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INSURER COMPETITION IN HEALTH CARE MARKETS

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ABSTRACT

The impact of insurer competition on welfare, negotiated provider prices, and premiums in the U.S. private health care industry is theoretically ambiguous. Reduced competition may increase the premiums charged by insurers and their payments made to hospitals. However, it may also strengthen insurers' bargaining leverage when negotiating with hospitals, thereby generating offsetting cost decreases. To understand and measure this trade-off, we estimate a model of employer-insurer and hospital-insurer bargaining over premiums and reimbursements, household demand for insurance, and individual demand for hospitals using detailed California admissions, claims, and enrollment data. We simulate the removal of both large and small insurers from consumers' choice sets. Although consumer welfare decreases and premiums typically increase, we find that premiums can fall upon the removal of a small insurer if an employer imposes effective premium constraints through negotiations with the remaining insurers. We also document substantial heterogeneity in hospital price adjustments upon the removal of an insurer, with renegotiated price increases and decreases of as much as 10% across markets.

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1 Introduction

This paper examines the impact of insurer competition on premiums, negotiated hospital prices, and welfare in the U.S. private and commercial health care industry. Our analysis is timely. In many markets, the creation of state and federal health insurance exchanges and the emergence of integrated and joint ventures by health providers and insurers have led to an increase in the number and variety of insurance plans that are available to consumers. On the other hand, recently proposed (e.g., between Aetna and Humana, and Anthem and Cigna) and consummated (e.g., between Centene and Health Net) national insurer mergers and other forms of consolidation tend towards a more concentrated, and less competitive, insurance sector. Given the scale of the private health care industry ($1 trillion in annual expenditures) and the magnitude of the payments made to hospitals through negotiated prices ($400 billion), understanding how such changes impact the level and growth of premiums and health care spending is of substantial policy relevance.[1]

There is a standard intuition that reduced insurer competition may increase health expenditures by raising insurer premiums and, with them, the payments made to medical providers. However, the complex interactions between insurers and other players in concentrated oligopolistic health care markets generate indirect effects that may offset such increases.[2] In particular, employers (or other significant purchasers) often constrain insurance product offerings in the large-group market, thereby limiting the extent to which premiums can rise following a reduction in competition. A less competitive insurance sector can also strengthen insurers' bargaining leverage when negotiating with medical providers over reimbursements, thus potentially reducing total payments. The overall impact of reduced competition on both premiums and payments is theoretically ambiguous, and can differ both across markets and—in the case of reimbursements—within a market across providers.[3]

Our aim is to assess the impact of market structure changes on equilibrium outcomes in health care markets. We focus on the large-group component of the employer-sponsored private health insurance market, serving approximately 60% of the non-elderly population in the U.S (Fronstin, 2010). We provide a framework for analyzing insurer-hospital bargaining over negotiated provider prices (or reimbursement rates), insurer-employer bargaining over premiums, household demand for insurers, and individual demand for hospitals. We estimate parameters in our model using detailed 2004 California admissions, claims, and enrollment data, and information on insurers' provider networks and negotiated hospital prices, obtained from a large health benefits manager. We leverage our framework and estimates to conduct simulations across several markets that alter the set of insurers that are available to consumers, and investigate the equilibrium impact of insurer competition on premiums, negotiated hospital prices, firm profits and consumer welfare. Our

[1] Figures are from Centers for Medicare and Medicaid Services (CMS) National Health Expenditure Accounts.

[2] The Hirschman-Herfindahl Index index (HHI) for the average U.S. hospital market (3,261) and the large employer insurance market (2,984) in 2006 was well above the U.S. Department of Justice and Federal Trade Commission merger guidelines' cut-off point for classifying a market as "highly concentrated" (Gaynor, Ho and Town, 2015).

[3] The recent antitrust lawsuits brought by health providers 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 reduced insurer competition sustains lower, rather than higher, reimbursements. See, for example, "Antitrust Lawsuits Target Blue Cross and Blue Shield," *Wall Street Journal*, May 27, 2015.

insights are relevant not only when employers change insurance plan menus offered to employees, but also when insurers merge, and when they enter or exit markets.

One of this paper's primary contributions is identifying and quantifying the mechanisms by which insurer competition affects negotiated hospital prices in equilibrium. If reducing insurer competition raises premiums via an increase in the remaining insurers' market power, there may be an upward pressure on negotiated prices as hospitals capture part of the increased industry surplus.[4] However, there are offsetting effects that arise if insurers consequently have greater bargaining leverage. This can occur if an insurer loses fewer enrollees to a rival insurer upon disagreement with a hospital and if a hospital "recaptures" fewer enrollees through a rival insurer upon disagreement with an insurer. If substantial, these additional effects—variants of countervailing power (Galbraith, 1952)—imply that greater downstream concentration can reduce total hospital payments.

Previous papers have examined the relationship between market concentration and medical provider prices, often within a regression framework (c.f. Gaynor and Town, 2012; Gaynor, Ho and Town, 2015).[5] We build on this literature by imposing structure derived from a theoretical model of competition in health care markets in order to uncover heterogeneous responses across firms and markets and conduct counterfactual simulations. Our approach is also related to Gowrisankaran, Nevo and Town (2015) who use a structural model of hospital-insurer bargaining to estimate the impact of hospital mergers on negotiated prices.[6] Our contributions include estimating a model of insurer competition for households in our empirical analysis and incorporating employer bargaining over premiums with insurers.[7] Capturing these interactions is critical for understanding how market structure affects outcomes in the large-group employer-sponsored market.

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 over a million individuals, comprising California state and public agency employees, retirees, and their families. We begin by estimating a model of individual demand for hospitals that conditions on hospital characteristics and each individual's location and

[4]This positive relationship between premiums and prices is consistent with statements 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 Northern CA hospital system (`http://www.sutterhealth.org/about/healthcare_costs.html` accessed on July 29, 2013).

[5]For example, Moriya, Vogt and Gaynor (2010) regresses hospital prices on hospital and insurer HHI measures and market and firm fixed effects, and find that increases in insurer concentration are associated with decreases in hospital prices. Melnick, Shen and Wu (2010) conduct a similar analysis with qualitatively similar results.

[6]Gowrisankaran, Nevo and Town (2015) conduct their main analysis under the assumption that premiums are fixed, and insurers do not compete with one another for enrollees; they also examine a calibrated version of their model in which insurers engage in Nash-Bertrand premium setting. See also Grennan (2013) (who models individual hospitals bargaining with medical device manufacturers), Lewis and Pflum (2013), and Dranove, Ody and Satterthwaite (2015).

[7]Ho (2006, 2009) relaxes the assumption that insurers do not compete with one another 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.

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 to estimate a model of household demand for insurance plans. We extend methods developed in Town and Vistnes (2001), Capps, Dranove and Satterthwaite (2003), and Ho (2006, 2009) by using detailed information on household characteristics and allowing for households to aggregate the preferences of individual household members when choosing an insurer. We thus admit more realistic substitution patterns across insurers upon counterfactual network changes than in previous work.[8] By allowing for preferences and the probability of admission for various diagnoses to vary across individuals by age and gender, our analysis also accounts for the selection of heterogeneous individuals across insurers as hospital networks, and insurer choice sets, change.

We assume that insurers engage in simultaneous bilateral Nash bargaining over premiums with CalPERS, and in simultaneous bilateral Nash bargaining with hospitals over prices in each market. This bargaining protocol, used in other studies of bilateral oligopoly to model the division of surplus (e.g., Horn and Wolinsky, 1988; Crawford and Yurukoglu, 2012), implies an equilibrium relationship between the "gains-from-trade" created when two parties come to an agreement and negotiated premiums and prices. Nash bargaining parameters allow for potentially asymmetric splits. Our estimates imply that hospitals capture nearly three-quarters of the gains-from-trade when bargaining with insurers, and that approximately 80% of negotiated hospital price levels are determined by functions of the loss in insurers' premium revenues upon losing a particular hospital, and the prices of neighboring hospitals. Realized insurer margins are less than half of what would be predicted under Nash Bertrand premium setting. We interpret this finding as evidence that CalPERS effectively constrains equilibrium premium levels through negotiation with insurers.

Our main application uses our estimated model to simulate the equilibrium impact of removing one of the three insurers—either Kaiser or Blue Cross—from enrollees' choice sets on premiums, negotiated prices, insurer enrollment, hospital utilization and total spending across all of California. We summarize our key predictions in Figure 1, reporting changes in both premiums and hospital prices as they are jointly determined in equilibrium. We highlight two factors that affect these changes for Blue Shield when a rival insurer is removed: (i) the size and attractiveness to enrollees of the insurer that is removed; and (ii) the presence of effective premium setting constraints. Panel (a) presents Blue Shield's predicted premium changes when either Blue Cross (left-column) or Kaiser (right-column) is removed. If premiums are not constrained by the employer—modeled by assuming that insurers compete à la Nash Bertrand for enrollees—premiums for Blue Shield are predicted to rise (top-row). However, predicted increases are larger upon the removal of Kaiser, which has approximately a 40% statewide market share, than Blue Cross, with a 16% share. This is consistent with the intuition that the removal of a stronger competitor supports higher premium levels for the firms that remain. When premium setting is constrained—modeled by assuming that CalPERS actively negotiates with insurers over premiums on behalf of its members—premium

[8] To our knowledge, only Ho (2006, 2009) and Shepard (2015) are able to recover how the demand for competing insurers varies as a function of their hospital networks; these papers assume that individuals (as opposed to households) choose both insurers and hospitals.

Premium Setting	*Insurer Removed* BC (Small)	*Insurer Removed* K (Large)
Unconstrained (Nash-Bertrand)	+11.0% [10.8%, 11.3%]	+19.3% [19.1%, 19.6%]
Constrained (Bargaining)	−3.4% [−4.0%, −3.3%]	+16.6% [15.8%, 16.8%]

(a) Premium Changes

Premium Setting	*Insurer Removed* BC (Small)	*Insurer Removed* K (Large)
Unconstrained (Nash-Bertrand)	−1.1% [−1.5%, −0.8%]	+3.0% [2.1%, 3.9%]
Constrained (Bargaining)	−8.9% [−13.3%, −7.7%]	+0.6% [−3.1%, 1.8%]

(b) Hospital Price Changes

Figure 1: Predicted (a) premium and (b) hospital price per admission changes for Blue Shield upon the removal of either Blue Cross (BC) or Kaiser (K), when insurers set premiums according to Nash-Bertrand competition or bargain with the employer. 95% confidence intervals are reported below estimates. See Section 4 for details.

increases are predicted to be smaller (bottom-row), and even *negative* when Blue Cross is removed.

Related to premium adjustments are changes in insurers' negotiated hospital prices, shown in Panel (b) of Figure 1. These changes vary with the insurer that is removed for at least two reasons. First, as discussed, the removal of a larger insurer generally supports higher premiums; this tends to raise negotiated prices as hospitals are able to extract some of the increase in premium revenues. Second, the larger the insurer that is removed, the greater the increase in bargaining leverage of the remaining insurers; this tends to depress negotiated hospital prices. On net, the first effect dominates when Kaiser is removed (where we predict an increase in average hospital prices paid by Blue Shield), but not when Blue Cross is removed (where we predict average prices to fall).

Overall, our simulations indicate that health care costs—both premiums and hospital reimbursements—need not increase upon the removal of an insurer. Although our findings regarding the net impact of insurer competition on reimbursement prices are application specific, there are several general takeaways. First, we establish the empirical relevance of countervailing power effects, which may lower negotiated prices and hence limit premium increases. Second, we highlight the importance of premium setting constraints, such as negotiations with large employers or policies such as medical loss ratio requirements, when evaluating changes in insurance market structure. When such constraints are absent, we predict that increased insurer concentration leads to higher premiums, consistent with recent findings (e.g., Dafny, 2010; Dafny, Duggan and Ramanarayanan, 2012; Trish and Herring, 2015). Third, in every counterfactual, the reported averages conceal substantial heterogeneity in price changes across providers and markets. For example, when Kaiser is removed, Blue Shield's negotiated hospital prices can increase or decrease by as much as 10% across markets. This implies a redistribution of rents across hospitals, and a long-term impact on provider investment, entry, and exit. Finally, we predict that consumers are harmed when an insurer is removed—in some cases, by as much as $200 per capita per year. This occurs even when premiums are predicted to fall, suggesting that restricted choice sets and product variety may be a substantial source of consumer harm when insurance markets become less competitive.

Our framework can be used to explore the effects of other changes to the structure of health care markets, including mergers and integration.[9] In addition, our setting bears similarities to other vertical markets in which individuals access goods and services provided by suppliers through an intermediary (including cable television markets and other hardware-software and platform markets; see, e.g., Lee, 2013). Thus, our findings regarding how suppliers interact with a concentrated intermediary market may also prove useful in non-health care contexts. To our knowledge, the only other papers that estimate and compute counterfactual negotiated input prices in an applied analysis of bilateral oligopoly with competing upstream and downstream firms are Crawford and Yurukoglu (2012) and Crawford et al. (2015) on the cable television industry; our analysis builds on important methodological contributions from these papers.[10]

That said, it is worth emphasizing two notable features of health care markets that do not generally apply to other industries. First, consumers are minimally exposed to insurers' marginal cost differences across providers when making utilization decisions, creating incentives for insurers to exclude certain hospitals from their networks.[11] Second, premiums are often restricted to be the same within groups of individuals, even though the costs borne by the insurer can vary dramatically across individuals due to heterogeneous health status or preferences over providers. Both of these features lead to adverse selection concerns (c.f. Akerlof, 1970; Rothschild and Stiglitz, 1976) as insurers' costs are a function of their enrollees' health risk (e.g., Einav, Finkelstein and Cullen, 2010; Handel, 2013) and propensity to choose more expensive providers (Shepard, 2015). In contrast, in many other settings consumers are exposed to marginal cost differences across products through product-specific prices (e.g., as in retail environments), and the costs of serving a given customer do not differ across individuals (e.g., in cable television markets, distributors pay content providers a linear fee per subscriber that does not vary across individuals or by viewership).

