 | 6,353.75 | -0.73% | 139.31 | -283.17 | 100.38 | 0.01 | -3.46 |
| **FIXING PREMIUMS** | | | | | | | | |
| All Mkts | 6,873.35 | 6,281.69 | -8.61% | - | -312.05 | -274.17 | 0.05 | -5.48 |
| 2. Sacramento | 7,868.21 | 7,697.85 | -2.17% | - | -144.32 | -22.83 | 0.03 | -3.23 |
| 4. SF Bay W. | 8,932.39 | 8,684.86 | -2.77% | - | -231.57 | -15.32 | 0.90 | -1.54 |
| 5. E. Bay | 7,125.87 | 6,929.21 | -2.76% | - | -124.19 | -66.92 | 0.09 | -5.64 |
| 9. C. Valley | 6,313.49 | 4,909.07 | -22.24% | - | -697.79 | -695.05 | 0.11 | -11.70 |
| 10. S. Barbara | 7,917.27 | 6,527.35 | -17.56% | - | -885.28 | -495.05 | -0.14 | -9.46 |
| 11. LA | 5,430.24 | 4,823.52 | -11.17% | - | -311.31 | -290.34 | 0.04 | -5.11 |
| 14. SD | 6,400.68 | 5,770.17 | -9.85% | - | -306.46 | -320.59 | 0.01 | -3.46 |

Notes: BS hospital DRG-adjusted price changes averaged across all markets and within a subset of markets (weighted by number of admissions) upon the removal of Blue Cross in all markets except HSAs 1 and 8, using estimates from specification (iv) in Table 5. Decomposition effects correspond to terms in equation 17, and are weighted by the number of admissions under the baseline scenario; their sum equals the predicted overall change in hospital prices.

The top panel of Table 9 allows premiums to adjust simultaneously with prices. The fixed-weighted average BS prices increase slightly when BC is removed and premiums are permitted to adjust (the 0.6% increase is not statistically different from the 1.0% reduction reported in Table 7 where hospital weights varied between the baseline and counterfactual scenarios). We can now see how the trade-off between the different effects plays out differently across markets. In most HSAs the premium increase when BC is removed generates a large enough change in the premium effect to outweigh the negative effects isolated in the second panel, implying an overall price increase (by as much as 8%), but this is not always the case. In particular, Central Valley and Santa Barbara are markets where BC had a relatively large market share (17% and 23% respectively, see Table 2). Central Valley is a fairly rural market where the Blue Cross PPO's relatively large network makes it attractive to consumers and able to compete effectively with Blue Shield. In these areas, when BC is present, the threat of losing enrollees to BC should the hospital system be dropped effectively constrains BS's ability to cut hospital prices. When BC exits this constraint is removed, implying a large enrollment effect which outweighs the premium effect and generates a price reduction of approximately 15%.

**Decomposing the Price Effects of Removing Kaiser.** A similar decomposition to Table 9 (not shown) can explain the estimates in the Kaiser counterfactual. As noted, removing Kaiser generates a much larger increase in BS premiums than removing BC, and this implies a larger increase in the premium effect on hospital prices. Further, in contrast to the BC counterfactual, removing Kaiser *increases* rather than decreasing the recapture effect since it removes the only insurer from which enrollees cannot retain access to non-Kaiser hospitals. Both factors tend to increase prices relative to the BC counterfactual and explain the finding that, across all markets, Blue Shield's negotiated hospital prices increase on average when Kaiser is removed.

The predicted heterogeneity across markets is again linked to cross-market differences in baseline insurer shares. As before, in some markets prices increase whereas in others they decrease; however, the set of markets where prices increase is different when Kaiser is removed than when BC is removed. The markets where BS prices fall when Kaiser is removed are those where Kaiser was previously a strong competitor (Sacramento, Bay Area, Los Angeles). Again, the higher the market share of the insurer being removed, the larger the change in the enrollment effect and the more likely it is to outweigh the premium effect and generate a price reduction.

Now consider Blue Cross premiums and prices. Recall that, in contrast to BS, BC premiums fall slightly, and prices always fall, when Kaiser is removed. To help understand this difference, Table 14 in the Appendix provides the change in both BS and BC enrollment across markets in this counterfactual. Although enrollment overall increases for both BS and BC, BS's enrollment increases in markets where Kaiser had a particularly large market share (and BC's share was low), but its enrollment falls upon the exit of Kaiser in other markets. This is consistent with BS increasing its statewide premiums upon exit of its major rival while BC, the smallest remaining firm with market shares that vary substantially across markets, takes advantage of the opportunity to gain enrollees in its higher-share markets by *reducing* its own statewide premiums. The reduction in BC premiums also generates a *negative* effect on prices which, together with the usual negative enrollment effect, generates an average price reduction for BC in all markets when Kaiser is removed. We note that this analysis not only helps explain the predicted variation in price effects on removal of Kaiser, but also demonstrates that our model is sufficiently flexible to capture the effects of cross-market differences in firm positioning on pricing strategies in a way that simple models of premiums as strategic substitutes cannot.

# 6 Key Assumptions and Robustness

**Premium Setting.** Our main analysis assumes that insurers engage in Nash Bertrand premium setting, and cannot charge different premiums across HSAs. Although the latter assumption is motivated by institutional details (i.e., CalPERS's practice of setting a single premium for the entire state for each family-type), a strict interpretation of the former may be inaccurate. As discussed, insurers compete for inclusion on employers' plans, and thus may face constraints on their ability to set premiums. In our main specification, we allow insurers to perceive that premium elasticities are scaled by a common factor when setting premiums to allow our model to better match observed margins. Appendix Tables 15-16 report our main counterfactual results without this scaling parameter, using estimates from specification (iii) in Table 5. Premiums are predicted to increase following the removal of an insurer by approximately double the amount for BS from our main specification. However, we find the impact on hospital prices to be approximately the same: e.g., for BS, hospital prices are statistically unchanged when BC is removed but increase by 4.6% (as opposed to 6.4%) on average upon the removal of Kaiser. Furthermore, we predict that the same markets experience hospital price increases and decreases upon the removal of either insurer, and the magnitudes of the price changes are the same (with effects ranging from -19% to 26%).

In Appendix B, we present estimates and discuss counterfactual results from two alternative premium setting models. The first assumes that insurers charge premiums based on a fixed 25% markup above their (hospital and non-hospital) marginal costs. This amount is motivated by the Medical Loss Ratio (MLR) requirement under the Patient Protection and Affordable Care Act of 2010 that insurers spend at least 80% of premium dollars on medical care.[48] The second provides an alternative mechanism by which insurers compete for employers by allowing insurers to face an increasing probability of being removed from an employer's choice set as their premiums increase. Estimated Nash bargaining parameters and insurer marginal costs from these alternative specifications are similar (and in most cases, statistically equivalent) to those obtained in our main specification ((iv) in Table 5). However, our counterfactual results differ under these two robustness tests: we predict that premiums *fall* for the remaining insurers when an insurer (either BC or Kaiser) is removed from the market, and that hospital prices *fall* across all markets (though there still remains significant heterogeneity, with price effects differing across markets by over 20% in levels). These alternative premium setting models restrict the amount by which insurers' premiums increase following the removal of a competitor. For example, under the second model, even holding fixed negotiated hospital prices at baseline levels, BS only increases its premiums by 1-4% as opposed to 4-11% under the main specification. Thus, the small premium effect is offset by the negative enrollment and price reinforcement effects on counterfactual negotiated prices.

