Vertical Integration between Hospitals and Insurers*

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Abstract. The increasing consolidation in the healthcare and insurance market has become a top concern for policymakers and researchers. We study the equilibrium effects of vertical integration between insurers and hospitals. First, we develop an equilibrium model of competition and bargaining between insurers and hospitals. Second, we estimate the model using suitable claims data from Chile, where we observe significant vertical integration between private insurers and hospitals. Using our structural estimates, we find that prohibiting vertical integration is beneficial to consumers unless the hospital costs increase by 13 percent or more due to efficiency losses caused by broken vertical relationships.

Keywords: health market, vertical integration, competition, bargaining
JEL Codes: I11, L13, L40

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1 Introduction

Expenditure in healthcare has increased steadily in the US and the rising consolidation in the health sector has become a top concern for policymakers and researchers. The welfare effects of the increasing concentration critically depend on the efficiency gains of more concentrated markets relative to their social costs caused by increasing market power. Thus, mergers and acquisitions in the health industry have been the focus of substantive antitrust attention, fueled by a considerable amount horizontal mergers between hospitals in last decades (Dafny, 2014). However, vertical integration between insurers and hospitals has received less attention from researchers (Gaynor and Town, 2011; Gaynor et al., 2015) despite the increasing levels of vertical consolidation witnessed by the antitrust authorities. There are several cases of recent vertical mergers in health markets. Anthem acquired Simply Healthcare in Florida, United Health acquired Monarch HealthCare in California along with DaVita, and Highmark acquired West Penn Allegheny System in Pennsylvania. Outside the U.S., Aetna bought the Indian Health Organization, and Cigna announced a similar strategy to enter the Indian and Chinese markets. Moreover, United Health recently acquired the largest healthcare company in Brazil, Amil, and agreed to acquire Banmédica in Chile.[1]

We study the equilibrium effects of vertical integration between insurers and hospitals. Our approach proceeds in three steps that combine a rich conceptual framework with an appropriate setting and exceptional data for empirical work. First, we develop an equilibrium model of competition and bargaining between insurers and hospitals that accommodates vertical integration. Second, we estimate the model using individual level administrative data on hospital admissions and plan choices from Chile, where we observe significant vertical integration between private insurers and hospitals. Finally, we use our structural estimates to compute the equilibrium implications of banning vertical integration. We find that banning vertical integration reduces hospital prices and increases welfare in the market, unless there are relatively large hospital cost efficiencies due to vertical integration.

We start by developing an equilibrium model for the interaction between insurers, hospitals, and consumers, related to the recent literature (Gowrisankaran et al. 2015; Prager 2016; Ho and Lee 2017b). It is worth mentioning that while health markets have a vertical component in the relationship between hospitals and insurers, they are not a vertical market in the traditional sense, in that consumers purchase both hospital and insurer services. Our model is structured as a four-stage game. In the first stage, hospitals and insurers bargain over hospital prices. Vertically integrated firms set prices to maximize their joint profits, while non-integrated hospitals and insurers bargain over healthcare prices. In the second stage, insurers set premiums taking hospital prices as given. In the third stage, households choose an insurance plan. Finally, in the fourth stage, consumers health risk is realized and, upon becoming sick, they choose their preferred hospi-

[1] Bossert et al. (2014) provides an in-depth discuss of increasing concentration in healthcare market in Latin America

tal within a choice set that depends on their selected insurance plan. Our model identifies two novel potential effects caused by vertical integration in a bargaining setting. The two distortions are related to vertically integrated firms steering demand from competing hospitals and insurers. First, an integrated firm may harm competing hospitals by setting a higher negotiated price with them, thus steering hospital demand to the integrated hospital. Second, the integrated firm may harm competing insurers by negotiating a higher hospital price with their hospital, thus reducing the value of the competing insurer network and steering demand to their insurer. We label these forces *foreclosure effects* and *worsening your rival network effect*.