The rest of this paper is organized as follows. In Section 2, we present our theoretical model of the U.S. private health care market and derive bargaining equations that relate negotiated prices and premiums to estimable objects that underly insurer, hospital and employer gains-from-trade from agreement. Section 3 describes our data and the empirical implementation of our model. Section 4 presents our counterfactual simulations, and Section 5 concludes.

[9] For example, Dafny, Ho and Lee (2015) use a version of our model to examine cross-market hospital mergers.

[10] Our analysis also contributes to the large literature in industrial organization on countervailing power and bargaining in bilateral oligopoly, and the impact of changes in concentration on negotiated prices (e.g., Horn and Wolinsky, 1988; Stole and Zweibel, 1996; Chipty and Snyder, 1999; Inderst and Wey, 2003). 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 their framework (which abstracts away from the upstream competition that is a central component of our setting), properties of the supplier's gross surplus function determine the effect of a merger on buyers' bargaining positions.

[11] Provider-specific cost-sharing mechanisms are typically limited, and even if they do exist (e.g., co-insurance rates), patients are often unaware or unable to determine their liability prior to choosing their provider.

2 Theoretical Framework

We begin with a stylized theoretical model of the U.S. private, or commercial, health care market. The majority of non-elderly consumers obtain health insurance coverage through their employer or benefits manager, typically paying a monthly premium for, among other things, access to a particular insurer's network of medical providers. We assume that a benefits manager (referred to as an employer from now on) bargains over premiums with the insurers that it offers, and that these insurers also bargain with hospitals over reimbursement prices. We use the model to support our subsequent empirical analyses by highlighting how particular objects of interest—notably household demand for insurers and individual demand for hospitals—determine equilibrium premiums and prices, and how changes in insurer competition affect these objects and hence counterfactual predictions. We also discuss why increased insurer competition has a theoretically ambiguous impact on prices and premiums. In this section we abstract away from various empirically-relevant details that are introduced later.

2.1 Setup

Consider the set of insurers (also known as managed care organizations, or MCOs) $\mathcal{M}$ that are offered by an employer, and a single market that contains a set of hospitals $\mathcal{H}$.[12] 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 present in 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 $\mathcal{G}^M_j$; similarly, $\mathcal{G}^H_i$ denotes the set of insurers that have contracted with (and are allowed to send patients to) hospital i. We take the network $\mathcal{G}$ as given, and assume the following timing:

1a. The employer and the set of MCOs bargain over premiums $\boldsymbol{\phi} \equiv \{\phi_j\}_{j\in\mathcal{M}}$, where ϕ_j represents the per-household premium charged by MCO j.

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

[12] We focus on premium and price bargaining and consumer choices *conditional* on the set of insurers offered to employees, and do not explicitly model the selection of insurers that are offered. In our empirical application, CalPERS primarily offered the three insurers that we focus on for the decade following 2003.

[13] Although in reality hospital contracts are more complicated (e.g., specifying case-rates, per-diems, or discounts off charges), they are essentially linear payments based on the services provided and the patient's diagnosis. If MCOs instead negotiated with hospitals over a fixed payment for inclusion on their networks (so that payments were invariant to actual utilization of hospitals' services), then changes in negotiated payments induced by changes in insurer competition would not necessarily be passed through to consumers in the form of lower premiums. In our empirical application, we multiply a Medicare diagnosis-related group (DRG) adjusted price p_{ij} by the expected DRG weight for a given admission to control for variation in patient severity across different age-sex categories and construct expected payments. This amounts to an assumption that hospitals negotiate a single price index (corresponding to an admission of DRG weight 1.0) with each MCO, which is then adjusted in accordance with the intensity (as measured by DRG weight) of treatment provided.

2. Given hospital networks and premiums, households choose to enroll in an MCO, determining household demand for MCO j, denoted by $D_j(\mathcal{G}, \boldsymbol{\phi})$.

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 $D^H_{ij}(\mathcal{G}, \boldsymbol{\phi})$, the number of individuals who visit each hospital i through each MCO j.[14]

The distinction between *households* choosing insurance plans (and paying premiums) and *individuals* choosing a hospitals is an important instutitional feature of the private health care market, and integral for linking the theoretical analysis with our data and empirical application.

MCOs and hospitals seek to maximize profits when bargaining over negotiated prices and premiums. For now, we assume that profits for an MCO j are

$$\pi^M_j(\mathcal{G}, \boldsymbol{p}, \boldsymbol{\phi}) = D_j(\cdot)(\phi_j - \eta_j) - \sum_{h \in \mathcal{G}^M_j} D^H_{hj}(\cdot) p_{hj} \ , \tag{1}$$

where the first term on the right-hand-side represents MCO j's total premium revenues (net of non-inpatient hospital costs, represented by η_j), and the second term represents payments made to hospitals in MCO j's network for inpatient hospital services. This last term sums, over all hospitals in an MCO's network, the price per admission negotiated with each hospital multiplied by the number of patients admitted to that hospital.

We assume that profits for a hospital i are

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

which sums, over all MCOs n with which hospital i contracts, the number of patients it receives multiplied by an average margin per admission (where c_i is hospital i's average cost per admission for a patient).[15] Any components of MCOs' or hospitals' profits that do not vary with the network, including fixed costs, do not affect the subsequent analysis and are omitted.

We take household and individual demand for insurers and hospitals as primitives of this section's theoretical analysis, deferring further discussion until our empirical application, and focus on the equilibrium determination of insurer premiums and hospital prices.

Employer-Insurer Bargaining over Premiums. We assume that premiums for each MCO are negotiated with the employer via simultaneous bilateral Nash bargaining, where the employer maximizes its employees' welfare minus its total premium payments. This assumption nests the standard Nash-Bertrand model of premium setting. It is consistent with evidence suggesting that

[14] In our empirical application, we allow for heterogeneous consumers who become sick with different diagnoses with different probabilities and whose preferences for hospitals depend on their diagnosis, age-sex category, and location.

[15] Our empirical analysis will utilize expected resource-intensity-adjusted prices and costs per admission that vary across age-sex categories and across each insurer-hospital pair.

large employers (including the one that we examine) constrain the level of premiums that are charged in the private health care market. Negotiated premiums ϕ_j for each MCO j thus satisfy

$$\phi_j = \arg\max_{\phi_j} \Bigg[\underbrace{\pi_j^M(\mathcal{G}, \boldsymbol{p}, \{\phi, \boldsymbol{\phi}_{-j}\})}_{GFT_j^M} \Bigg]^{\tau^\phi} \times \Bigg[\underbrace{W(\mathcal{M}, \{\phi, \boldsymbol{\phi}_{-j}\}) - W(\mathcal{M} \setminus j, \boldsymbol{\phi}_{-j})}_{GFT_j^E} \Bigg]^{(1-\tau^\phi)} \quad \forall j \in \mathcal{M} \ , \tag{3}$$

(where $\boldsymbol{\phi}_{-j} \equiv \boldsymbol{\phi} \setminus \phi_j$) subject to the constraints that the terms $GFT_j^M \geq 0$ and $GFT_j^E \geq 0$. These terms represent MCO j's and the employer's "gains-from-trade" (GFT) from coming to agreement and having MCO j in the employer's choice set. The MCO's gains-from-trade are its profits from being offered by the employer (as the MCO's disagreement outcome is assumed to be 0). The employer's gains-from-trade are represented by the difference between its objective, represented by $W(\cdot)$, when MCO j is and is not offered. In our empirical example, $W(\cdot)$ will be the employer's total employee welfare net of its premium payments to insurers; an explicit parameterization is provided in section 3.4. Given our timing assumptions, outside options from disagreement are determined by removing MCO j from the employer's choice set, holding fixed premiums and negotiated hospitals prices for other MCOs, but allowing employees to choose new insurance plans (but not switch employers).

The "premium Nash bargaining parameter" is represented by $\tau^\phi \in [0, 1]$, where $\tau^\phi = 1$ implies that MCOs simultaneously set profit-maximizing premiums (i.e., compete à la Nash-Bertrand), and $\tau^\phi = 0$ implies that the employer pays each MCO only enough to cover its costs (i.e., so that $GFT_j^M = 0$ for all j).

Insurer-Hospital Bargaining over Hospital Prices. As with premiums, we assume that hospital prices $\boldsymbol{p}$ are determined via simultaneous bilateral Nash bargaining.[16] Each negotiated price per-admission $p_{ij} \in \boldsymbol{p}$ between hospital $i \in \mathcal{H}$ and MCO $j \in \mathcal{M}$ (for all $ij \in \mathcal{G}$) maximizes the pair's bilateral Nash product:

$$p_{ij} = \arg\max_{p_{ij}} \Bigg[\underbrace{\pi_j^M(\mathcal{G}, \boldsymbol{p}, \boldsymbol{\phi}) - \pi_j^M(\mathcal{G} \setminus ij, \boldsymbol{p}_{-ij}, \boldsymbol{\phi})}_{\text{MCO } j\text{'s GFT with hospital } i} \Bigg]^{\tau_j} \times \Bigg[\underbrace{\pi_i^H(\mathcal{G}, \boldsymbol{p}, \boldsymbol{\phi}) - \pi_i^H(\mathcal{G} \setminus ij, \boldsymbol{p}_{-ij}, \boldsymbol{\phi})}_{\text{Hospital } i\text{'s GFT with MCO } j} \Bigg]^{(1-\tau_j)} \quad \forall ij \in \mathcal{G} \ . \tag{4}$$

[16] Our empirical application allows for insurers to bargain simultaneously with *hospital systems*, where we assume that a system removes all of its hospitals from an insurer's hospital network upon disagreement (see Appendix A.4). We also note that our approach implicitly assumes that different prices for each insurer-hospital pair may be negotiated for different employers.

That is, each price p_{ij} maximizes the product of MCO j and hospital i gains-from-trade, holding fixed all other negotiated prices $\boldsymbol{p}_{-ij} \equiv \boldsymbol{p} \setminus p_{ij}$, 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. As each bilateral bargain occurs concurrently with premium setting, if hospital i comes to a disagreement with MCO j, we assume that both parties believe that the new disagreement network will be $\mathcal{G} \setminus ij$, and all other prices $\boldsymbol{p}_{-ij}$ and premiums $\boldsymbol{\phi}$ remain fixed.

The "price Nash bargaining parameter" for MCO j is represented by $\tau_j \in [0, 1]$ for all $j \in \mathcal{M}$.

Remarks. The assumption that each bilateral negotiation maximizes bilateral Nash products (taking the outcomes of all other bargains as given) was proposed in Horn and Wolinsky (1988). It is a type of *contract equilibrium* as defined in Cremer and Riordan (1987), and has been subsequently used in applied work to model upstream-downstream negotiations over input prices in oligopolistic vertical markets (e.g., Crawford and Yurukoglu (2012), Grennan (2013), Gowrisankaran, Nevo and Town (2015)).[17] Our paper is the first in the literature to allow the "consumer" of the downstream firms' products (here, the employer) to also negotiate over downstream prices (premiums).

We assume that both premiums and hospital prices are simultaneously determined, implying that they will be "optimal" (i.e., maximize their bilateral Nash products) with respect to each other in equilibrium.[18] This assumption implies that prices remain fixed when evaluating payoffs from premium bargaining in (3) and that premiums remain fixed when considering both agreement and disagreement payoffs from hospital price bargaining in (4). Although we adopt this timing assumption primarily to simplify the computation and estimation of our model, we also note that as prices and premiums are set at staggered intervals and are fixed for different period lengths in reality, an alternative timing assumption—that prices are negotiated before premiums and that premiums immediately adjust to changes in negotiated prices—may be unrealistic.[19]

2.2 Equilibrium Negotiated Premiums and Hospital Prices

We next derive the first-order conditions for our premium and hospital price bargaining equations in (3) and (4) to examine how insurer competition affects their determination in equilibrium.

[17] Collard-Wexler, Gowrisankaran and Lee (2016) provide a non-cooperative extensive form that allows for firms to participate in multiple bargains with multiple parties that, under certain conditions, yields the bargaining solution over premiums and prices given by (3) and (4)—i.e., where each pair chooses a transfer to maximize their bilateral Nash product holding the outcomes of other bargains as fixed—as an equilibrium outcome.

[18] See also Gal-Or (1999), Nocke and White (2007), Draganska, Klapper and Villas-Boas (2010), and Crawford et al. (2015) who use a similar timing assumption in other settings. As negotiated hospital prices are assumed to be linear, double marginalization will still be present.

[19] In our empirical application, we find that premiums would not significantly adjust to an increase in any particular hospital's negotiated price, and thus our results are also likely to be robust to assuming that hospital prices are determined before premiums. I.e., using our estimated parameters, we compute the elasticity of premiums with respect to hospital prices (i.e., $(p_{ij}/\phi_j) \times (\partial \phi_j / \partial p_{ij})$) for each hospital i and insurer j pair at observed premiums and price levels when premiums are determined after hospital prices are negotiated: the maximum elasticity across all insurer and hospital pairs is no greater than .03, with a mean of 4×10^{-4}. These small magnitudes are attributable to the presence of state-wide premium setting and the fact that no single hospital serves more than 12% of an insurer's total admissions (with a mean of less than 0.5%).

Insurer Premiums. Setting the first-order conditions of (3) equal to 0 (for a given network and set of premiums $\boldsymbol{\phi}_{-j}$, and set of negotiated prices $\boldsymbol{p}^*$) implies that

$$\frac{\partial \pi_j^M(\cdot)}{\partial \phi_j} = \frac{1-\tau^\phi}{\tau^\phi} \times \frac{\pi_j^M(\cdot) \times \left(-\partial GFT_j^E(\cdot)/\partial \phi_j\right)}{GFT_j^E(\cdot)} \qquad \forall j \; , \tag{5}$$

where, again, $GFT^E(\cdot)$ represents the change in the employer's objective function when MCO j is added to the choice set.