We stress, however, that these variations on Nash Bertrand (or fixed markup) premium setting are only stylized approximations to the true interactions in employer-sponsored insurance markets where insurers compete for inclusion on employers' plan menus. Accurately modeling these environments would require us to specify a model of insurer competition for employers, and—in the case of self-insured plans—distinguish between the value of the administrative services provided by self-insured products and the additional risk coverage offered by fully-insured plans. This is beyond the scope of this paper (and our data, as we do not observe choice set variation nor information on other insurance products available in the market).

Nevertheless, we note that both of our alternative models of premium setting strongly suggest that there may be a *negative* premium effect on the negotiated hospital prices when there are

[48] This test is also motivated by noting that one of the three insurance plans in our analysis (BC) is a self-insured product (i.e., CalPERS covers all costs and sets premiums for the BC plan but pays BC an administrative fee for processing claims, negotiating with network providers, and other services), and that both Kaiser and BS are non-profit entities that may employ objectives other than straightforward profit maximization: e.g., anecdotal evidence suggests that Kaiser may pursue other premium setting strategies (such as undercutting competitor premiums by a fixed percentage) within reasonable constraints.

significant constraints on the ability of insurers to charge higher markups after the removal of a competing insurer. That is, a reduction in insurer competition could lead to price and premium *reductions* across the board in settings—perhaps including exchanges—where markups are heavily regulated. The true model for our setting is likely to fall somewhere in between the extremes represented by our various specifications. Given that the magnitudes of equilibrium hospital price effects are relatively similar across our various specifications, we believe that our main result—that reducing insurer competition leads to heterogeneous and economically significant impacts on hospital prices, and likely lowers them in some markets—remains robust.

**Switching Costs and Inertia.** Previous work (e.g., Handel (2013); Ho, Hogan and Morton (2015); Polyakova (2015)) has documented switching costs or other forms of inertia in health plan choice with respect to changes in the financial characteristics (e.g., premiums) of plans. In our current analysis, we identify household premium elasticities from cross-household-type variation in premiums. One concern may be that if frictions are significant, the true premium elasticities may differ from our estimates, and this may affect our estimated insurer marginal costs, bargaining parameters, and predicted counterfactual premiums and hospital prices. We respond in two ways. First, as noted earlier, our estimated household premium elasticities correspond well to the range estimated in previous papers which have utilized panel data and time variation in premiums. Second, household premium elasticities are not the only determinant of equilibrium premiums. For example, employers—who may not be subject to such frictions—are likely to have some input into premium determination when choosing the insurer menu on behalf of their enrollees; also, as noted, insurers may engage in alternative premium setting behavior that does not condition on these elasticities. In this case, our other robustness tests may be more informative.

One may also be concerned that our estimated insurer "network" elasticities (i.e., sensitivity to an insurer's hospital network), identified from cross-household and cross-zip code variation in the expected utility derived from each insurer's hospital network, may also be affected (perhaps over-stated) due to the presence of consumer choice frictions. However, there is evidence to suggest that enrollees in our setting are responsive to hospital network changes, and do not face insurmountable frictions when switching plans. In 2005 (the year after our sample), BS removed 24 hospitals on its CA network for CalPERS enrollees, 13 of which were owned by Sutter Health. Approximately 20% of enrollees on BS in three counties surrounding Sacramento switched to BC that year, with another 9% moving to Kaiser.[49] Our model's estimates predict that BS's enrollment would fall by just under 10% in the Sacramento HSA if Sutter hospitals were dropped. We note that this difference can partially be accounted for by the fact that the CalPERS BS plan also dropped 17 physician groups (including some owned by Sutter) in that year.[50] This analysis suggests that, if switching costs do exist, they do not lead us to substantially over-estimate switching probabilities in

[49] "CalPERS Announces Enrollment Results; No Consumer Stampede to Retain Sutter," Press Release, CalPERS, December 14, 2004.

[50] See Dafny, Ho and Lee (2015) for a discussion of why physician and hospital mergers can yield positive price effects for the merging parties.

response to network changes. Indeed, even without accounting for switching costs or other frictions, we may be *understating* the extent to which insurers lose enrollees upon dropping a hospital system if there are also changes to physician or other services, and these are not adequately controlled for by our measures of hospital network utility ($WTP$).[51]

To examine the sensitivity of our results to the estimated responsiveness of consumers to hospital network changes, we repeat our analysis by increasing *and* decreasing our estimated $\alpha_\kappa^W$ $WTP$ coefficients by 25%, re-estimating the bargaining parameters and insurer marginal costs as in 4.4, and recomputing counterfactual outcomes. Although the parameter estimates change slightly, the counterfactual results and substantive findings are qualitatively similar.

**Consumer Selection Across Insurers and Hospitals.** Our analysis implicitly assumes that, conditional on premium levels, the quantity and composition of consumer types who choose particular hospitals or plans are not directly affected by negotiated hospital prices. This implies that (i) insurers are unable to steer patients to certain (e.g., lower cost) hospitals,[52] and (ii) consumers do not respond to hospital prices when selecting where to go. As the two HMO plans in our data have zero co-insurance rates, and we believe that price transparency is limited for enrollees during this period, we argue that this assumption is reasonable for our setting.

We also rule out the selection of consumers across insurance plans based on unobservable characteristics other than age, sex, income, household type, or zip code when estimating our hospital and insurer demand systems. In particular, we assume that firms form expectations over the probability of admission ($\gamma^a_{\kappa(k)}$), and (for a given admission) the probability of a particular diagnosis ($\gamma_{\kappa(k)}$) and its DRG weight ($E[DRG_a|\kappa(k)]$) for an individual $k$ based on that individual's age-sex "type", $\kappa(k)$. As is common in the hospital demand literature, we also rule out the correlation of unobservable consumer preferences with observable hospital characteristics, including location. However, conditioning on age and sex does control for a significant amount of heterogeneity in admission and diagnosis probabilities. As insurers are unable to set premiums or otherwise screen based on age, sex, or location, our model allows for insurers to engage in behavior similar to cream-skimming by anticipating the likely selection of heterogeneous consumers onto their plans when setting premiums or negotiating hospital prices. Finally, as Table 3 indicates, both average admission probabilities and DRG weights within age-sex categories are very similar for BS and BC enrollees, suggesting only limited selection across these plans based on underlying health risks.[53]

The assumption that consumers choose insurance plans based on their *expected* probability of

[51] As we rely on within-market across-zip-code variation in hospital network utility to identify the coefficients on $WTP$ terms ($\{\alpha_\kappa^W\}$), this can occur if physician offices are not located in the same zip codes as affiliated hospitals and if the utility from physician networks is absorbed by insurer-market fixed effects.