To study the welfare effects of banning vertical integration, we utilize the Chilean private healthcare market as a setting for empirical work. This market is suitable for our purposes as it combines the presence of relevant vertically integrated firms with rich administrative data. The health sector is an oligopoly composed by six insurance providers and a relatively small number of large hospitals. Some of the largest insurers and private hospitals are vertically integrated through the common ownership of a parent company or holding. Furthermore, we have access to detailed administrative data on individual claims and health plan choices for all consumers between 2013 and 2016.

We provide reduced form evidence regarding some stylized facts on the role of vertical integration in this market. We find that consumers pay lower copays when choosing a hospital integrated with their insurer, as the insurer covers a more significant share of a cheaper bill. Additionally, we find some suggestive evidence that vertical integration induces some cost control that can be seen as efficiency gains. Finally, we find that consumers insured by a vertically integrated insurer tend to choose integrated hospitals more often, which suggests that vertical integration affects hospital choice.

We exploit this setting and data to estimate the primitives of our model. First, we estimate the demand for hospital services and health insurance plans using discrete choice models. Our hospital choice model shows that consumers value hospital quality, prices, and location. Also, we find that hospital price-sensitivity decreases with income and age. Second, we estimate demand for insurance plans, and find that households are sensitive to premiums and value the expected utility of healthcare services provided by plans. Third, we estimate the supply side of the model using a GMM estimator based on optimality conditions from the model. We use such procedure to estimate hospital marginal costs and bargaining parameters. We find that vertically integrated hospitals display lower marginal costs, although we do not impose any efficiency gain coming from vertical integration. Regarding the bargaining parameters, we find that vertically integrated hospitals have larger bargaining weights when negotiating with non-integrated insurers than non-integrated hospitals.

Using our structural estimates, we study the equilibrium effects of banning vertical integration. We find that hospital prices and plan premiums decrease on average in the absence of vertical integration. The welfare effects of vertical integration depend on whether it induces hospital cost efficiencies. In absence of any cost efficiencies, banning vertical integration increases consumer surplus more than enough to compensate decreases in insurer profits and hospital profits, such that overall welfare increases in a scenario without vertical integration. Of course, as cost efficiencies due to vertical integration increase, welfare gains from banning vertical integration decrease. We explore a range of potential hospital cost efficiencies, and find that cost efficiencies as large as 13 percent would be required to make welfare larger under a market structure with vertical integration than under a market structure without vertical integration.

The main contributions of this paper are twofold. First, we build a model in line with the recent related literature to accommodate vertical integration in a bargaining setting. This model identifies new insights that are important for understanding incentives in vertical markets and should be relevant for potential antitrust analysis. Second, our counterfactual exercise on banning vertical integration sheds light on the magnitude of different effects that interact in the complex healthcare market. To the best of our knowledge, we are the first paper tackling this counterfactual exercise in the presence of vertical integration with bargaining.

This paper is related to three strands of the literature. First, our paper relates to the vast literature on healthcare competition (Gaynor and Town, 2011; Gaynor et al., 2015). Most of that literature has focused on market concentration and horizontal mergers between hospitals (Dafny, 2009; Dafny et al., 2012, 2016; Gowrisankaran et al., 2015; Lewis and Pflum, 2017), although there is some recent research on horizontal mergers across insurers (Chorniy et al., 2016). Research on the effects of vertical integration in health markets is scarce, partly because attention has been focused on horizontal mergers due to the large number of such cases in recent decades. Nevertheless, the current trend in the industry towards vertical integration between hospitals and insurers demands more attention.

Second, our paper relates to the recent work on bargaining in vertical markets. Using the so-called Nash-in-Nash bargaining model (Horn and Wolinsky, 1988; Collard-Wexler et al., 2017), several empirical papers have confirmed the relevance of the bargaining setting between upstream and downstream players in different markets. This literature have covered a large list of research topics such as horizontal mergers (Gowrisankaran et al., 2015), insurer competition (Ho and Lee, 2017b), bundling (Crawford and Yurukoglu, 2012), foreclosure (Crawford et al., 2017), and network formation (Prager, 2016; Ghili, 2017; Ho and Lee, 2017a). Our paper extends the analysis of bargaining and vertical integration in the healthcare market where bargaining plays a central role.