As (5) shows, if $\tau^\phi = 1$, these conditions correspond to the standard Nash-Bertrand first-order conditions: $\partial \pi_j^M(\cdot)/\partial \phi_j = 0$ for all j. However, holding fixed $\boldsymbol{\phi}_{-j}$, if $\tau^\phi < 1$, then (5) implies that $\partial \pi_j^M(\cdot)/\partial \phi_j \geq 0$ and the equilibrium premium for j will likely be lower than that predicted under Nash Bertrand premium setting.[20] The negotiated premium level will be particularly low relative to the Nash Bertrand outcome if the right-hand side of (5) is large in magnitude: for example, if the MCOs' Nash bargaining parameter (τ^ϕ) is low, the profits that MCO j receives from the employer ($\pi^M(\cdot)$) are high, the employer's gains-from-trade with the MCO (GFT_j^E) are low, or the harm to the employer from higher premiums ($-\partial GFT_j^E(\cdot)/\partial \phi_j$) is large.

Hospital Prices. Turning now to hospital prices, the first-order conditions of (4) (for a given network, set of premiums $\boldsymbol{\phi}$, and set of negotiated prices $\boldsymbol{p}^*_{-ij}$) are

$$\underbrace{p_{ij}^* D_{ij}^H}_{\text{total hospital payments}} = (1-\tau_j) \Bigg[\underbrace{[\Delta_{ij} D_j](\phi_j - \eta_j)}_{\substack{\text{(i) ``premium and enrollment effects''} \\ (\Delta \text{ MCO revenues net of non-hosp costs})}} - \underbrace{\Bigg( \sum_{h \in \mathcal{G}_j^M \setminus ij} p_{hj}^* [\Delta_{ij} D_{hj}^H] \Bigg)}_{\substack{\text{(ii) ``price reinforcement effect''} \\ (\Delta \text{ MCO } j \text{ payments to other hospitals})}} \Bigg] + \tau_j \Bigg[\underbrace{c_i D_{ij}^H}_{\substack{\text{(iii) ``hospital cost effect''} \\ \text{(total hospital costs)}}} - \underbrace{\sum_{n \in \mathcal{G}_i^H \setminus ij} [\Delta_{ij} D_{in}^H](p_{in}^* - c_i)}_{\substack{\text{(iv) ``recapture effect''} \\ (\Delta \text{ Hospital } i \text{ profits from other MCOs})}} \Bigg] \qquad \forall ij \in \mathcal{G} \; , \tag{6}$$

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

[20] If $\tau^\phi < 1$, the right-hand side of (5) is positive: π_j^M and GFT_j^E must be weakly positive if the employer and MCO j are observed to have an agreement, and the negative change in employer welfare from an increase in premiums is also positive. If $\pi_j^M(\cdot)$ is globally concave, then a value of ϕ_j for which $\partial \pi_j^M(\cdot)/\partial \phi_j \geq 0$ will be no greater than the value of ϕ_j for which $\partial \pi_j^M(\cdot)/\partial \phi_j = 0$.

Equation (6) decomposes the determinants of negotiated payments when MCO j and hospital i bargain over the gains-from-trade created when that hospital is included in j's network. These gains are primarily obtained by MCOs through higher premiums and additional enrollees. Although the gains are shared with hospitals via negotiated per-admission prices, we use the *total hospital payment* on the left-hand-side of (6) as a measure of revenues that is comparable across hospitals for a particular MCO and is not dependent on the number of admissions that a hospital actually receives.[21]

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*: this is the effect of hospital i's inclusion in MCO j's network on the MCO's premium revenues. It is a function of both the level of the MCO's premiums and the change in its enrollment if i is removed from its network.

(ii) *Price reinforcement effect*: the adjustment in payments per enrollee that j makes to other hospitals in its existing network upon dropping i. It is a function of the substitutability and equilibrium negotiated prices of all hospitals in MCO j's network.

The second line of (6), representing hospital i's gains from being included in MCO j's network, also comprises two terms:

(iii) *Hospital cost effect*: this implies that every unit increase in hospital i's costs results in a τ_j unit increase payments.

(iv) *Recapture effect*: this represents the adjustment in hospital i's reimbursements from other MCOs $n \neq j$ when i is removed from MCO j's network.

These terms have intuitive effects on equilibrium negotiated prices. The premium and enrollment effects indicate that the greater is the loss in an MCO's premium revenues (net of non-hospital costs) from losing access to a hospital, the more that hospital is paid, since it has more "leverage" over the MCO's profits. The price reinforcement effect indicates that the higher the price of the hospitals in j's network that j's enrollees visit in the case when i is dropped, the higher will be p^*_{ij}. That is, if hospital i's patients on MCO j substitute to cheaper hospitals when i is dropped, hospital i is paid less than if its patients visited more expensive hospitals. The hospital cost effect implies that the Nash bargaining parameter determines how completely the hospital is able to pass through cost increases to the MCO. And finally, the recapture effect represents hospital i's "opportunity cost" from being in MCO j's network: i.e., the more hospital i would be paid by other MCOs if i dropped MCO j, the more MCO j pays i in equilibrium.

[21] 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 $D^H_{Aj} < D^H_{Bj}$). 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.

2.3 The Impact of a Change in Insurer Competition on Premiums and Prices

We now use the bargaining first-order conditions from our model, given by (5) and (6), to examine the effects of insurer competition on premiums and hospital prices.

Insurer Premiums. Consider the impact of a reduction in insurer competition. The left-hand side of the first-order condition in (5) implies that the standard logic from Nash-Bertrand premium setting is still present: the removal of an insurer from an employer's choice set tends to reduce "competitive pressures" (i.e., the elasticity of demand with respect to premiums for each MCO), and thus increase premiums.

However, if $\tau^{\phi} < 1$, then the right-hand side of (5) will be non-zero, leading both initial and "counterfactual" (i.e., post-removal of an insurer) premiums to differ from Nash Bertrand levels. For example, the term $GFT_j^E(\cdot)$ will tend to increase for an MCO j when a rival insurer is removed from the choice set. This will reduce the extent to which premium setting departs from Nash-Bertrand behavior and lead to additional upward pressure in MCO j's premiums when another MCO is removed. Such an increase may be partially offset by an increase in $\pi_j^M(\cdot)$ when a rival insurer is removed, because now MCO j stands to lose more upon being dropped.

Unlike with standard Nash-Bertrand premium setting, in our premium bargaining model it is possible that removing an MCO from the employer's choice set can actually lead to a *reduction* in premiums for the remaining insurers (holding fixed hospital prices) when $\tau^{\phi} < 1$ if an employer's bargaining leverage is strengthened. To understand how this is possible, observe that if $GFT_j^E(\cdot)$ *decreases* when a rival MCO is removed from the choice set, then the right-hand side of (5) will tend to increase; if this effect is large enough to offset other adjustments, premiums may actually fall. One example of how $GFT_j^E(\cdot)$ can decrease if a rival MCO k is removed from the choice set is if k is a high-cost insurer with higher premiums than its rivals.[22] Allowing for negotiated hospital prices to change (and potentially fall) can reinforce this effect, and further admit the possibility that a "countervailing power" result—i.e., a more concentrated downstream (insurer) market leading to both lower negotiated upstream (hospital) and downstream (employer) prices—can occur.

Hospital Prices. To understand how insurer competition affects hospital prices, we focus on how the removal of a rival MCO adjusts each of the right-hand side terms in (6) for a particular MCO j and hospital i pair. Term (i), referred to as the *premium and enrollment effects*, is a function of both the change in MCO j's demand upon losing access to hospital i (the enrollment effect), and the level of its premiums in the market (the premium effect). We decompose the adjustment in these effects when a rival MCO is removed into an *enrollment effect change*, and a *premium effect*

[22] I.e., if MCO k is in the choice set, a disagreement between the employer and MCO j may lead to most enrollees in j choosing to join k and substantially increase the employer's premium payments. However, if MCO k is not in the choice set, then a disagreement between the employer and MCO j may lead to the employer's enrollees choosing a more cost-effective plan, harming the employer by less.

change:

$$\underbrace{\left([\Delta_{ij} D_j^{CF}] - [\Delta_{ij} D_j]\right) \times \left(\phi_j^{CF} - \eta_j\right)}_{\text{enrollment effect change}} + \underbrace{[\Delta_{ij} D_j] \times \left(\phi_j^{CF} - \phi_j\right)}_{\text{premium effect change}}, \tag{7}$$

where "CF" superscripts denote counterfactual values of demand and premiums terms when an MCO is removed. An adjustment to insurer competition will often cause these two terms to move in opposite directions. On one hand, when a rival insurer is no longer competing for the same enrollees, the loss of hospital i typically results in a smaller adjustment in MCO j's enrollment ($[\Delta_{ij} D_j^{CF}] < [\Delta_{ij} D_j]$). This negative *enrollment effect change* is a primary source of MCOs' additional bargaining leverage when negotiating with hospitals in less competitive markets, and can lead to lower negotiated prices. On the other hand, as previously discussed, a less competitive insurance market may generate higher premiums; this positive *premium effect change* will tend to increase negotiated prices. Thus, the effect of insurer competition on the first term in (6) is theoretically ambiguous.

Note that the impacts of insurer competition on terms (ii) and (iv)—i.e., a *price reinforcement effect change* and *recapture effect change*—are more difficult to sign because they are not only affected by *changes in changes in demand* ($\Delta D_{in}^{H,CF} - \Delta D_{in}^{H}$) for all MCOs n, but they are also a function of the equilibrium prices paid to all other hospitals. Finally, the impact of insurer competition on negotiated per-admission prices induced by a *hospital cost effect change* (a change in term (iii) of (6)) will be limited in our model, as hospital costs per admission are not assumed to be a function of realized hospital demand.[23]

Summary. Even in this fairly stylized setting, we have shown that the equilibrium effects of insurer competition on negotiated prices and premiums (and consequently on consumer welfare and industry profits) are complicated, and that it may not be possible to sign these effects without more detailed analysis. The ultimate impact will depend on underlying demand primitives, firm heterogeneity, and institutional details. We thus turn to our empirical application for further guidance, using the insights developed here to guide our approach and inform the interpretation of our findings.

3 Empirical Application and Estimation

In this section we discuss our empirical setting and estimation strategy. 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 and household demand for insurance plans. Estimates from this demand model are used as inputs for the estimation of a model of employer-insurer bargaining over

[23] In Appendix A.7, we provide a formal derivation and further discussion of how the objects in (6) (extended to allow for hospital system bargaining) adjust upon a change in insurer competition.

premiums and hospital-insurer bargaining over reimbursement prices.

3.1 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 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 38,604 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.[24] We discuss our measure of a price per-admission negotiated between an insurer and hospital in Section 3.4.

We categorize individuals into 5 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 category, 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 category, in California (from 2003 OSHPD discharge data) by Census data on the total commercially insured population. We also compute the probability of an individual in each age-sex category of being admitted for particular diagnoses in a similar fashion.

For enrollment data we use information on the 2004 plan choices of state employee households, for which we observe the age, sex, and zip code for each household member and salary information in \$10K bins for the primary household member. We limit our attention to enrollees into either BS, BC, or Kaiser, which represents over 90% of state enrollees.[25] 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

[24] 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."

[25] 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%.

Table 1: Summary Statistics

		BS	BC	Kaiser
Premiums	Single	3782.64	4192.92	3665.04
(per year)	2-Party	7565.28	8385.84	7330.08
	Family	9834.84	10901.64	9529.08
	Revenues (per individual)	2860.34	3179.39	2788.05
Insurer	# Hospitals in Network	189	223	27
Characteristics	# Hospital Systems in Network	119	149	-
	Hospital Prices (per admission)	7191.11	6023.86	-
	Hospital Payments (per individual)	623.20	554.00	-
	Hospital Costs (per admission)	1709.56	1639.92	-
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. The number of hospitals and hospital systems in network for BS and BC are determined by the number of in-network hospitals or systems with at least 10 admissions observed in the data. Hospital prices and costs per admission are average unit-DRG amounts, weighted across hospitals by admissions. Hospital payments per individual represent average realized hospital payments made per enrollee (not weighted by DRG).

codes and markets in which Kaiser is not available to enrollees as an option.

In addition to our main dataset, we use hospital characteristics, including location, from the American Hospital Association (AHA) survey. Hospital costs are taken from the OSHPD Hospital Annual Financial Data for 2004.[26] We use demographic information from the 2000 Census. Finally, we use 2004 financial reports for each of our three insurers from the California Department of Managed Health Care (DMHC) to compute medical loss ratios (MLRs) by dividing total medical and hospital costs by total revenues.[27]

Summary Statistics. Summary statistics are provided in Table 1. In 2004, annual premiums for single households across BS, BC, and Kaiser were $3,782, $4,193, and $3,665; 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 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

[26] Our measure of costs is the average cost associated with the reported "daily hospital services per admission" divided by the the computed average DRG weight of admissions at that hospital (computed using our data).

[27] The obtained ratios for BS, BC and Kaiser are $(0.82, 0.79, 0.91)$. MLR information for large-group plans offered by insurers is available from CMS for 2011 onwards; using our approach to compute 2011 MLRs for the three insurers that we examine yields similar figures to those reported to CMS in 2011. To address the possibility that the CalPERS margins for BC (the only self-insured product in our sample) are smaller than those reported in the DMHC data, we also re-estimate our model and compute counterfactuals under the assumption that BC's margins are half the level observed in the DMHC data: we find broadly similar parameter estimates and counterfactual predictions, with the exception that we estimate higher BC non-inpatient hospital costs per enrollee (implied by the lower margins used in estimation).

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.

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 including insurer-market specific fixed effects, controlling for each insurer's hospital network, and 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 quite similar across samples. Older patients are admitted more often and with higher weights; the exceptions are 20-34 year old females, who are admitted more often than any other age-sex category at lower average DRG weights (consistent with admission primarily for labor and delivery services).

3.2 Individual Demand for Hospitals

Our model of individual demand for hospitals and insurers builds on Ho (2006), which estimates 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.