[52] Ho and Pakes (2014) find that in California, when referring physicians are given incentives to use low-cost hospitals through capitation payments, the hospital referral is influenced by its price. However the estimated effect is small or insignificant for both BC (which rarely uses capitation payments for its physicians) and BS (a not-for-profit plan). We therefore abstract away from these patient steering issues.

[53] Though we control for selection across insurance plans based on income and premium sensitivities, we do not consider selection on moral hazard or risk aversion as in Einav et al. (2013). While important, these issues are orthogonal to our model since we do not consider choices regarding the amount of care received and assume that consumers do not respond to price variation across providers.

admission and diagnosis has commonly been used in option-demand-model settings where consumers' value for an insurance product is based on ex ante expected utilities (Town and Vistnes, 2001; Capps, Dranove and Satterthwaite, 2003; Ho, 2006; Gowrisankaran, Nevo and Town, 2015). Allowing consumers to condition on a richer set of information (which may include prior health conditions or idiosyncratic preferences) when choosing health plans may enable these and similar models to better match counterfactual patient flows upon network changes, and is the subject of related and future work.[54]

**Additional Counterfactual Assumptions.** Finally, we stress that our analysis holds all non-price characteristics of hospitals and insurers fixed. Allowing other characteristics to adjust may alter the magnitudes of some predictions: e.g., if BC improved its average quality or provider network in those markets where its baseline share was low when Kaiser was removed, then we might expect its premiums and negotiated prices to fall by less or perhaps even rise. Furthermore, incorporating hospitals' investment responses to changes in negotiated reimbursements is crucial to completely understand the potential welfare effects and distributional consequences of any policy intervention of the form we examine. Nonetheless, we believe that our framework is a necessary step upon which more complete analyses of these dynamic issues can be based.

# 7 Discussion & Concluding Remarks

This paper presents a framework for analyzing the impact of insurer competition on premiums, hospital prices, and welfare. We limit our attention to the effect of changing the insurer choice set for a particular population of consumers—those covered by CalPERS—and for this reason our results are most applicable to the large group employer-sponsored insurance market. We do not attempt to model the impact of insurers entering or exiting the market (or consolidating), since this would raise questions regarding insurer and hospital fixed costs and costs of entry and exit that are outside our existing framework. However, our results are also relevant for the health insurance exchanges set up by the Patient Protection and Affordable Care Act (2010): insurers that are active in the state choose whether or not to participate in the exchange, and variation in the number of participants is likely to have similar effects to those predicted by our model.

Our counterfactual analyses suggest that removing an insurer from the choice set may lead to increases in premiums, and possibly in hospital prices, on average. However, the price effect varies in both sign and magnitude across markets. In areas where the insurer being removed is an attractive substitute for those that remain, its presence represents a potentially important constraint on the extent to which other insurers can reduce their hospital prices. When it is removed, relaxing this constraint can outweigh the effect on premiums and lead to hospital price reductions. Furthermore,

[54] For example, the "recapture" effect in our model may be larger than estimated if consumers know ex ante before choosing an insurance plan that they will visit a particular hospital, and will switch plans and visit the hospital if their current insurer drops that hospital. Incorporating selection on unobservables by consumers onto insurance plans can be accounted for by estimating the hospital and insurer demand systems jointly at the cost of increased computational complexity (see Lee (2013)). See also Shepard (2015) who examines related issues.

when there are significant constraints on premium setting—e.g., through insurer competition for employers or via regulation on insurer medical loss ratios—removing an insurer may lead to lower premiums through the substantial reduction of average negotiated hospital prices across the board.

Now consider the implications of our results for the impact of *adding* an insurer to a plan menu (with the caveat that the initial menu be appropriately small, as our analysis is based on the specific case of removing a single insurer from a choice set of three). While insurer entry may generate premium and hospital price reductions on average, adding a dominant insurer is likely to lead to hospital price increases for incumbent plans in some markets, and the price increases will be exacerbated in the presence of premium setting constraints.

We conclude that the costs and benefits of encouraging insurer competition are far more nuanced than simple models would predict, leading to heterogeneous welfare effects across markets that depend on, among other things, existing market structure and the relative profit margins of insurers and hospitals. In addition, the resulting redistribution of rents across medical providers may have dynamic implications for long-term investment, entry, and exit incentives. Appropriate policy responses to a wide ranging set of issues (including insurer consolidation, integration with health providers, and non-compete agreements) should thus explicitly account for these concerns.

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# A Estimation and Computation: Further Details and Results

## A.1 Hospital Demand: Further Details

Table 10: Definition of Diagnosis Categories

| Category | MDC or ICD-9-CM codes |
|---|---|
| Cardiac | MDC: 05 (and not cancer) |
| | ICD-9-CM: 393-398; 401-405; 410-417; 420-249 |
| Cancer | ICD-9-CM: 140-239 |
| Neurological | MDC: 19-20 |
| | ICD-9-CM: 320-326; 330-337; 340-359 |
| Digestive | MDC: 6 (and not cancer or cardiac) |
| | ICD-9-CM: 520-579 |
| Labor | MDC 14-15 (and aged over 5) |
| | ICD-9-CM: 644; 647; 648; 650-677; V22-V24; V27 |

Notes: Patient diagnoses were defined using MDC codes in the admissions data where possible. In other cases, supplemental ICD-9-CM codes were used.

Table 11: Definition of Hospital Services

| Cardiac | Imaging | Cancer | Births |
|---|---|---|---|
| CC laboratory | Ultrasound | Oncology services | Obstetric care |
| Cardiac IC | CT scans | Radiation therapy | Birthing room |
| Angioplasty | MRI | | |
| Open heart surgery | SPECT | | |
| | PET | | |

Notes: The exact methodology for rating hospitals is as follows. If the hospital provides none of the services, its rating = 0. If it provides the least common service, its rating = 1. If it offers some service X but not the least common service its rating = (1 - x) / (1 - y), where x = the percent of hospitals offering service X and y = the percent of hospitals offering the least common service.

Our consumer demand model is outlined in Section 3.2. We follow the method in Ho (2006), estimating demand for hospitals using a discrete choice model that allows for observed differences across consumers.