We group individuals into one of 10 age-sex categories (described previously), and assume that an individual in category (or of "type") κ requires admission to a hospital with probability γ^a_κ. Conditional on admission, the individual receives one of six diagnoses $l \in \mathcal{L} \equiv$\{cardiac, cancer, neurological, digestive, labor, other\} with probability $\gamma_{\kappa,l}$. Individuals can only visit a hospital in their market m and insurer's network, and individual k of type $\kappa(k)$ with diagnosis l derives the following utility from hospital i:

$$u^H_{k,i,l,m} = \delta_i + z_i \upsilon_{k,l} \beta^z + d_{i,k} \beta^d_m + \varepsilon^H_{k,i,l,m} \tag{8}$$

where δ_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 can therefore 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. We also assume that negotiated hospital prices do not influence individuals' choices of which hospital to visit.[28]

The model predicts the probability that an individual k—who lives in market m, is enrolled in MCO j, and has diagnosis l—visits hospital i; we estimate the parameters of this model via maximum likelihood using our admissions data. Additional details and results are provided in Appendix A.1.

Identification. Identification of individual preferences for hospitals relies on variation in hospital choice sets across markets and differences in choice probabilities for hospitals with particular

[28] 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).

characteristics both within and across diagnosis categories.[29] The distance coefficient, which is assumed to be market-specific, is identified from within-market, across-zip code variation in choice probabilities for consumers who live at varying distances 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). We use the estimated demand model, not only to predict changes in hospital demand following hypothetical network changes, but also to construct a measure of consumers' ex-ante expected utility for an insurer's hospital network. We follow an established literature by referring to this measure as "willingness-to-pay" (WTP) (Town and Vistnes, 2001; Capps, Dranove and Satterthwaite, 2003; Ho, 2006; Farrell et al., 2011). This object will 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 WTP for the hospital network offered by plan j is

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

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.[30] 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.

3.3 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), taking all household members' hospital preferences into account.

The utility a household or family f receives from choosing insurance plan $j \in \{BS, BC\}$ in market m is given by

$$u^M_{f,j,m} = \underbrace{\delta_{j,m} + \alpha^\phi_f (.2 \times \phi_j \Phi_{\lambda(f)}) + \sum_{\forall \kappa} \alpha^W_\kappa \sum_{k \in f, \kappa(k) = \kappa} WTP_{k,j,m}}_{\tilde{u}^M_{f,j,m}} + \varepsilon^M_{f,j,m}, \quad (9)$$

[29]Here, and throughout the paper, we use the word "identification" in an informal sense. A formal identification argument would require further conditions.

[30]$EU_{k,j,l,m}(G_{j,m})$ 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 $\{\varepsilon^H_{k,i,d}\}$.

where $\delta_{j,m}$ is an insurer-market fixed effect that controls for physician networks, brand effects, and other insurer characteristics; ϕ_j is the single household premium, which is scaled by the consumer contribution of 20%; $\lambda(f) \in$ {single, 2-party, family} is the household "type" for family f; and $\Phi \equiv [1, 2, 2.6]'$ is a vector of premium multipliers for each household type. The term $\sum_{\forall \kappa} \alpha_\kappa^W \sum_{k \in f, \kappa(k)=\kappa} WTP_{k,j,m}(\cdot)$ controls for a household's WTP for the insurer's hospital network by summing over the value of $WTP_{k,j,m}$ for each member of the household multiplied by an age-sex category specific coefficient, α_κ. Finally ε_{fjm}^M 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.[31,32] We assume that in markets where Kaiser is available, Kaiser is the "outside-option" and delivers utility $u_{f,Kaiser,m}^M = \tilde{u}_{f,Kaiser,m}^M + \varepsilon_{f,Kaiser,m}$, where $\tilde{u}_{f,Kaiser,m}^M \equiv \alpha_f^\phi(.2 \times \phi_{Kaiser}\Phi_{\lambda(f)}) + \alpha_m^K d_f^K$ and d_f^K is the (drive-time) distance between household f's zip code and the closest Kaiser hospital. In the two HSAs where Kaiser is not available we assume that $\delta_{BC,m} = 0$.

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

$$\hat{\sigma}_{f,j,m}(\boldsymbol{\phi}, \mathcal{G}) = \frac{\exp(\tilde{u}_{f,j,m}^M)}{\sum_{n \in \mathcal{M}_{z(f)}} \exp(\tilde{u}_{f,n,m}^M)} \qquad j \in \mathcal{M}_{z(f)}\ , \tag{10}$$

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

Identification. Our dataset contains little variation in premiums but substantial variation on other dimensions. In particular, the expected utility derived from an MCO's network differs at the zip code and family level. Thus, the coefficients $\{\alpha_\kappa^W\}_{\forall \kappa}$ 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).

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. 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. The insurer-market fixed effects will absorb variation in plan benefits that do not vary within markets; we assume that they also absorb any variation in unobserved plan quality that could be correlated with premiums or hospital networks and lead to biased estimates.[33] Concerns about

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

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

[33] We do not explicitly model household responsiveness to deductibles, copays, or—in the case of BC—coinsurance

Table 4: Estimates: Insurance Plan Household Price Elasticities

	Single	2-Party	Family
BS	-1.23	-2.15	-2.53
BC	-1.62	-2.50	-2.95
Kaiser	-1.23	-2.12	-2.53

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

endogeneity are further mitigated by the use of exogenous fixed multiples to scale premiums across household types.

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 $p = .05$) and of the expected sign, except for one (which is insignificant). We find that higher-income households are less price sensitive and that, all else equal, households prefer insurance plans that deliver higher network expected utility. The desirability of Kaiser as an insurer is decreasing in the distance to the closest Kaiser hospital.

Table 4 provides the implied own-premium elasticities for each plan and household type.[34] The magnitudes range from -1.23 for single-person households for Kaiser to -2.95 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 (1998) 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 that, while the estimated household premium elasticities are an important input into the premium setting model, they may not be the only constraint faced by insurers when setting premiums. If in reality CalPERS bargains with insurers over premiums, then failing to account for this (e.g., by assuming that insurers unilaterally set their own premiums) would lead us to predict higher markups than would be observed in the data. We return to this issue below.

3.4 Insurer Premiums and Hospital-Insurer Bargaining

We next turn to the estimation of insurer (non-hospital) marginal costs $\boldsymbol{\eta} \equiv \{\eta_{BS}, \eta_{BC}, \eta_K\}$ and Nash bargaining parameters $\boldsymbol{\tau} \equiv \{\tau_{BS}, \tau_{BC}, \tau^{\phi}\}$. We first detail the construction of the objects that are required to estimate our remaining parameters (hospital-insurer prices and insurer and hospital demand) and then discuss how we adapt our theoretical model to fit our empirical setting.

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.

[34] 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.

Construction of Hospital-Insurer Prices. To construct a measure of the price negotiated between each insurer-hospital pair, we take the total amount paid to the hospital by an insurer across all admissions, and divide it by the sum of the 2004 Medicare DRG weights associated with these admissions. This "DRG-adjusted price" accounts for differences in relative values across diagnoses. 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 $a \in \mathcal{A}_{ij}$, the total observed payment made for that admission $p^o_a = p^*_{ij} \times DRG_a + \varepsilon_a$, where p^*_{ij} is the price per-admission (for an admission of DRG weight 1.0) negotiated by i and j given by (6), DRG_a is the observed DRG-weight for admission a, and ε_a represents a mean-zero admission specific payment shock reflecting unanticipated procedures or costs (which 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 $\hat{p}_{ij} \equiv (\sum_{\forall a \in \mathcal{A}_{ij}} p^o_a)/(\sum_{\forall a \in \mathcal{A}_{ij}} DRG_a) = p^*_{ij} + \varepsilon^A_{ij}$, where $\varepsilon^A_{ij} \equiv \hat{p}_{ij} - p^*_{ij} = (\sum_{\forall a \in \mathcal{A}_{ij}} \varepsilon_a)/(\sum_{\forall a \in \mathcal{A}_{ij}} DRG_a)$ and, by assumption, is not known in advance to either hospitals or insurers.[35]

Predicted and Counterfactual Hospital and Insurer Demand. Our insurer and hospital demand systems allow us to condition on any set of premiums and hospital-insurer networks, and construct estimates for: (i) the number of households of each type $\lambda \in \{\text{single}, \text{2-party}, \text{family}\}$ that enroll in MCO j in market m, denoted $\hat{D}_{j,\lambda,m}(\cdot)$; (ii) the number of *individual* enrollees for all MCOs j and markets m, denoted $\hat{D}^E_{j,m}(\cdot)$; and (iii) hospital demand for all hospitals i, MCOs j, age-sex category κ, and markets m, denoted $\hat{D}^H_{i,j,\kappa,m}(\cdot)$. We account for potential differences in disease severity across admissions by scaling this last value by the expected admission DRG weight for patients of type κ. We assume that our estimates of these demand terms condition on exactly the set of observables in firms' information sets so that they are optimal predictors and equal to firms' expectations for these objects. Additional details are provided in Appendix A.3.

[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.

Extending the Theoretical Model. We adjust (1) to accommodate the institutional details of our application, and assume that the profits for MCO j are given by

$$\pi_j^M(\mathcal{G},\boldsymbol{p},\phi_j) = \sum_m \left(\underbrace{\phi_j \Phi' \boldsymbol{D}_{j,m}(\cdot)}_{\text{premium revenues}} - \underbrace{D^E_{j,m}(\cdot)\eta_j}_{\text{non-inpatient hospital costs}} - \underbrace{\sum_{h\in\mathcal{G}^M_{j,m}} D^H_{h,j,m}(\cdot)p_{h,j}}_{\text{hospital payments}} \right). \tag{11}$$

The first term on the right-hand side of (11) represents total premium revenues obtained by MCO j. It accounts for the different premiums charged to different household types: ϕ_j is MCO j's premium charged to single households, Φ is the vector of premium multipliers for each household type, and $\boldsymbol{D}_{j,m}(\cdot)$ is a vector containing the number of households of each type λ enrolled in MCO j. The second term makes the distinction that an MCO's non-inpatient hospital costs η_j are incurred on an *individual* and not a household basis, and thus are multiplied by $D^E_{j,m}(\cdot)$.[36] The third term represents expected payments made to hospitals in MCO j's network for inpatient services, where each term $D^H_{h,j,m}(\cdot)$ sums across all age-sex categories of individuals. As noted above, we scale by the expected admission DRG weight for patients of the relevant age-sex category to account for variation in severity across admissions. Our model will therefore 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.

For the remainder of this section, any demand term that is missing a market subscript m denotes the value of that term summed over all markets; e.g., (11) is equivalent to $\pi^M_j(\cdot) = \phi_j\Phi'\boldsymbol{D}_j(\cdot) - D^E_j(\cdot)\eta_j - \sum_{h\in\mathcal{G}^M_j} D^H_{h,j}(\cdot)p_{h,j}$.

Estimation of Insurer Marginal Costs and Nash Bargaining Parameters. We jointly estimate $\boldsymbol{\theta} \equiv \{\boldsymbol{\eta},\boldsymbol{\tau}\}$ 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 $\{\boldsymbol{\omega}^n\}_{n\in\{1,2,3\}}$ and sets of instruments $\{\boldsymbol{Z}^n\}_{n\in\{1,2,3\}}$ below.[37]

1. *Premium Bargaining.* Our model accounts for the fact that, in our application, premiums for different household types are required to be the fixed multiples of single household premiums observed in the data and are the same across all markets. Thus, each MCO j negotiates only the single household premium ϕ_j with the employer. Rewriting the first-order condition of

[36] 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-inpatient hospital marginal costs per enrollee, which may include physician, pharmaceutical, and other fees. Since we do not observe hospital prices for Kaiser, η_{Kaiser} will also include Kaiser's inpatient hospital costs.

[37] All error terms are 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, and are explicitly defined in Appendix A.5.

(3), and using our general version of MCO profits given by (11), yields

$$\omega_j^1(\boldsymbol{\theta}) = \tau^\phi \times \frac{\partial \pi_j^M}{\partial \phi_j} - (1-\tau^\phi) \times \left(\frac{\pi_j^M \times \left(\Phi' \hat{\boldsymbol{D}}_j(\cdot) + .8 \sum_{k \in \mathcal{M}} \phi_k \Phi' \frac{\partial \hat{\boldsymbol{D}}_k(\cdot)}{\partial \phi_j} \right)}{GFT_j^E(\cdot)} \right) \qquad \forall j \ , \quad (12)$$

where

$$\frac{\partial \pi_j^M(\cdot)}{\partial \phi_j} = \Phi \times \hat{\boldsymbol{D}}_j(\cdot) + \phi_j (\Phi' \frac{\partial \hat{\boldsymbol{D}}_j(\cdot)}{\partial \phi_j}) - \frac{\partial \hat{D}_j^E(\cdot)}{\partial \phi_j} \eta_j - \sum_{h \in \mathcal{G}_j^H} \frac{\partial \hat{D}_{h,j}^H(\cdot)}{\partial \phi_j} \hat{p}_{h,j} \ , \qquad (13)$$

and $GFT_j^E(\cdot)$, defined in (3) and representing the employer's gains from trade with MCO j, can be derived using our specification of household MCO utility from (9) and distributional assumptions on demand shocks:

$$\begin{aligned} GFT_j^E(\cdot) &\equiv W(\mathcal{M}) - W(\mathcal{M} \setminus j) \qquad (14) \\ &= \left(\sum_m \sum_{f \in \mathcal{F}_m} \frac{1}{|\alpha_f^\phi|} \log \frac{\sum_{k \in \mathcal{M}} \exp(\hat{\tilde{u}}_{f,k,m}^M)}{\sum_{k \in \mathcal{M} \setminus j} \exp(\hat{\tilde{u}}_{f,k,m}^M)} \right) - .8 \sum_{k \in \mathcal{M}} \phi_k \Phi' [\Delta_j^M \hat{\boldsymbol{D}}_k] \ . \end{aligned}$$

In this equation, $\hat{\tilde{u}}_{f,k,m}^M$ is our estimate of the term defined in (9) and $[\Delta_j^M \hat{\boldsymbol{D}}_k]$ is the change in MCO k's enrollment across all household types and markets when MCO j is removed from the employer's choice set. The first term on the right-hand-side of (14) is the change in employee welfare when MCO j is removed from the choice set. The second accounts for the change in the employer's payments to insurers when j is removed; these terms are scaled by the employer contribution of 80% of premiums (the other 20% is accounted for in the household utility ($\hat{\tilde{u}}_{f,k,m}^M$) terms).[38]

With the exception of $\boldsymbol{\eta}$ and τ^ϕ (which are both contained in $\boldsymbol{\theta}$), all objects on the right-hand-side of (12) are computable from the hospital and insurer demand systems estimated in the previous subsections. By construction, the term ω_j^1 is mean zero; we use a constant and the number of hospital systems in the network of each insurer as instruments in $\boldsymbol{Z}^1$ to form two moment conditions.