We define 5 diagnosis categories using ICD-9-CM codes and MDC (Major Diagnosis Category) codes, as shown in Table 10. The categories are cardiac, cancer, labor, digestive diseases, and neurological diseases. The sixth category, 'other diagnoses,' includes all other categories in the data other than newborn babies (defined as events with MDC 15 where the patient is less than 5 years old). The hospital 'service' variables are defined using American Hospital Association data for 2003-2004 (if observations are missing for a particular hospital in one year we fill them in from the other). These variables summarize the services offered by each hospital; they cover cardiac, imaging, cancer, and birth services. Each hospital is rated on a scale from 0 to 1, where 1 implies that the hospital offers the least common of a list of relevant services and 0 implies that it offers none of the services. Details are given in Table 11. Finally, since we do not observe household income for non-state agency enrollees (and we estimate our demand system using observed admissions from all enrollees), we use the mean household income in each zip code from Census data (winsorized at the 5% level).

## A.2 Hospital and Insurer Demand Results

Table 12 shows estimates from our hospital demand system (omitting hospital fixed effects due to space constraints). The results are in line with Ho (2006) and the previous hospital choice literature. The coefficient

Table 12: Estimates: Hospital Demand System

| Interaction Terms | Variable | Parameter | Std. Err. |
|---|---|---|---|
| Interactions: Teaching | Income ($000) | 0.012*** | 0.002 |
| | PPO enrollee | 0.155* | 0.066 |
| | Cancer | 0.124 | 0.107 |
| | Cardiac | −0.524*** | 0.081 |
| | Digestive | −0.204* | 0.095 |
| | Labor | −0.064 | 0.098 |
| | Neurological | 1.206*** | 0.176 |
| Interactions: Nurses Per Bed | Income ($000) | −0.003 | 0.001 |
| | PPO enrollee | −0.043** | 0.033 |
| | Cancer | 0.125** | 0.056 |
| | Cardiac | 0.063 | 0.040 |
| | Digestive | −0.099** | 0.045 |
| | Labor | −0.172*** | 0.046 |
| | Neurological | −0.916*** | 0.100 |
| Interactions: For-Profit | Income ($000) | 0.001 | 0.002 |
| | PPO enrollee | 0.062 | 0.048 |
| | Cancer | −0.006 | 0.083 |
| | Cardiac | 0.109 | 0.056 |
| | Digestive | −0.124* | 0.065 |
| | Labor | 0.325*** | 0.063 |
| | Neurological | 0.585*** | 0.115 |
| Interactions: Cardiac Services | Income ($000) | 0.002 | 0.002 |
| | PPO enrollee | 0.249*** | 0.045 |
| | Cardiac | 0.282*** | 0.050 |
| Interactions: Imaging Services | Income ($000) | 0.000 | 0.002 |
| | PPO enrollee | 0.298*** | 0.053 |
| | Cancer | 0.113 | 0.085 |
| | Cardiac | 0.057 | 0.065 |
| | Digestive | −0.018 | 0.062 |
| | Labor | −0.469*** | 0.065 |
| | Neurological | −0.684*** | 0.128 |
| Interactions: Cancer Services | Income ($000) | −0.011*** | 0.005 |
| | PPO enrollee | 0.056 | 0.127 |
| | Cancer | 0.341 | 0.229 |
| Interactions: Labor Services | Income ($000) | 0.008*** | 0.002 |
| | PPO enrollee | −0.159*** | 0.049 |
| | Labor | 1.139*** | 0.069 |
| Distance interactions: | HSA 1 | −0.107*** | 0.003 |
| | HSA 2 | −0.063*** | 0.001 |
| | HSA 3 | −0.246*** | 0.010 |
| | HSA 4 | −0.275*** | 0.009 |
| | HSA 5 | −0.241*** | 0.005 |
| | HSA 6 | −0.187*** | 0.005 |
| | HSA 7 | −0.243*** | 0.013 |
| | HSA 8 | −0.148*** | 0.004 |
| | HSA 9 | −0.108*** | 0.003 |
| | HSA 10 | −0.164*** | 0.008 |
| | HSA 11 | −0.275*** | 0.004 |
| | HSA 12 | −0.132*** | 0.003 |
| | HSA 13 | −0.312*** | 0.008 |
| | HSA 14 | −0.079*** | 0.004 |
| | Number of Admissions | 37676 | |
| | Hospital Fixed Effects | Yes | |
| | Pseudo-R2 | 0.536 | |

Standard errors in parentheses
$^{*}$ $p < 0.10$, $^{**}$ $p < 0.05$, $^{***}$ $p < 0.01$

Notes: Maximum likelihood estimation of demand for hospitals using a multinomial logit model. Specification includes hospital fixed effects.

on distance is negative and varies across markets (likely reflecting differences in transportation options and costs), with similar magnitudes to those in Ho (2006). The non-interacted effects of teaching hospitals

Table 13: Estimates: Insurer Demand System

| | |
|---|---|
| Premium ($\alpha_0^{\phi}$) | -0.0650*** |
| | (0.00137) |
| Log(Income) × Premium ($\alpha_1^{\phi}$) | 0.00568*** |
| | (0.000123) |
| WTP ($\alpha^W$ Age 0-19) | 0.261 |
| | (0.256) |
| WTP ($\alpha^W$ Male, Age 20-34) | 9.181*** |
| | (0.601) |
| WTP ($\alpha^W$ Female, Age 20-34) | 1.121*** |
| | (0.0985) |
| WTP ($\alpha^W$ Male, Age 35-44) | 3.485*** |
| | (0.354) |
| WTP ($\alpha^W$ Female, Age 35-44) | 1.596*** |
| | (0.131) |
| WTP ($\alpha^W$ Male, Age 45-54) | 1.552*** |
| | (0.165) |
| WTP ($\alpha^W$ Female, Age 45-54) | 1.716*** |
| | (0.131) |
| WTP ($\alpha^W$ Male, Age 55-64) | 1.086*** |
| | (0.116) |
| WTP ($\alpha^W$ Female, Age 55-64) | 1.547*** |
| | (0.137) |
| Drive Time to Kaiser ($\alpha^K$ HSA 2) | -0.0181*** |
| | (0.00104) |
| Drive Time to Kaiser ($\alpha^K$ HSA 3) | -0.0333*** |
| | (0.00219) |
| Drive Time to Kaiser ($\alpha^K$ HSA 4) | -0.0166*** |
| | (0.00482) |
| Drive Time to Kaiser ($\alpha^K$ HSA 5) | -0.0220*** |
| | (0.00352) |
| Drive Time to Kaiser ($\alpha^K$ HSA 6) | -0.0166*** |
| | (0.00317) |
| Drive Time to Kaiser ($\alpha^K$ HSA 7) | -0.0271*** |
| | (0.00731) |
| Drive Time to Kaiser ($\alpha^K$ HSA 10) | -0.0541*** |
| | (0.0135) |
| Drive Time to Kaiser ($\alpha^K$ HSA 11) | -0.0199*** |
| | (0.00125) |
| Drive Time to Kaiser ($\alpha^K$ HSA 12) | -0.0246*** |
| | (0.000979) |
| Drive Time to Kaiser ($\alpha^K$ HSA 13) | -0.0194*** |
| | (0.00376) |
| Drive Time to Kaiser ($\alpha^K$ HSA 14) | -0.0314*** |
| | (0.00238) |
| HSA-Insurer Fixed Effects | Yes |
| Pseudo-R2 | .1801 |