Finally, recall that if $\tau^\phi = 1$, moments based on (12) are equivalent to assuming that MCOs engage in Nash Bertrand premium competition.

2. *Insurer Margins.* We define:

$$\omega_j^2(\boldsymbol{\theta}) = MLR_j^o - \underbrace{\frac{\hat{D}_j^E(\cdot)\eta_j + \sum_{h \in \mathcal{G}_j} \hat{D}_{h,j}^H(\cdot) \hat{p}_{h,j}}{\phi_j \Phi' \hat{\boldsymbol{D}}_j(\cdot)}}_{\text{Predicted MLR from (11)}} \qquad \forall j \qquad (15)$$

[38] One can show that $\partial GFT_j^E(\cdot)/\partial \phi_j = -\left(\Phi' \hat{\boldsymbol{D}}_j(\cdot) + .8 \sum_k \phi_k \Phi' \frac{\partial \hat{\boldsymbol{D}}_k(\cdot)}{\partial \phi_j} \right)$; this is used in the derivation of (12).

where MLR_j^o represents the value of each insurer's MLR obtained from the 2004 financial reports provided by the California Department of Managed Health Care. We use the same instruments as for the premium setting moments in addition to the number of hospitals on each insurer, providing three additional moments.

3. *Hospital-Insurer Bargaining.* In Appendix A.4, we derive the generalization of the hospital-insurer bargaining first-order condition given by (6) to allow all hospitals in a hospital system to bargain jointly with insurers. We rewrite this generalized condition (derived in Appendix A.4 and given by (19)) as

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

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

where $\mathcal{S}$ is a particular hospital system and $\boldsymbol{\mathcal{S}}$ is the set of all systems.

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 $\omega^3_{\mathcal{S}j}$:

- Two instruments for the term $\tilde{Z}^3_{1;\mathcal{S}j}$ in (16). Each is constructed by replacing $\hat{p}_{hj}$ for each hospital h in the expression by either the hospital's 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 enrolled in 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, and m is the market in which h is located);
- The term $Z^3_{2;\mathcal{S},j}$ in (16), which is the predicted change in individual enrollment in MCO j upon losing system $\mathcal{S}$;
- 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 $\{\varepsilon^A_{ij}\}$ (present in $\omega^3_{\mathcal{S}j}$) are mean-zero and mean-independent of firm and hospital observable characteristics.[39]

Due to the simultaneous determination of premiums and negotiated prices in our model, the value of τ^ϕ 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.[40]

Identification. The non-hospital marginal costs ($\boldsymbol{\eta}$) and the premium Nash bargaining parameter (τ^ϕ) are primarily identified from the premium setting and margin moments. Intuitively, since premiums and inpatient hospital payments are observed, the margin moments constructed from (15) closely pin down non-hospital marginal costs for BS and BC and the total medical marginal costs for Kaiser.[41] The assumed form of premium bargaining governed by (12) relates estimated premium elasticities and observed premiums to marginal costs and therefore helps to identify τ^ϕ.

To illustrate how τ^ϕ is identified, we re-compute equilibrium single premiums for all MCOs at different values of τ^ϕ using (12) and our main parameter estimates (to be discussed later), and plot these values in Figure 2. As τ^ϕ increases from 0 to 1, single premiums for all insurers are predicted to increase smoothly, from a level where their costs are just covered to a level (approximately $2000 higher) that exceeds the premiums that we observe in the data. That is, at our estimated household premium elasticities for insurance plans, Nash-Bertrand premium setting behavior would generate implied profit margins higher than those we observe. Thus a value of $\tau^\phi > 0$ is consistent with positive MCO margins, and a value of $\tau^\phi < 1$ rationalizes lower MCO margins than predicted under Nash Bertrand premium setting (given estimated premium elasticities).

Identification of the bargaining parameter τ_j for BS and BC leverages the bargaining moments constructed from (16). Several sources of variation in negotiated hospital prices are relevant. One source 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 MCO

[39]The hospital and insurer-market fixed effects included in the demand equations (8) and (9) 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 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.

[40]Accounting for the effect of variance in the hospital and insurer demand estimates on standard errors in our last stage of estimation is outside the scope of this analysis.

[41]There is also additional information on MCO non-hospital marginal costs contained within the bargaining first-order condition in (16) because η_{BS} and η_{BC} affect the correlation between hospital price and changes in the number of individual enrollees for each MCO upon disagreement with a given hospital.

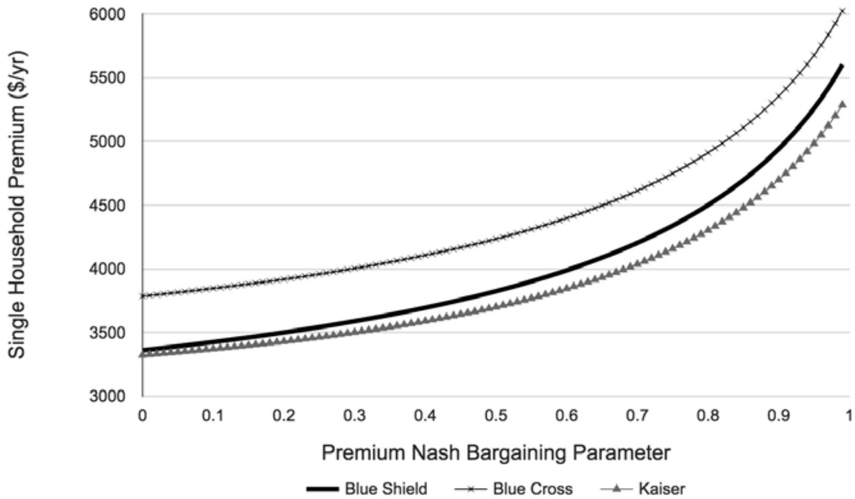

Figure 2: Predicted equilibrium single household premiums at estimated parameters from specification (ii) in Table 5 as the premium Nash bargaining parameter (τ^{ϕ}) varies.

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

		(i)	(ii)
Insurer Non-Inpatient	η_{BS}	925.78	1,691.50
Marginal Costs		11.12	10.41
(per individual)	η_{BC}	1,417.73	1,948.61
		6.93	8.14
	η_K	1,496.44	2,535.14
		-	0.62
Nash Bargaining	τ_{BS}	0.33	0.31
Parameters		0.01	0.05
	τ_{BC}	0.40	0.38
		0.02	0.03
	τ^{ϕ}	1.00	0.47
		-	0.00
Use Margin Moments		N	Y
Number of Bilateral Pairs		268	268

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 $\tau^{\phi} = 1.00$, and Kaiser marginal costs are directly obtained from (12) by setting $\omega^1_{Kaiser} = 0$. 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.

j's negotiated hospital prices are correlated with the predicted loss in its premium revenues when hospitals are dropped from its network ($\phi_j \Phi'[\Delta_{\mathcal{S}j} \hat{D}_j]$), then our model will predict that hospitals capture a proportion of their created gains from trade (i.e., $\tau_j < 1$).

Estimates. Table 5 contains estimates for MCOs' non-hospital marginal costs and the Nash bargaining parameters for both price and premium setting across two specifications. Specification (i) assumes that MCOs engage in Nash-Bertrand competition over premiums (setting $\tau^{\phi} = 1$); it does not rely on insurer margin data.[42] Under this specification, we estimate that non-hospital per enrollee per year marginal costs range from approximately $926 for BS to $1,418 for BC; total (including hospital) marginal costs are estimated to be $1,496 per enrollee per year for Kaiser. These non-hospital marginal costs are likely to be under-estimated: predicted average insurer margins under Nash-Bertrand premium setting are over 40%, much larger than those observed in the data.

Motivated by this discrepancy, specification (ii) incorporates employer-insurer bargaining over premiums (and allows for $\tau^{\phi} \leq 1$), matches observed insurer margins, and hence recovers higher marginal costs which range from approximately $1,690 for BS to $1,950 for BC. Total (including hospital) marginal costs are estimated to be $2,535 for Kaiser. These estimates are close to those reported by 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.[43]

To match observed margins (and rationalize our marginal cost estimates), we obtain an estimate of $\tau^{\phi} = 0.47$. That is, insurers and CalPERS have approximately equal bargaining weights during premium negotiations. This predicted existence of employer bargaining leverage over premiums will be important for our counterfactual analyses.

Estimated Nash bargaining parameters for insurer-hospital bargaining in specification (ii) are .31 and .38 for BS and BC, lower than the estimates in specification (i). To understand this difference, note that (ii) implies that insurers, with lower margins and higher marginal costs, have less surplus to share with hospitals when bargaining. Thus, to rationalize the observed level of hospital prices in the data, our model predicts that hospitals capture more of these "gains from trade" under specification (ii) than (i), resulting in lower estimated insurer Nash bargaining parameters.

For all subsequent analyses (unless otherwise specified), we use estimates from specification (ii).

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.[44] It also reports the decomposition of hospital prices into our different bargaining effects: i.e., we compute the fraction of hospital price *levels* that are determined by each term in our general hospital-system bargaining equation (given by (19)), and reports the weighted (by predicted number of hospital

[42]Hospital payments are included in η_K for Kaiser, and thus we fix $\omega^1_{Kaiser} = 0$. Without using hospital margin data and under the assumption that $\tau^{\phi} = 1$, marginal costs are still identified from the premium setting moments for BS and BC; $\hat{\eta}_{Kaiser}$ in this case can be recovered directly from (12) alone.

[43]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 in addition to the commercially insured enrollees in our sample.

[44]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: Estimates: Negotiated Hospital Price Decomposition

	Price	(i) Premium & Enrollment	(ii) Price Reinforcement	(iii) Hospital Costs	(iv) Recapture Effect
BS	7,191.11	24.2%	66.3%	8.9%	0.6%
		[23.6%, 25.5%]	[64.9%, 69.3%]	[5.1%, 10.6%]	[0.4%, 0.8%]
BC	6,023.86	32.3%	52.6%	12.1%	3.0%
		[31.8%, 33.7%]	[51.8%, 55.1%]	[9.2%, 13.1%]	[2.3%, 3.3%]

Notes: Weighted average (by hospital admissions) decomposition of negotiated hospital prices into the components provided in (19) for each insurer and hospital system (omitting residuals, and scaling by τ_j or $1-\tau_j$ where appropriate). 95% confidence intervals, reported below estimates, 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.

admissions) average across all hospitals.[45] We predict that the largest determinants of hospital price levels are the *price reinforcement effect* and the *premium and enrollment effects*, which represent over 80% of hospital price levels across both insurers. The other effects are predicted to have a smaller, but still significant, impact on hospital prices.[46]

4 The Equilibrium Effects of Insurer Competition

In this section, we use our estimated model to simulate the impact of removing an insurer from enrollees' choice sets, and examine conditions under which premium increases can be mitigated (or completely offset) by employer bargaining or adjustments in negotiated hospital prices. We also decompose predicted changes in hospital payments into adjustments in each of our theoretical bargaining effects in order to better understand the circumstances under which they are likely to increase or decrease.

Setup and Assumptions. For our 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, insurer enrollment, and hospital utilization upon the removal of either BC or Kaiser from CalPERS' menu of plans.[47] Our analysis implicitly assumes

[45]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.

[46]The recapture effect, in particular, is small relative to the premium and enrollment effects. Based on the assumptions of our model, an enrollee who previously visited hospital i through MCO j will be recaptured by hospital i upon disagreement with MCO j only if the enrollee chooses to switch to a different insurer from which she can access i (which cannot include Kaiser), becomes sick enough to be admitted, and then chooses to visit the same exact hospital. 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) and the fact that enrollees choose insurance plans based on ex ante expectations over admission risk and their hospital preferences, help to explain the recapture effect's relatively small magnitude. Further, in reality the realization of any recapture effect is likely to be delayed because enrollees may not be able to switch plans until the following year.

[47]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 details are provided in the Appendix.

that: (i) the menu of insurance plans is held fixed, (ii) hospital prices are negotiated specifically for CalPERS by each insurer-hospital pair; and (iii) counterfactual changes do not induce hospitals to enter or exit or hit capacity constraints.[48] As the insurers that we observe are three of the five largest in the state (covering over two-thirds of California's commercially insured population in 2004), and CalPERS has substantial scale (representing approximately 8% of commercially insured individuals), we argue that our analysis can be seen as representative of scenarios facing other employers in large group insurance markets.

We assume that premiums are determined through insurer-employer bargaining before examing how results are affected if insurers instead engage in Nash Bertrand premium setting.

4.1 Counterfactual 1: Removing Kaiser Permanente

Table 7 reports premiums, enrollment, hospital payments and prices, and surplus in our baseline setting where all three insurers are available (recomputed from model estimates), and across our two counterfactual exercises. We focus first on results from the removal of Kaiser Permanente, presented in panel (i).

Insurer Premiums. Even though we have estimated that CalPERS has substantial bargaining power when negotiating with insurers over premiums, removing Kaiser—an attractive insurer with 39% market share overall in California, and over 50% in several markets—leads premiums for the remaining insurers to increase by approximately 14-17%. The intuition for this finding is straightforward. First there is a standard market power effect: removing a large competitor reduces competitive pressures for the remaining insurers. Second, CalPERS' outside option from disagreement with the remaining insurers is harmed by the loss of Kaiser (represented by an increase in $GFT_j^E(\cdot)$ in equation (5)); as discussed in Section 2.3, this generates additional upward pressure on the remaining insurers' premiums.

Hospital Prices. In spite of BS's large premium increase, we find that average hospital payments per enrollee and (unit-DRG) prices per admission do not change significantly for BS when Kaiser is removed. This suggests that any increases in negotiated prices induced by higher premiums are being offset by changes in bargaining leverage for BS. However, BC's hospital prices increase significantly, suggesting that such bargaining effects may not be as substantial for BC.

To explore this impact on hospital prices in more detail, panels (ia) and (ib) of Table 8 report hospital price changes for BS and BC across a sample of markets when Kaiser is removed. Columns 3-6 provide levels and changes in negotiated prices both when premiums are held fixed at levels

[48]We motivate the first assumption by noting that CalPERS held fixed the set of insurers that were offered for several years both prior to and after our sample period. Due to CalPERS' scale, we believe that it is feasible that insurers would be willing to negotiate CalPERS-specific prices. At the same time, CalPERS' enrollees still comprise only a relatively small portion of hospitals' total admissions (which come from both public and price sources); hence counterfactual adjustments in utilization for any particular hospital are likely to be small relative to its capacity.

Table 7: Removing an Insurer: Summary Results

		Baseline	(i) Remove Kaiser		(ii) Remove BC	
		Amount	Amount	% Change	Amount	% Change
Premiums	BS	3.78	4.41	16.6%	3.65	-3.4%
(per year)		[3.76, 3.79]	[4.36, 4.43]	[15.8%, 16.8%]	[3.62, 3.66]	[-4.0%, -3.3%]
	BC	4.19	4.80	14.4%	-	-
		[4.18, 4.20]	[4.75, 4.81]	[13.7%, 14.6%]		
	Kaiser	3.67	-	-	3.62	-1.4%
		[3.66, 3.67]			[3.60, 3.62]	[-1.6%, -1.3%]
Household	BS	73.91	124.16	68.0%	87.73	18.7%
Enrollment		[73.65, 74.34]	[124.13, 124.25]	[67.1%, 68.6%]	[87.44, 88.51]	[18.4%, 19.3%]
	BC	27.49	38.56	40.2%	-	-
		[27.49, 27.50]	[38.47, 38.59]	[39.9%, 40.4%]		
	Kaiser	61.31	-	-	64.99	6.0%
		[60.88, 61.58]			[64.21, 65.27]	[5.2%, 6.3%]
Hospital	BS	0.66	0.66	0.5%	0.60	-8.5%
Payments		[.65, .68]	[.64, .68]	[-3.1%, 1.7%]	[.57, .62]	[-12.7%, -7.5%]
(per individual)	BC	0.56	0.68	21.2%	-	-
		[.55, .58]	[.67, .72]	[20.0%, 24.8%]		
Hospital Prices	BS	7.19	7.23	0.6%	6.55	-8.9%
(per admission)		[7.06, 7.35]	[6.92, 7.43]	[-3.1%, 1.8%]	[6.19, 6.74]	[-13.3%, -7.7%]
	BC	6.02	7.29	21.0%	-	-
		[6.04, 6.40]	[7.14, 7.64]	[19.8%, 24.6%]		
Surplus	Insurer	0.44	0.99	125.9%	0.38	-13.3%
(per individual)		[.44, .44]	[.99, .99]	[124.6%, 126.6%]	[.38, .39]	[-13.8%, -11.7%]
	Hospitals	0.30	0.51	69.7%	0.27	-9.0%
	(Non-K)	[.29, .31]	[.49, .52]	[63.0%, 72.3%]	[.26, .28]	[-13.8%, -7.6%]
	Δ Cons.	-	-0.19	-	-0.01	-
			[-.19, -.18]		[-.01, -.01]	

Notes: Results from simulating removal of Blue Cross or Kaiser from all markets using estimates from specification (iv) in Table 5. All figures are in thousands. 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.

observed in the data and when they are allowed to adjust.[49] In addition, the final columns of Table 8 report the *changes* in the main insurer-hospital bargaining effects from (6) upon removal of an insurer when premiums are allowed to adjust.[50] As discussed in Section 2.3, these changes in bargaining effects will determine the effect of insurer competition on negotiated equilibrium prices. In general, a positive *premium effect change* will tend to increase prices, but if offset by a larger negative *enrollment effect change*, prices can fall.

When premiums are held fixed (columns 3-4 of Table 8) so that the premium effect change is restricted to be zero, hospital prices fall across all markets for BS and on average for BC when Kaiser is removed. This is broadly consistent with the intuition that, when premiums do not

[49]To clarify comparisons and decompositions, we hold fixed the weights used when averaging across hospital prices to be equal to baseline admission probabilities. For this reason, counterfactual hospital prices in column 6 of Table 8 do not correspond exactly to those in Table 7 which uses scenario-specific weights.

[50]We provide the formal derivation of the terms in equation (20) in the Appendix.

Table 8: Removing an Insurer: Counterfactual Blue Shield and Blue Cross Hospital Price Changes Across Markets

	Avg. Hospital Price ($ / admission)					Decomposition of Change ($ / admission)				
		Fix Premiums		Adjust Premiums		(ia) Prem	(ib) Enroll	(ii) Price	(iii) Cost	(iv) Re-
	Baseline	CF	% Change	CF	% Change	Effect	Effect	Reinforce	Effect	Capture
(ia) REMOVE KAISER: BS PRICES										
All Mkts	7191.13	6451.01	-10.29%	7175.65	-0.22%	624.97	-1149.39	473.70	0.65	34.59
2. Sacramento	8204.98	7318.75	-10.80%	7751.96	-5.52%	605.39	-1572.02	491.33	1.83	20.45
4. SF Bay W.	8825.62	7994.95	-9.41%	8589.65	-2.67%	616.37	-1439.98	533.81	-0.86	54.69
5. E. Bay	7368.50	5967.77	-19.01%	6537.55	-11.28%	717.37	-1820.40	229.04	0.15	42.89
9. C. Valley	6591.73	6369.72	-3.37%	7329.03	11.19%	556.42	-550.32	681.83	0.00	49.36
10. S. Barbara	7934.89	7779.92	-1.95%	8709.83	9.77%	402.15	-187.53	533.88	2.55	23.90
11. LA	5878.37	4829.25	-17.85%	5661.03	-3.70%	662.05	-1163.77	258.83	0.43	25.12
14. SD	6673.04	6038.49	-9.51%	6634.70	-0.57%	472.14	-908.62	380.01	-0.04	18.16
(ib) REMOVE KAISER: BC PRICES										
All Mkts	6023.83	5988.53	-0.59%	7219.85	19.85%	671.85	-130.41	580.01	0.24	74.33
2. Sacramento	6651.31	6703.09	0.78%	8186.10	23.08%	839.58	-137.89	728.48	2.05	102.58
4. SF Bay W.	7602.06	7734.73	1.75%	9189.30	20.88%	836.40	-157.26	747.50	-0.70	161.29
5. E. Bay	7158.45	7150.76	-0.11%	8570.60	19.73%	835.46	-220.00	684.32	0.18	112.19
9. C. Valley	5210.75	5215.51	0.09%	6763.68	29.80%	875.55	-134.94	700.05	0.00	112.27
10. S. Barbara	5130.74	5094.60	-0.70%	6395.60	24.65%	699.55	-84.34	599.56	2.52	47.55
11. LA	6084.19	5803.18	-4.62%	6960.25	14.40%	687.32	-386.22	540.62	0.21	34.12
14. SD	5381.70	5482.36	1.87%	6841.04	27.12%	807.95	-143.63	719.75	-0.02	75.29
(ii) REMOVE BLUE CROSS: BS PRICES										
All Mkts	7191.13	6898.64	-4.07%	6620.28	-7.94%	-129.81	-247.77	-167.38	0.01	-25.89
2. Sacramento	8204.98	8098.96	-1.29%	7799.41	-4.94%	-125.74	-131.81	-134.28	-0.02	-13.72
4. SF Bay W.	8825.62	8643.19	-2.07%	8370.37	-5.16%	-128.03	-195.86	-95.34	0.10	-36.12
5. E. Bay	7368.50	7252.44	-1.58%	6913.99	-6.17%	-149.00	-113.83	-170.56	0.00	-21.11
9. C. Valley	6591.73	5945.62	-9.80%	5781.16	-12.30%	-115.57	-485.97	-152.72	-0.02	-56.29
10. S. Barbara	7934.89	7248.92	-8.65%	7170.32	-9.64%	-83.53	-610.90	-17.78	-0.28	-52.08
11. LA	5878.37	5623.27	-4.34%	5304.90	-9.76%	-137.51	-216.72	-200.27	-0.02	-18.94
14. SD	6673.04	6373.32	-4.49%	6161.37	-7.67%	-98.07	-239.34	-160.35	0.00	-13.91

Notes: Average (DRG-adjusted) hospital prices for Blue Shield 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. Decomposition effects correspond to terms in equation 20, and are weighted by the number of admissions under the baseline scenario; their sum equals the predicted overall change in hospital prices.

adjust following the removal of an insurer, the remaining insurers generally have greater negotiating leverage over hospitals because they tend to lose fewer enrollees upon a bargaining disagreement.[51] We find that price reductions can be large when premiums are fixed: hospital prices for BS fall by over 17% in two markets, and by 10% on average.

However, when both premiums and prices are permitted to adjust, hospital price changes for both insurers are more positive due to the predicted positive premium effect change. For Blue Shield the average price change is insignificant, but in some markets prices increase by approximately 10%, and in others they fall by the same amount. Blue Cross prices are predicted to increase across all markets.

What drives this cross-market variation? As shown in Table 8, the premium effect change for BS is positive (which follows from its predicted 17% premium increase) but does not vary substantially across markets; this is unsurprising given premiums are restricted to be the same across the entire state. However, the enrollment effect change exhibits much more variability across markets, and large negative values are the sole reason for hospital price reductions for BS when Kaiser is removed.

The enrollment effect change represents the extent to which an insurer (either BS or BC) loses fewer patients upon coming to a disagreement with a hospital when Kaiser is absent than when Kaiser is present. Kaiser's market-specific attractiveness relative to the insurer in question will be a primary determinant of the magnitude of this effect. Consider BS's negotiations with hospitals. If BS drops a hospital system from its network, more of BS's enrollees will likely switch to Kaiser (causing a larger negative enrollment effect change) in markets where Kaiser is a strong competitor than in markets where it is not. Thus, a hospital price reduction is more likely in markets where the insurer being removed is more attractive (where attractiveness could be caused by particularly dense or high-quality hospital or physician networks, for example, and should be reflected in a particularly high market share in the relevant area). Consistent with this intuition, Table 8 shows that the enrollment effect is most negative in markets where Kaiser has the largest market share (e.g. Sacramento and East Bay, each with a Kaiser share of over 50%). These in turn are also the markets in which BS is predicted to have the largest hospital price reductions.

However, since BC is not as direct a substitute for Kaiser (largely because most of its enrollees live in areas further away from Kaiser hospitals), BC benefits less from Kaiser's removal when bargaining with hospitals, and the negative enrollment effect change for BC is smaller than that for BS. Thus, the positive premium and price reinforcement effect changes dominate in all markets for BC, leading to price increases.

This discussion highlights why the competitiveness of the insurer being removed in a given market is an important predictor of hospital price changes. We find that characteristics of the hospital market, in contrast, do not yield clear predictions. Though the quality of the relevant

[51] In all but one market in which BC has less than 10% market share in the baseline scenario (Sacramento, Sonoma (unreported), San Francisco, and San Diego), we find that the removal of Kaiser with fixed premiums leads to average BC hospital price *increases*. This arises from a large positive recapture effect change: more enrollees are willing to switch from BC to BS in order to access a dropped hospital when Kaiser is removed. This offsets other negative effects and illustrates that, even with fixed premiums, insurers need not always have increased bargaining leverage when insurer competition is reduced.

hospital and presence of reasonable substitutes directly affects the level of the enrollment effect for a given insurer-hospital pair, using measures related to the competitiveness or concentration of the hospital market to predict average bargaining effect changes (including, for example, the enrollment effect change) when a insurer is removed is less clear. Consistent with this, we find that cross-market correlations between the average changes in our bargaining effects and measures of hospital concentration differ in magnitude and sign across counterfactuals.

Welfare. The bottom of Table 7 reports the surplus that accrues to insurers and hospitals, and the change in consumer welfare on a per-capita basis, across baseline and counterfactual scenarios. When Kaiser is removed, total insurer surplus (across all insurers that are present) increases due to premium increases for BS and BC. Non-Kaiser hospitals' surplus increases, by 70%, due both to increased prices and to their new admissions of former Kaiser enrollees. Higher premiums and a reduced choice set generate consumer surplus reductions of approximately \$200 per capita.[52]

4.2 Counterfactual 2: Removing Blue Cross

Panel (ii) of Table 7 reports results from the removal of BC from the choice set.[53] We focus our discussion on findings that differ from the previous counterfactual.

Insurer Premiums. The removal of BC, a smaller insurer than Kaiser, leads to a premium *decrease* for both remaining MCOs (a reduction of 3.4% for BS and 1.4% for Kaiser). To understand how the removal of an insurer can lead to lower negotiated premiums, recall the discussion in Section 2.3: if an insurer with higher premiums (i.e., higher costs to the employer) than its rivals is removed from the choice set, this can lead to a reduction in $GFT^E_j(\cdot)$ in equation (5) for the remaining insurers, and can thus *strengthen* the employer's bargaining position. If this change outweighs other effects it can generate a premium reduction. The BC counterfactual fits this description quite closely: BC has over 10% higher premiums than BS and Kaiser, and its low market share indicates a relatively low attractiveness to consumers, further depressing the change in $GFT^E_j(\cdot)$ when it is removed.