Standard errors in parentheses
$^{*}$ $p < 0.10$, $^{**}$ $p < 0.05$, $^{***}$ $p < 0.01$

Notes: Results for insurer demand estimation. Drive Time to Kaiser represents the calculated drive time to the nearest Kaiser hospital from a household's zipcode. In HSA 1 and 8, Kaiser is not available to enrollees and a distance coefficient was not estimated; and in HSA 9, no Kaiser hospital existed (only medical offices), and the Kaiser drive time was normalized to 0 for all zipcodes in this market.

and other hospital characteristics are absorbed in the fixed effects; however, the interactions show that patients with very complex conditions (cancer and neurological diseases) attach the highest positive weight to teaching hospitals. Many of the interactions are difficult to interpret, but it is clear that patients with cardiac diagnoses place a strong positive weight on hospitals with good cardiac services, cancer patients on those with cancer services (although, as in Ho (2006), this coefficient is not significant at p=0.1), and women in labor on hospitals with good birthing services.

Table 13 shows estimates from our insurer demand system outlined in Section 4.3 (omitting insurer-market fixed effects). The coefficient on premium is negative and significant, with premium sensitivity decreasing with income; elasticities are provided in the main text. The coefficient on $WTP$ is positive for every age-gender group, and significant at p=0.05 for all groups except enrollees aged 0-19. Coefficient magnitudes are larger for males aged 20-34 and 35-44 than for women in the same age groups. This partially reflects the fact that the higher probability of admission for women of child-bearing age translates to a higher standard deviation in the $WTP$ variable for women than for men (so that a smaller coefficient is needed to generate the same valuation for a 1 standard deviation increase in $WTP$). Further discussion of the estimates is contained in the main text.

## A.3 Counterfactual Simulations: Further Details

In all of our exercises, a counterfactual equilibrium is defined as a set of hospital networks, premiums, and prices $\{\mathcal{G}^{CF}, \boldsymbol{\phi}^{CF}, \boldsymbol{p}^{CF}\}$, and implied "demand" objects:

- $\hat{\boldsymbol{D}}^{CF} \equiv \{\{\hat{\boldsymbol{D}}^{CF}_{j,m}\}, \{\hat{\boldsymbol{D}}^{E,CF}_{j,m}\}, \{\hat{\boldsymbol{D}}^{H,CF}_{h,j,m}\}\}_{\forall j,m}$
- $\partial\hat{\boldsymbol{D}}^{CF} \equiv \{\{\partial\hat{\boldsymbol{D}}^{CF}_{j,m}/\partial\phi_j\}, \{\partial\hat{\boldsymbol{D}}^{E,CF}_{j,m}/\partial\phi_j\}, \{\partial\hat{\boldsymbol{D}}^{H,CF}_{h,j,m}/\partial\phi_j\}\}_{\forall j,m}$
- $\Delta\hat{\boldsymbol{D}}^{CF} \equiv \{\{\Delta_{\mathcal{S},j}\hat{\boldsymbol{D}}^{CF}_{j,m}\}, \{\Delta_{\mathcal{S},j}\hat{\boldsymbol{D}}^{E,CF}_{j,m}\}, \{\Delta_{\mathcal{S},j}\hat{\boldsymbol{D}}^{H,CF}_{h,j,m}\}_{\forall h}\}_{\forall \mathcal{S},j,m}$

such that (i) $\mathcal{G}^{CF}_{j,m}$ is the same as in our observed data for all MCOs $j$ active in market $m$; (ii) single household premiums $\phi_j$ for all insurers satisfy (14) given $\hat{\boldsymbol{D}}^{CF}$, $\partial\hat{\boldsymbol{D}}^{CF}$ and $\boldsymbol{p}^{CF}$; (iii) all negotiated hospital prices $\boldsymbol{p}^{CF}$ satisfy (16) given $\hat{\boldsymbol{D}}^{CF}$, $\Delta\hat{\boldsymbol{D}}^{CF}$, and $\boldsymbol{p}^{CF}$; and (iv) all demand terms $\hat{\boldsymbol{D}}^{CF}$, $\partial\hat{\boldsymbol{D}}^{CF}$, and $\Delta\hat{\boldsymbol{D}}^{CF}$ are consistent with networks $\mathcal{G}^{CF}$, premiums $\boldsymbol{\phi}^{CF}$, and behavior given by our estimated models of hospital and insurer demand.

To compute a new equilibrium, we iterate on the following steps, where for each iteration $\iota$:

1. *Update Premiums and Demand Terms.* Given negotiated hospital prices $\boldsymbol{p}^{\iota-1}$, we repeat the following for each iteration $\iota'$:

   (a) Update terms $\hat{\boldsymbol{D}}^{\iota'}$ and $\partial\hat{\boldsymbol{D}}^{\iota'}$ given premiums $\phi^{\iota'-1}$ and counterfactual networks $\mathcal{G}^{CF}$ using estimated hospital and insurer demand systems;

   (b) Update $\phi^{\iota'}_j$ using (14) and $\hat{\boldsymbol{D}}^{\iota'}$ and $\partial\hat{\boldsymbol{D}}^{\iota'}$ terms;

   until premiums converge within a tolerance of \$0.1 (using a sup-norm across all insurers). This provides updated values of $\boldsymbol{\phi}^{\iota}$, $\hat{\boldsymbol{D}}^{\iota}$ and $\partial\hat{\boldsymbol{D}}^{\iota}$. Update $\Delta\hat{\boldsymbol{D}}^{\iota}$ using $\boldsymbol{\phi}^{\iota}$.

2. *Update Negotiated Hospital Prices.* Using updated values of $\boldsymbol{\phi}^{\iota}$, $\hat{\boldsymbol{D}}^{\iota}$ and $\Delta\hat{\boldsymbol{D}}^{\iota}$, (16) is used to update $\boldsymbol{p}^{\iota}$. Since (16) only defines total payments for hospital systems, there is only an equation for each hospital system and insurer pair, and not for each hospital and insurer pair; however, negotiated prices at the hospital level are required to determine an equilibrium. To proceed, we assume that the ratios of negotiated (DRG-adjusted) per-admission prices within a hospital system are the same as those observed in the data: i.e., for any two hospitals $h$ and $h'$ in the same hospital system and MCO $j$, $p^{CF}_{hj}/p^{CF}_{h'j} = p^o_{hj}/p^o_{h'j}$, where $p^o_{\cdot}$ are observed per-admission hospital prices.