Hospital Prices. This negative premium effect change coupled with a negative enrollment effect change across markets leads to an average reduction in BS hospital payments of approximately 9% when BC is removed. Thus countervailing effects dominate and hospital prices fall; this leads to lower premiums than would result if prices were held fixed. Table 8 again shows that the magnitude of price changes varies substantially across markets. Consistent with earlier discussion, we find that negative enrollment effect changes and price reductions are largest in markets where

[52]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. The total insured population does not change across baseline and counterfactual scenarios.

[53] We retain BC in HSAs 1 and 8, as in these markets Kaiser is not offered and removing BC would leave BS as a monopolist in the choice set.

BC has a relatively large share (e.g., in rural areas like Central Valley where BC's larger hospital network than its competitors makes it attractive to consumers).

Welfare. Total insurer surplus falls when BC is removed, not surprisingly given the reduction in premiums. Non-Kaiser hospital profits fall due to their lower prices. Consumer welfare is predicted to fall slightly (by approximately $10 per capita per year) despite the premium reduction. This is (at least in part) a result of removing enrollee access to BC and its network of hospitals.

4.3 Counterfactuals Under Nash Bertrand Premium Setting

Our main analysis assumes that insurers and CalPERS engage in Nash bargaining over premiums. We believe that it is reasonable to assume that CalPERS is involved in determining premium levels since it constrains premiums to vary only across family size and not across demographics or geographic markets. However, the scale of CalPERS' leverage in negotiations may be unusual and likely affects how premiums and negotiated prices respond to the removal of an insurer. Here, we investigate how our predictions would change if insurers instead engaged in Nash Bertrand premium setting and did not face bargaining constraints.

Table 9 presents counterfactual estimates for the scenario where BC is removed, using insurer marginal cost and bargaining parameter estimates from specification (i) in Table 5. Rather than predicting a premium reduction as in our main specification, we now find that premiums increase by 9-11% for the remaining insurers; consumer welfare is predicted to fall by approximately $90 per capita per year. There is no significant change in average hospital payments, as positive premium effect changes offset negative enrollment effect changes. Again the overall changes are heterogeneous: prices rise in some markets and fall in others.

We have also examined a scenario where insurers charge premiums based on a fixed markup above their (hospital and non-hospital) marginal costs. This exercise is motivated by the minimum medical loss ratio standards established under the Patient Protection and Affordable Care Act of 2010.[54] Here we predict that premiums would fall for the remaining insurers when either BC or Kaiser was removed from the market, and that hospital prices would fall across all markets (though there would still remain significant heterogeneity in the magnitude of the price effects). The now-familiar explanation is that this alternative premium setting model places heavy restrictions on the amount by which insurers' premiums can increase following the removal of a competitor. Hence, the small premium effect change is easily offset by the negative enrollment and price reinforcement effect changes.

These exercises reinforce the notion that understanding the degree to which employers or other constraints mitigate premium increases is crucial for determining whether or not overall premium

[54] It 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.

Table 9: Removing an Insurer: Summary Results (Nash-Bertrand Premium Setting)

		Baseline	(iii) Remove BC (Nash-Bertrand)	
		Amount	Amount	% Change
Premiums	BS	3.78	4.20	11.0%
(per year)		[3.76, 3.79]	[4.17, 4.22]	[10.8%, 11.3%]
	BC	4.19	-	-
		[4.18, 4.21]		
	Kaiser	3.67	3.98	8.7%
		[3.66, 3.67]	[3.97, 4.00]	[8.4%, 8.9%]
Household	BS	73.91	82.99	12.3%
Enrollment		[73.53, 74.56]	[82.71, 83.39]	[11.8%, 12.5%]
	BC	27.49	-	-
		[27.06, 27.77]		
	Kaiser	61.31	71.13	16.0%
		[61.10, 61.44]	[70.78, 71.38]	[15.8%, 16.2%]
Hospital	BS	0.66	0.66	-0.4%
Payments		[.65, .68]	[.65, .67]	[-.7%, -.1%]
(per individual)	BC	0.56	-	-
		[.55, .58]		
Hospital Prices	BS	7.19	7.11	-1.1%
(per admission)		[7.06, 7.36]	[6.96, 7.29]	[-1.5%, -.8%]
	BC	6.02	-	-
		[6.03, 6.40]		
Surplus	Insurer	1.27	1.57	24.1%
(per individual)		[1.27, 1.27]	[1.57, 1.58]	[23.4%, 24.7%]
	Hospitals	0.30	0.29	-2.8%
	(Non-K)	[.29, .31]	[.28, .30]	[-3.9%, -1.9%]
	Δ Cons.	-	-0.09	-
			[-.09, -.08]	

Notes: Results from simulating removal of Blue Cross or Kaiser, using estimates from specification (i) in Table 5 (without insurer margin moments) and assuming Nash-Bertrand premium setting. All figures are in thousands. 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.

reductions and cost savings can result when an insurer is removed. Absent such constraints, our results suggest that premiums will tend to increase, and may increase substantially.

4.4 Additional Assumptions and Robustness

Switching Costs and Inertia. Previous work (e.g., Handel (2013); Ho, Hogan and Morton (2015); Polyakova (2015)) has documented switching costs and 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 substantial, true premium elasticities may differ from our estimates; in turn, 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, the estimated household premium elasticities correspond well to the range estimated in previous papers which utilize panel data and time variation in premiums. Second, household premium elasticities are not the only determinants of equilibrium premiums: e.g., employers—who may not be subject to such frictions—have substantial input into premium determination through the bargaining process.

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 and perhaps overstated due to the presence of consumer choice frictions. Appendix A.8 presents evidence suggesting that enrollees in our setting are responsive to hospital network changes and do not face insurmountable frictions when switching plans. There, we also describe robustness tests that examine the sensitivity of our results to changing the estimated responsiveness of consumers to hospital network changes.

Consumer Selection Across Hospitals and Insurers. Our analysis implicitly assumes that, conditional on premium levels, the quantity and composition of consumers who choose particular hospitals or plans are not directly affected by negotiated hospital prices. This implies that insurers are unable to directly steer patients to certain (e.g., lower cost) hospitals, and consumers do not respond to hospital prices when selecting where to go.[55] Because 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 the probability of a particular diagnosis ($\gamma_{\kappa(k)}$) and its DRG weight ($E[DRG_a|\kappa(k)]$) for an individual k conditional on admission based on that individual's age-sex category, $\kappa(k)$. 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-sex category controls for a significant amount of heterogeneity in admission and diagnosis probabilities. Since insurers are unable to set premiums or otherwise screen based on age, sex, or location, our model allows insurers to engage in behavior similar to cream-skimming by anticipating the likely selection of heterogeneous consumers onto their plans when setting premiums and 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.[56]

[55] 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.

[56] 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

The assumption that consumers choose insurance plans based on their *expected* probability of 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). 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.[57]

5 Concluding Remarks

This paper presents a framework for examining the impact of insurer competition on premiums, hospital prices, and welfare. We limit our attention to adjusting the insurer choice set for a particular population of consumers, and for this reason our results are most applicable to the large group employer-sponsored insurance market. However, our analysis is also relevant for examining state health insurance exchanges set up by the Patient Protection and Affordable Care Act (2010): for example, insurers must choose whether or not to participate in each exchange, and variation in the number of participants will likely have similar effects to those predicted by our model. Though our analysis does not explicitly model the entry, exit, or consolidation of insurers (as this would raise additional issues that are outside the scope of our analysis, including the determination of fixed, entry, and exit costs, and potential merger efficiencies), the mechanisms that we identify are still present whenever market structure changes.

Our analysis emphasizes the importance of the characteristics of the insurer that is removed and how employers or institutions constrain insurer premium setting. Although we predict that premiums typically increase, we also show that a reduction in premiums—and thereby a substantial mitigation of consumer harm—is empirically plausible with external premium setting constraints. Even with significant premium increases, hospital prices need not increase on average; indeed, hospital prices often fall in multiple markets as the remaining insurers exercise increased bargaining leverage. Markets with price reductions are those in which removing a particular insurer most harms hospitals' bargaining positions, which in turn are those markets where the removed insurer was dominant. We find that consumer welfare falls by as much as $200 per capita per year upon the removal of an insurer.

We conclude with potential directions for future research. Our current analysis conditions on the set of insurers that are offered to enrollees, and holds all non-price characteristics of hospitals and insurers fixed. However, additional responses by medical providers (including physician groups, pharmaceutical firms, and device manufacturers) and by insurers (which may adjust provider net-

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.

[57]For example, the "recapture" effect may be larger than estimated if consumers know before choosing an insurance plan that they will visit a particular hospital, and will switch plans in order to access that hospital if it is dropped by their current insurer. Consumer selection into plans based on unobservables can be accounted for by estimating the hospital and insurer demand systems jointly at the cost of increased computational complexity (c.f. Lee, 2013).

works, financial terms, or other aspects of benefit design) are likely to be important.[58] Finally, we have documented considerable heterogeneity in price changes across providers. Predicting long-run welfare effects and distributional consequences of market structure changes will require an understanding of providers' dynamic investment, entry, and exit responses.

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[58] E.g., see Lee and Fong (2013) and Ho and Lee (2016) which builds on results from this paper to analyze counterfactual adjustments to networks and contracting partners.

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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.

A Estimation and Computation: Further Details and Results

A.1 Hospital Demand: Details

Our consumer demand model outlined in Section 3.2 predicts that a individual k, who lives in market m, is enrolled in MCO j, and has diagnosis l, visits hospital i with probability

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

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

$$\sigma^H_{i,j,k,m}(\mathcal{G}_m) = \gamma^a_{\kappa(k)} \sum_{l \in \mathcal{L}} \gamma_{\kappa(k),l}\sigma^H_{i,j,k,m|l}(\mathcal{G}_m) . \quad (17)$$

We estimate this model via maximum likelihood using our admission data. In each market we normalize one hospital fixed effect to zero. We choose the largest hospital in each market to ensure comparability across markets.

We define 5 diagnosis categories using ICD-9-CM codes and major diagnosis category (MDC) 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 5%).

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 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 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

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.

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 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 birthing services.

Table 13 shows estimates from our insurer demand system outlined in Section 3.3 (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=0.01 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 Predicted and Counterfactual Hospital and Insurer Demand: Details

Given parameter estimates from our hospital and insurer demand systems, we construct estimates for insurer and hospital demand given any set of premiums and hospital-insurer networks as follows:

- *Insurer Demand:* For each insurer j and household type $\lambda \in$ {single, two-party, family}, we predict expected insurer household demand as $\hat{D}_{j,\lambda,m}(\mathcal{G}, \boldsymbol{\phi}) \equiv \sum_{f \in \mathcal{F}_{\lambda,m}} \hat{\sigma}_{f,j,m}(\mathcal{G}, \boldsymbol{\phi})$, where $\mathcal{F}_{\lambda,m}$ is the set of households of type λ in market m, and $\hat{\sigma}_{f,j,m}$ is the our predicted probability that household f chooses MCO j given by (10). 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-κ 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 κ in family f visits hospital i on MCO j's network given by (17) 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 κ (given by $E[DRG_a|\kappa]$), as follows: $\hat{D}^H_{i,j,m}(\mathcal{G}, \boldsymbol{\phi}) \equiv \sum_{\forall \kappa} E[DRG_a|\kappa] \times \hat{D}^H_{i,j,\kappa,m}(\cdot)$.

  Weighting $\hat{D}^H_{i,j,\kappa,m}(\cdot)$ by the average admission DRG weight for a type-κ 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.

Table 12: Estimates: Hospital Demand System

Interaction Terms	Variable	Parameter	Std. Err.
Interactions: Teaching	Income ($000)	0.008***	0.002
	PPO enrollee	0.123*	0.065
	Cancer	0.098	0.108
	Cardiac	−0.521***	0.082
	Digestive	−0.237**	0.096
	Labor	−0.069	0.098
	Neurological	1.281***	0.172
Interactions: Nurses Per Bed	Income ($000)	0.000	0.001
	PPO enrollee	0.054*	0.032
	Cancer	0.121**	0.055
	Cardiac	0.073*	0.039
	Digestive	−0.087**	0.044
	Labor	−0.179***	0.046
	Neurological	−1.009***	0.097
Interactions: For-Profit	Income ($000)	−0.000	0.002
	PPO enrollee	0.033	0.047
	Cancer	0.012	0.084
	Cardiac	0.107*	0.056
	Digestive	−0.122*	0.066
	Labor	0.324***	0.063
	Neurological	0.609***	0.113
Interactions: Cardiac Services	Income ($000)	0.008***	0.002
	PPO enrollee	0.254***	0.046
	Cardiac	0.251***	0.050
Interactions: Imaging Services	Income ($000)	−0.003**	0.002
	PPO enrollee	0.142***	0.051
	Cancer	0.139*	0.083
	Cardiac	0.049	0.063
	Digestive	0.037	0.061
	Labor	−0.475***	0.065
	Neurological	−0.775***	0.123
Interactions: Cancer Services	Income ($000)	−0.013***	0.005
	PPO enrollee	−0.133	0.127
	Cancer	0.444**	0.225
Interactions: Labor Services	Income ($000)	0.006***	0.002
	PPO enrollee	−0.168***	0.048
	Labor	1.164***	0.069
Distance interactions:	HSA 1	−0.107***	0.003
	HSA 2	−0.155***	0.004
	HSA 3	−0.235***	0.008
	HSA 4	−0.274***	0.009
	HSA 5	−0.240***	0.005
	HSA 6	−0.186***	0.005
	HSA 7	−0.246***	0.013
	HSA 8	−0.149***	0.004
	HSA 9	−0.106***	0.003
	HSA 10	−0.165***	0.008
	HSA 11	−0.276***	0.004
	HSA 12	−0.132***	0.003
	HSA 13	−0.312***	0.008
	HSA 14	−0.114***	0.005
	Number of Admissions	38064	
	Hospital Fixed Effects	Yes	
	Pseudo-R2	0.540	

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

Notes: Results from estimated hospital demand model. Specification includes hospital fixed effects (not reported).

Table 13: Estimates: Insurer Demand System

Premium (α_0^ϕ)	-0.0648***
	(0.00137)
Log(Income) × Premium (α_1^ϕ)	0.00563***
	(0.000123)
WTP (α^W Age 0-19)	-0.0281
	(0.265)
WTP (α^W Male, Age 20-34)	8.909***
	(0.619)
WTP (α^W Female, Age 20-34)	0.936***
	(0.0910)
WTP (α^W Male, Age 35-44)	4.388***
	(0.363)
WTP (α^W Female, Age 35-44)	1.885***
	(0.127)
WTP (α^W Male, Age 45-54)	1.643***
	(0.166)
WTP (α^W Female, Age 45-54)	2.314***
	(0.132)
WTP (α^W Male, Age 55-64)	0.917***
	(0.114)
WTP (α^W Female, Age 55-64)	1.838***
	(0.138)
Drive Time to Kaiser (α^K HSA 2)	-0.0420***
	(0.00119)
Drive Time to Kaiser (α^K HSA 3)	-0.0351***
	(0.00220)
Drive Time to Kaiser (α^K HSA 4)	-0.0175***
	(0.00483)
Drive Time to Kaiser (α^K HSA 5)	-0.0226***
	(0.00352)
Drive Time to Kaiser (α^K HSA 6)	-0.0182***
	(0.00316)
Drive Time to Kaiser (α^K HSA 7)	-0.0286***
	(0.00732)
Drive Time to Kaiser (α^K HSA 10)	-0.0548***
	(0.0135)
Drive Time to Kaiser (α^K HSA 11)	-0.0218***
	(0.00125)
Drive Time to Kaiser (α^K HSA 12)	-0.0253***
	(0.000979)
Drive Time to Kaiser (α^K HSA 13)	-0.0190***
	(0.00375)
Drive Time to Kaiser (α^K HSA 14)	-0.0366***
	(0.00240)
Number of Households	162,719
HSA-Insurer Fixed Effects	Yes
Pseudo-R2	.1811

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

Notes: Results from estimated insurer demand model. 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. Specification includes market-insurer fixed effects (not reported).

A.4 Hospital System Bargaining

In our empirical application, we allow hospitals to jointly negotiate as part of a system within a market.[59] Let $\boldsymbol{\mathcal{S}}$ be a partition of the set of hospitals $\mathcal{H}$ into hospital systems (under the realistic assumption that

[59] Allowing systems to jointly negotiate across markets does not affect the analysis as we have assumed that insurer and hospital demand is separable across markets (c.f. Dafny, Ho and Lee (2015)).

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 $|\mathcal{S}| = 1$.

Define the profits for a hospital system $\mathcal{S}$ to be the sum of the profits of all hospitals $h \in \mathcal{S}$: $\pi_{\mathcal{S}}(\mathcal{G}, \boldsymbol{p}, \boldsymbol{\phi}) = \sum_{h\in\mathcal{S}} \pi_h^H(\mathcal{G}, \boldsymbol{p}, \boldsymbol{\phi})$. We assume that each insurer must carry all or none of the hospitals in a system in a given market, 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:

$$p_{i,j} = \arg\max_{p_{i,j}} \Bigg[\underbrace{\pi_j^M(\mathcal{G}, \boldsymbol{p}, \boldsymbol{\phi}) - \pi_j^M(\mathcal{G} \setminus \mathcal{S}, \boldsymbol{p}_{-ij}, \boldsymbol{\phi})}_{\text{MCO } j\text{'s "gains from trade" with system } \mathcal{S}} \Bigg]^{\tau_j} \times \Bigg[\underbrace{\pi_i^H(\mathcal{G}, \boldsymbol{p}, \boldsymbol{\phi}) - \pi_i^H(\mathcal{G} \setminus \mathcal{S}, \boldsymbol{p}_{-ij}, \boldsymbol{\phi})}_{\text{Hospital system } \mathcal{S}\text{'s "gains from trade" with MCO } j} \Bigg]^{(1-\tau_j)} \quad \forall i \in \mathcal{S}, \forall \mathcal{S} \in \boldsymbol{\mathcal{S}}, \tag{18}$$

where we use our general version of MCO profits given by (11). This is the system bargaining analogue to (4), where the disagreement outcome between hospital $i \in \mathcal{S}$ and MCO j involves MCO j dropping all hospitals in $\mathcal{S}$. Every hospital in the same system has the same first-order-condition for (18):

$$\begin{aligned} \underbrace{\sum_{i\in\mathcal{S}} p_{i,j}^* D_{i,j}^H}_{\text{system payments}} =& (1-\tau_j) \Bigg[\underbrace{\left(\phi_j \Phi' [\Delta_{\mathcal{S},j} \boldsymbol{D}_j] - [\Delta_{\mathcal{S},j} D_j^E] \eta_j)\right)}_{\text{(i) } \Delta \text{ MCO revenues net of non-hosp costs}} - \underbrace{\Big(\sum_{h\in\mathcal{G}_j^M \setminus \mathcal{S}} p_{hj}^* [\Delta_{\mathcal{S},j} D_{hj}^H] \Big)}_{\text{(ii) } \Delta \text{ MCO } j \text{ payments to other hospitals}} \Bigg] \\ &+ \tau_j \Bigg[\underbrace{\sum_{i\in\mathcal{S}} c_i D_{i,j}^H}_{\text{(iii) system costs}} - \underbrace{\sum_{i\in\mathcal{S}} \sum_{n\in\mathcal{G}_{\mathcal{S}}^H, n\neq j} ([\Delta_{\mathcal{S},j} D_{i,n}^H](p_{i,n}^* - c_i)}_{\text{(iv) } \Delta \text{ system profits from other MCOs}} \Bigg] \quad \forall \mathcal{S} \in \boldsymbol{\mathcal{S}}, \end{aligned} \tag{19}$$

where $[\Delta_{\mathcal{S},j} \boldsymbol{D}_j]$, $[\Delta_{\mathcal{S},j} D_j^E]$, and $[\Delta_{\mathcal{S},j} D_{hj}^H]$ represent changes in these objects when MCO j and system $\mathcal{S}$ come to a disagreement. As before, we drop all arguments of demand terms for expositional convenience, and assume that demand terms without market subscripts represent sums of those terms across all markets. Note that (19) is equivalent to (6) (using the simpler version of MCO profits) 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.

A.5 Derivation of Error Terms

The error terms used in the construction of our estimating moments are:

$$\begin{aligned} \omega_j^1 &= -\left[\sum_{h\in\mathcal{G}_j} \left(\frac{\partial \hat{D}_{h,j}^H(\cdot)}{\partial \phi_j} + \frac{(1-\tau^\phi)(\partial GFT_j^E / \partial \phi_j)}{\tau^\phi GFT_j^E} \hat{D}_{h,j}^H(\cdot) \right) \varepsilon_{h,j}^A \right] \quad \forall j, \\ \omega_j^2 &= -(\sum_{h\in\mathcal{G}_j} \hat{D}_{h,j}^H(\cdot) \varepsilon_{h,j}^A) / \phi_j \Phi' \hat{\boldsymbol{D}}_j(\cdot) - \nu_j \quad \forall j, \\ \omega_{\mathcal{S}j}^3 &= \left(\sum_{i\in\mathcal{S}} \varepsilon_{ij}^A \hat{D}_{ij}^H \right) + (1-\tau_j) \sum_{h\in\mathcal{G}_j^M \setminus \mathcal{S}} \varepsilon_{hj}^A [\Delta_{\mathcal{S},j} \hat{D}_{h,j}^H] + \tau_j \sum_{i\in\mathcal{S}} \sum_{n\in\mathcal{G}_{\mathcal{S}}^H, n\neq j} \varepsilon_{i,n}^A [\Delta_{\mathcal{S},j} D_{i,n}^H] \quad \forall j, \mathcal{S} \in \boldsymbol{\mathcal{S}}, \end{aligned}$$

where ν_j, referenced in the definition of ω_j^2, represents mean zero independent measurement error in MLR_j^o.

A.6 Counterfactual Simulations: 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 ϕ_j for all insurers satisfy (13) 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 ι:

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

   (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 $\phi_j^{\iota'}$ using (12) 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). When updating premiums, we hold fixed the recovered value of $\hat{\omega}^1_j$ (scaled by the predicted number of hospital admissions) for all MCOs. 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.[60] Each entry of $\boldsymbol{p}^\iota$, p^ι_{ij}, is the negotiated price per-admission for that given hospital-MCO pair. Each entry of B^ι_{ij} is:

$$B^\iota_{ij} = (1-\tau_j)\left[\left(\phi_j\Phi'[\Delta_{\mathcal{S}j}\hat{D}^\iota_j]\right) - \eta_j[\Delta_{\mathcal{S}j}\hat{D}^{E,\iota}_j]\right] + \tau_j\left[\sum_{h\in\mathcal{S}}\sum_{n\in\mathcal{G}^H_{\mathcal{S}}} c_h[\Delta_{\mathcal{S}j}\hat{D}^{H,\iota}_{hn}]\right) + \tilde{\omega}^3_{\mathcal{S}j}\sum_{i\in\mathcal{S}}\hat{D}^H_{ij} \qquad i\in\mathcal{S}$$

   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. The parameter $\tilde{\omega}^3_{\mathcal{S}j} \equiv \hat{\omega}^3_{\mathcal{S}j}/(\sum_{i\in\mathcal{S}}\hat{D}^H_{ij})$ is recovered during estimation, and held fixed in our counterfactual simulations. 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:

   - $A^\iota_{ij;hj} = \hat{D}^{H,\iota}_{hj}$ 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 $n\neq j$;

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

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.

A.7 Decomposition of Bargaining Effect Changes

We decompose the change in negotiated prices into changes in the components introduced earlier in Section 2.2. Beginning with equation (19), 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

$$
\begin{aligned}
\bar{p}^{CF}_{\mathcal{S}j} - \bar{p}^{o}_{\mathcal{S}j} = & \underbrace{(1-\tau_j)\left[\frac{[\Delta_{\mathcal{S},j}\hat{D}^o_j]}{\hat{D}^{H,o}_{\mathcal{S}j}}(\phi^{CF}_j - \phi^o_j)\right]}_{\text{(ia) } \Delta \text{ Premium Effect}} \\
& + \underbrace{(1-\tau_j)\left[(\frac{[\Delta_{\mathcal{S},j}\hat{D}^{CF}_j]}{\hat{D}^{H,CF}_{\mathcal{S},j}} - \frac{[\Delta_{\mathcal{S},j}\hat{D}^o_j]}{\hat{D}^{H,o}_{\mathcal{S},j}})(\phi^{CF}_j) - (\frac{[\Delta_{\mathcal{S},j}\hat{D}^{E,CF}_j]}{\hat{D}^{H,CF}_{\mathcal{S},j}} - \frac{[\Delta_{\mathcal{S},j}\hat{D}^{E,o}_j]}{\hat{D}^{H,o}_{\mathcal{S},j}})(\eta_j)\right]}_{\text{(ib) } \Delta \text{ Enrollment Effect}} \\
& - \underbrace{(1-\tau_j)\left[(\frac{\sum_{h\in\mathcal{G}^M_j\setminus\mathcal{S}} p^{CF}_{h,j}[\Delta_{\mathcal{S}j}\hat{D}^{H,CF}_{h,j}]}{\hat{D}^{H,CF}_{\mathcal{S},j}}) - (\frac{\sum_{h\in\mathcal{G}^M_j\setminus\mathcal{S}} p^{o}_{h,j}[\Delta_{\mathcal{S},j}\hat{D}^{H,o}_{h,j}]}{\hat{D}^{H,o}_{\mathcal{S},j}})\right]}_{\text{(ii) } \Delta \text{ Price Reinforcement Effect}} \\
& + \underbrace{\tau_j\left[\frac{\sum_{i\in\mathcal{S}} c_i\hat{D}^{H,CF}_{i,j}}{\hat{D}^{H,CF}_{\mathcal{S},j}} - \frac{\sum_{i\in\mathcal{S}} c_i\hat{D}^{H,o}_{i,j}}{\hat{D}^{H,o}_{\mathcal{S},j}}\right]}_{\text{(iii) } \Delta \text{ Hospital Cost Effect}} \\
& - \underbrace{\tau_j\left[\sum_{n\in\mathcal{G}^H_{\mathcal{S}}, n\neq j} \frac{\sum_{i\in\mathcal{S}}(p^{CF}_{i,n}-c_i)\Delta_{\mathcal{S},j}\hat{D}^{H,CF}_{i,n}}{\hat{D}^{H,CF}_{\mathcal{S}j}} - \frac{\sum_{i\in\mathcal{S}}(p^{o}_{in}-c_i)\Delta_{\mathcal{S},j}\hat{D}^{H,o}_{i,n}}{\hat{D}^{H,o}_{\mathcal{S}j}}\right]}_{\text{(iv) } \Delta \text{ Recapture Effect}},
\end{aligned}
\tag{20}
$$

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.

Changes in term (i) in (19) (premium and enrollment effects) can be decomposed into:

(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.

Changes in terms (ii) - (iv) in (19) 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 (20) will hold exactly.

A.8 Robustness: Switching Costs and Inertia

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.[61] 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.[62] This analysis suggests that, if switching costs do exist, they do not lead us to substantially over-estimate switching probabilities in 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).[63]

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 α_κ^W WTP coefficients by 25%, re-estimating the bargaining parameters and insurer marginal costs as in Section 3.4, and recomputing counterfactual outcomes. Although the parameter estimates change slightly, the counterfactual results and substantive findings are qualitatively similar.

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

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

[63] 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.