   We implement this using the following matrix inversion: $\boldsymbol{p}^{\iota} = (\boldsymbol{A}^{\iota})^{-1}\boldsymbol{B}^{\iota}$, where each row of vectors $\boldsymbol{p}^{\iota}$ and $\boldsymbol{B}^{\iota}$ and square matrix $\boldsymbol{A}^{\iota}$ corresponds to a particular hospital $i$ and MCO $j$.[55] Each entry of $\boldsymbol{p}^{\iota}$, $p^{\iota}_{ij}$, is the negotiated price per-admission for that given hospital-MCO pair. Each entry of $B^{\iota}_{ij}$ is:

$$B^{\iota}_{ij} = (1-\tau_j)\left[\left([\Delta_{\mathcal{S}j}\hat{D}^{\iota}_j]\phi_j\right) - \eta_j[\Delta_{\mathcal{S}j}\hat{D}^{E,\iota}_j]\right] + \tau_j\left[\sum_{h\in\mathcal{S}}\sum_{n\in\mathcal{G}^H_{\mathcal{S}}} c_h\hat{D}^{H,\iota}_{\mathcal{S}j}\right] + \tilde{\omega}^2_{\mathcal{S}j}\hat{D}^{H,\iota}_{\mathcal{S}j} \qquad i\in\mathcal{S}$$

   if $ij$ is the first observation in the vector for a given system $\mathcal{S}$, $i \in \mathcal{S}$, and MCO $j$; and $B^{\iota}_{ij} = 0$ otherwise. Finally, $\boldsymbol{A}^{\iota}$ is a matrix where each entry $A^{\iota}_{r;c}$, corresponding to a row $r$ and $c$ which in turn each represent a given hospital-MCO pair, is given by:

[55] This is similar to the procedure used in Crawford et al. (2015).

- $A^{\iota}_{ij;hj} = \hat{D}^{H,\iota}_{hj}$ for all hospitals $h$ in the same system and HSA as $i$ (including $i$);
- $A^{\iota}_{ij;hj} = (1-\tau_j)[\Delta_{\mathcal{S}j}\hat{D}^{H,\iota}_{hj}]$ if hospital $h$ is on a different system as $i$, but located in the same HSA as hospital $i$;
- $A^{\iota}_{ij;hn} = \tau_j[\Delta_{\mathcal{S}j}\hat{D}^{H,\iota}_{hn}]$ for all hospitals $h$ in the same system and HSA as $i$ (including $i$) for $n \neq j$;

if $ij$ is the first observation in the vector for a given system $\mathcal{S}$ and MCO $j$. If row $ij$ corresponds to a repeat observation for a given system $\mathcal{S}$ and MCO $j$, then

- $A^{\iota}_{ij;ij} = 1$;
- $A^{\iota}_{ij;hj} = -p^o_{ij}/p^o_{hj}$ where $h$ is on the same hospital system as $i$, and $hj$ is the first entry for the hospital system and MCO $j$ in the matrix.

All other elements of $\boldsymbol{A}^{\iota}$ are 0.

Note that $\boldsymbol{A} \times \boldsymbol{p}^o = \boldsymbol{B}$ is equivalent to (16) for the observed prices and demand terms, with the additonal restriction that hospital prices within a hospital system for a particular MCO are assumed to be a constant ratio with respect to one another.

We repeat until between iterations, premiums do not differ by more than \$0.1, and predicted household demand across insurers and household types do not differ by more than one household.

Table 14: Remove Kaiser Counterfactual: Enrollment Changes

| | Baseline (Predicted) | | | CF: Remove Kaiser | | | |
|---|---|---|---|---|---|---|---|
| HSA Market | BS | BC | Kaiser | BS | % Change | BC | % Change |
| All Mkts | 189625 | 69799 | 166224 | 254600 | 34.27% | 171048 | 145.06% |
| 1. North | 5398 | 15112 | 0 | 2493 | -53.83% | 18017 | 19.23% |
| 2. Sacramento | 54502 | 6453 | 60762 | 94079 | 72.62% | 27637 | 328.31% |
| 3. Sonoma / Napa | 6607 | 999 | 13937 | 15029 | 127.46% | 6514 | 552.06% |
| 4. San Francisco Bay West | 5749 | 1036 | 5001 | 8315 | 44.65% | 3471 | 235.01% |
| 5. East Bay Area | 7340 | 1284 | 11195 | 14205 | 93.52% | 5614 | 337.35% |
| 6. North San Joaquin | 9811 | 4056 | 3984 | 8664 | -11.70% | 9188 | 126.51% |
| 7. San Jose / South Bay | 2370 | 793 | 4839 | 4178 | 76.27% | 3824 | 382.16% |
| 8. Central Coast | 7818 | 13575 | 0 | 4117 | -47.34% | 17276 | 27.26% |
| 9. Central Valley | 26484 | 8388 | 10615 | 25144 | -5.06% | 20343 | 142.53% |
| 10. Santa Barbara | 3919 | 1474 | 654 | 2931 | -25.20% | 3116 | 111.36% |
| 11. Los Angeles | 17482 | 7250 | 24123 | 22764 | 30.22% | 26091 | 259.85% |
| 12. Inland Empire | 20645 | 3762 | 16583 | 27231 | 31.90% | 13759 | 265.71% |
| 13. Orange | 7284 | 2988 | 5901 | 7934 | 8.92% | 8238 | 175.73% |
| 14. San Diego | 14215 | 2629 | 8632 | 17516 | 23.22% | 7960 | 202.82% |

Notes: Insurer enrollment by HSA in the baseline scenario and in the scenario when Kaiser has been removed. Baseline numbers are predicted using model estimates from specification (iv) in Table 5.

**Additional Tables.** Table 14 presents individual enrollments by insurer across all markets for both the baseline and the remove Kaiser counterfactual scenarios. It is referenced in Section 5.2 when discussing the heterogeneity in negotiated prices across markets when Kaiser is removed.

# B Robustness

## B.1 Counterfactual Results With Standard Nash Bertrand Premium Setting

Tables 15-16 present our main counterfactual results upon the removal of BC or Kaiser without using the scaling parameter $\rho$ or moments based on computed insurer margins, and relies on estimates from specification (iii) in Table 5. As discussed in Section 6, although predicted premium adjustments are larger under this specification (due to lower premium elasticities faced by insurers when setting premiums), the relative effects on negotiated prices across providers are similar in both sign and magnitude to those predicted under the main specification discussed in the text.

Table 15: Removing an Insurer: Summary Results (No Margin Moments)

| | | Baseline | (i) Remove BC | | (ii) Remove Kaiser | |
|---|---|---|---|---|---|---|
| | | Amount | Amount | % Change | Amount | % Change |
| Baseline | Remove BC | | Remove Kaiser | | | |
| | | (Pred) Amount | Amount | % Change | Amount | % Change |
| Premiums | BS | 3.78 | 4.18 | 10.75% | 4.52 | 19.81% |
| | | [3.76, 3.80] | [4.16, 4.21] | [10.5%, 10.9%] | [4.50, 4.55] | [19.6%, 20.1%] |
| (Single, $000/yr) | BC | 4.20 | - | - | 4.13 | -1.53% |
| | | [4.19, 4.21] | | | [4.12, 4.16] | [-2.0%, -.9%] |
| | Kaiser | 3.66 | 3.98 | 8.70% | - | - |
| | | [3.65, 3.67] | [3.96, 4.00] | [8.5%, 8.9%] | | |
| Enrollment | BS | 72.34 | 81.20 | 12.24% | 100.07 | 38.32% |
| | | [71.78, 72.93] | [80.81, 81.59] | [11.8%, 12.6%] | [99.66, 100.49] | [37.7%, 39.1%] |
| (Total HHs, 000s) | BC | 26.77 | - | - | 62.65 | 134.08% |
| | | [26.37, 27.12] | | | [62.23, 63.06] | [131.8%, 136.3%] |
| | Kaiser | 63.61 | 72.91 | 14.63% | - | - |
| | | [63.41, 63.83] | [72.59, 73.21] | [14.5%, 14.7%] | | |
| Avg Hosp Pmts | BS | 0.68 | 0.69 | 0.11% | 0.72 | 4.61% |
| | | [.68, .69] | [.68, .69] | [-.2%, .4%] | [.70, .73] | [3.6%, 5.4%] |
| ($000 / Enrollee) | BC | 0.58 | - | - | 0.49 | -15.53% |
| | | [.57, .59] | | | [.48, .51] | [-17.7%, -12.8%] |
| Avg Hosp Prices | BS | 7.40 | 7.34 | -0.79% | 7.63 | 3.19% |
| | | [7.29, 7.51] | [7.23, 7.45] | [-1.1%, -.5%] | [7.50, 7.76] | [2.2%, 4.0%] |
| ($000 / Admission) | BC | 6.25 | - | - | 5.48 | -12.28% |
| | | [6.48, 6.85] | | | [5.34, 5.67] | [-14.5%, -9.4%] |
| Surplus | Insurer | 1.28 | 1.58 | 23.50% | 1.58 | 23.03% |
| | | [1.28, 1.29] | [1.58, 1.59] | [22.8%, 24.0%] | [1.57, 1.58] | [22.5%, 23.5%] |
| ($000 / Capita) | Hospitals | 0.23 | 0.23 | 0.03% | 0.33 | 47.72% |
| | (Non-K) | [.22, .23] | [.22, .23] | [-.9%, .8%] | [.33, .34] | [44.9%, 50.8%] |
| | $\Delta$ Cons. | - | -0.08 | - | -0.18 | - |
| | | | [-.08, -.08] | | [-.18, -.17] | |

Notes: Results from simulating removal of Blue Cross from all markets except HSAs 1 and 8; or removing Kaiser from all markets, using estimates from specification (iii) in Table 5 (without insurer margin moments). Baseline numbers are recomputed from model estimates. Average insurer payments to hospitals and average (DRG-adjusted) hospital prices are weighted by the number of admissions each hospital receives from each insurer under each scenario. Surplus figures represent total insurer, hospital, and changes to consumer surplus per insured individual. 95% confidence intervals, reported below estimates, are constructed by using 80 bootstrap samples of admissions within each hospital-insurer pair to re-estimate hospital-insurer DRG weighted admission prices, re-estimate insurer marginal costs and Nash bargaining parameters, and re-compute counterfactual simulations.

## B.2 Alternative Premium Setting Models

In this section, we provide two alternative premium setting models that are used in the estimation of insurer marginal costs and Nash bargaining parameters.

**Fixed Margins.** We conduct our analysis under the alternative assumption that insurers charge premiums to maintain a fixed 80% medical loss ratio. We use this assumption, rather than the Nash first order condition for premiums, to estimate non-hospital costs $\eta_j$ and to compute counterfactual premiums. In particular, we modify the premium setting moment condition used when estimating insurer marginal costs and bargaining parameters from (14) to:

$$\phi_j\Big(\sum_m [1, 2, 2.6] \times \hat{\boldsymbol{D}}_{j,m}(\cdot)\Big) = 1.25 \times \sum_m \Big(\hat{D}^E_{j,m}(\cdot)\eta_j + \sum_{h \in \mathcal{G}_{j,m}} \hat{D}^H_{h,j,m}(\cdot)\hat{p}_{h,j}\Big) + \tilde{\omega}^1_j \qquad \forall j$$

where $\tilde{\omega}^1_j \equiv -\sum_m \sum_{h \in \mathcal{G}_{j,m}} \hat{D}^H_{h,j,m}\varepsilon^A_{h,j}$, and also use this equation to update premiums in the counterfactual scenarios. We do not use insurer margin moments in our estimation.

Table 16: Removing an Insurer: Hospital Price Changes Across Markets (No Margin Moments)

| | Baseline | (i) Remove BC | | | | (ii) Remove Kaiser | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Fix Premiums | | Adjust Premiums | | Fix Premiums | | Adjust Premiums | |
| | Amount | Amount | % Chg | Amount | % Chg | Amount | % Chg | Amount | % Chg |
| **BLUE SHIELD** | | | | | | | | | |
| All Mkts | 7,398.66 | 6,793.70 | -8.18% | 7,339.88 | -0.79% | 5,669.52 | -23.37% | 7,634.81 | 3.19% |
| 2. Sacramento | 8,491.07 | 8,312.10 | -2.11% | 9,044.45 | 6.52% | 6,176.97 | -27.25% | 7,625.48 | -10.19% |
| 4. SF Bay W. | 9,487.45 | 9,255.78 | -2.44% | 9,946.84 | 4.84% | 7,607.05 | -19.82% | 9,144.74 | -3.61% |
| 5. E. Bay | 7,866.48 | 7,706.92 | -2.03% | 8,507.55 | 8.15% | 5,153.01 | -34.49% | 6,879.39 | -12.55% |
| 9. C. Valley | 6,628.60 | 5,360.43 | -19.13% | 5,752.38 | -13.22% | 5,957.36 | -10.13% | 8,378.55 | 26.40% |
| 10. S. Barbara | 8,213.28 | 6,825.69 | -16.89% | 7,008.19 | -14.67% | 7,790.68 | -5.15% | 9,922.90 | 20.82% |
| 11. LA | 6,139.65 | 5,740.70 | -6.50% | 6,477.09 | 5.50% | 4,245.55 | -30.85% | 6,581.51 | 7.20% |
| 14. SD | 6,871.88 | 6,288.12 | -8.49% | 6,762.75 | -1.59% | 5,407.90 | -21.30% | 7,192.49 | 4.67% |
| **BLUE CROSS** | | | | | | | | | |
| All Mkts | 6,247.11 | - | | - | | 6,097.45 | -2.40% | 5,479.79 | -12.28% |
| 2. Sacramento | 6,581.76 | - | | - | | 6,464.89 | -1.78% | 6,245.87 | -5.10% |
| 4. SF Bay W. | 7,255.99 | - | | - | | 7,118.76 | -1.89% | 6,847.90 | -5.62% |
| 5. E. Bay | 7,493.95 | - | | - | | 7,235.26 | -3.45% | 6,902.13 | -7.90% |
| 9. C. Valley | 5,250.57 | - | | - | | 5,197.50 | -1.01% | 4,597.19 | -12.44% |
| 10. S. Barbara | 4,881.69 | - | | - | | 4,845.83 | -0.73% | 4,060.12 | -16.83% |
| 11. LA | 6,180.09 | - | | - | | 5,733.47 | -7.23% | 5,011.94 | -18.90% |
| 14. SD | 5,461.60 | - | | - | | 5,513.95 | 0.96% | 5,105.16 | -6.53% |

Notes: Average (DRG-adjusted) hospital prices from simulating the removal of Blue Cross or Kaiser across all HSAs, or within a selected sample of HSAs, using estimates from specification (iii) in Table 5 (without insurer margin moments). Baseline numbers are recomputed from model estimates. Average hospital prices are weighted by the number of admissions each hospital receives from each insurer under each scenario.

**CalPERS Competition.** Our second alternative premium setting model assumes that each insurer faces a probability that CalPERS may immediately terminate and remove the insurer from its plan menu after premiums are set (after stage 1 but before stage 2 of our model). Let the probability that an insurer $j$ be kept on CalPERS plan menu be given by $z(\phi_j)$, which we allow to be a function of the single-household premium that the insurer sets. Thus, an insurer maximizes $z_j(\phi_j) \times \pi_j^M(\mathcal{G}, \boldsymbol{p}, \boldsymbol{\phi})$ (where $\pi_j^M(\cdot)$ is given by (1)). The first order condition of this maximization problem with respect to premiums can be re-written as:

$$0 = \sum_m \left( [1, 2, 2.6] \times \hat{\boldsymbol{D}}_{j,m}(\cdot) + \phi_j [1, 2, 2.6] \times \frac{\partial \hat{\boldsymbol{D}}_{j,m}(\cdot)}{\partial \phi_j} - \frac{\partial \hat{D}^E_{j,m}(\cdot)}{\partial \phi_j} \eta_j - \sum_{h \in \mathcal{G}^H_{j,m}} \frac{\partial \hat{D}^H_{h,j,m}(\cdot)}{\partial \phi_j} \hat{p}_{h,j} \right)$$
$$+ \zeta \sum_m \left( \phi_j [1, 2, 2.6] \times \hat{\boldsymbol{D}}_{j,m}(\cdot) - \hat{D}^E_{j,m}(\cdot) \eta_j - \sum_{h \in \mathcal{G}^H_{j,m}} \hat{D}^H_{h,j,m}(\cdot) \hat{p}_{h,j} \right) + \tilde{\omega}^1_j \qquad \forall j \tag{18}$$

where $\zeta \equiv z'_j(\phi_j)/z_j(\phi_j)$. Note that if $z'_j(\phi_j) = 0$ so that the probability an insurer remains on CalPERS's plan menu is unaffected by the level of its premium, (18) is equivalent to (14) when $\rho = 1$. We estimate the model under the alternative specification for $\tilde{\omega}^1_j$ with the same set of moments (including insurer margins) and instruments. We implicitly assume that $\zeta$ is constant across insurers and premium levels by holding it fixed at its estimated value in counterfactual simulations.

**Estimates from Alternative Premium Setting Models.** Estimates from both robustness specifications are broadly similar to each other and to those obtained in the main specification in the text ((iv) from Table 5). All estimated parameters in specification (vi) are statistically equivalent to estimates in (iv) (with the exception of $\rho$ and $\zeta$, which are not shared across the specifications). Our estimate for $\zeta = -.0011$ implies that insurers perceive that a \$1 increase in premiums reduces its (current) probability of remaining on CalPERS plan menu by 0.1%. If we assume that this parameter remains constant, a \$100 increase in premiums will reduce its baseline probability of remaining on the menu by approximately 9.5% (and a \$1000 increase by 67%).

Table 17: Estimates: Insurer Marginal Costs and Nash Bargaining Parameters (Robustness)

| | | Fixed Margins | CalPERS Competition |
|---|---|---|---|
| | | (v) | (vi) |
| Insurer | $\eta_{BS}$ | 1534.87 | 1,631.35 |
| Marginal Costs | | (19.46) | (97.77) |
| | $\eta_{BC}$ | 1957.69 | 2,107.27 |
| | | (8.57) | (67.42) |
| | $\eta_K$ | 2230.44 | 2,517.41 |
| | | - | (37.16) |
| Nash Bargaining | $\tau_{BS}$ | 0.18 | 0.14 |
| Parameters | | (0.04) | (0.03) |
| | $\tau_{BC}$ | 0.26 | 0.17 |
| | | (0.02) | (0.04) |
| Employer Competition | $\zeta$ | - | -0.11 |
| ($10^{-2}$) | | - | (0.01) |
| System Bargaining | | Y | Y |
| Use Margin Moments | | N | Y |
| Number of Observations | | 266 | 266 |

Notes: 2-step GMM estimates of marginal costs for each insurer (which do not include hospital payments for BS and BC), Nash bargaining parameters, and "Employer Competition" parameter $\zeta$. Under fixed markups, insurer margin moments are not used; Kaiser marginal costs are directly obtained from (18). Standard errors are computed using 80 bootstrap samples of admissions within each hospital-insurer pair to re-estimate hospital-insurer DRG weighted admission prices and re-estimating these parameters.

Although parameter estimates are similar, counterfactual results for both of these robustness specifications (not reported) differ from those in the main text. Both robustness specifications predict that estimated premiums for BS *fall* subsequent to the removal of an insurer (either BC or BS), with hospital prices falling on average. E.g., under specification (vi), BS premiums are reduced by approximately 1% upon the removal of either BC or Kaiser, due to the renegotiation of 11-21% lower hospital prices on average across markets. As mentioned in the main text, holding fixed negotiated hospital prices, BS is predicted to increase premiums by only 1-4% following the removal of one of its competitors (as opposed to by 4-11% under the main specification) as BS, at the estimated value of $\zeta$, appropriately trades off higher revenues with the increased probability of being removed from CalPERS's plan menu when setting premiums. We find that there is still significant heterogeneity in the impact on negotiated hospital prices across markets, with some markets experiencing price decreases of 8% and others as much as 22% upon the removal of BC.