Third, our paper relates to the broad literature on vertical integration. Although the theoretical literature is massive, empirical research on how appealing is vertical integration for social welfare is relatively scarce and displays mixed evidence. For instance, Hastings (2004) finds anticompetitive effects of vertical mergers in the gasoline market. On the contrary, Hortaçsu and Syverson (2007) shows that in the concrete market vertically integrated plants are more efficient and that markets with a larger share of integrated firms compete more effectively. Our paper assesses the cost and benefits of the vertical integration in the healthcare markets providing the degree of efficiency gains that could offset the benefits of banning vertical integration.

The remainder of the paper is organized as follows. Section 2 proposes a model of competition and bargaining in health markets and discusses the potential effects of vertical integration. Section 3 describes the institutional framework of the Chilean health market, the data we use in the empirical application, and provides some reduced form evidence for the role of vertical integration in our setting. Then, Section 4 introduces our estimation strategy and presents the results, while section 5 describes and discusses the welfare analysis of banning vertical integration in this market. Finally, Section 6 concludes.

2 A Model of Bargaining between Hospitals and Insurers

In this section, we present a model of competition in healthcare markets, in which upstream healthcare providers might be integrated with downstream health insurance providers. We model the market as a four-stage game. In the first stage, hospital prices are set for each insurer in the market. If a hospital is integrated with an insurer, hospital prices are set by joint profit maximization of the hospital and the insurer, while if they are not integrated, they engage in negotiation over hospital prices. In the second stage, insurers optimally set plan premiums taking hospital prices as given. In the third stage, households choose a health insurance plan based on premiums and the expected utility from healthcare services the plan provides. In the fourth stage, consumers health risk is realized. Upon becoming sick, consumers choose their preferred hospital given the hospital characteristics and the out-of-pocket expenditure as determined by their plan choice.

Our model is related to recent papers in this literature (Gowrisankaran et al., 2015; Prager, 2016; Ho and Lee, 2017b). There are some relevant distinctions between our model and those. First, we assume that insurers set premiums taking hospital prices as given, which is different from Ho and Lee (2017b). This assumption is related to our setting, where insurers can adjust their supply of plans more easily than hospitals can adjust prices. Second, we accommodate vertical integration and show how such vertical links affect incentives in the market.

2.1 Setup

We denote by $\mathcal{M}$ the set of insurers in the health insurance market. Each insurer $m \in \mathcal{M}$ offers a menu of insurance plans denoted by $\mathcal{J}_m$, where each plan $j \in \mathcal{J}_m$ charges a premium ϕ_j for a given coverage structure and a specific hospital network. Hospital networks offered are unrestricted. However, plans may offer tiered networks, where tiers differ in the coinsurance rates to enrollees. We assume the set of plans offered, their coinsurance rates and their network structure as given in our analysis.

Similarly, we denote by $\mathcal{H}$ the set of hospitals in the healthcare market, which might belong to a horizontally integrated system indexed by $s \in \mathcal{S}$. We denote the set of hospitals in a given system as $\mathcal{H}_s$. Each hospital $h \in \mathcal{H}$ offers healthcare services and charges price p_{mh}, which is hospital-insurer specific.[2] Patient out-of-pocket payment is a fraction of the total hospital price, determined by the coverage offered by the patient's plan at hospital h. Given that hospital networks are unrestricted and hospitals cannot refuse healthcare to patients, consumers can choose any hospital in the market regardless of their insurance plan.

2.1.1 *Timing of the Game*

As presented above, our model consists of a four-stage game. Formally, the stages are as follows:

1. Hospital prices $\boldsymbol{p}$ are determined either by bilateral negotiation between insurers and hospitals or by joint profit maximization if the hospital and the insurer are vertically integrated.
2. Profit maximization by the insurers determines the vector of plan premiums $\boldsymbol{\phi} = \boldsymbol{\phi}(\boldsymbol{p})$, taking hospital prices $\boldsymbol{p}$ as given.
3. Households choose a health insurance plan j of insurer m based on premiums and the expected utility from healthcare services the plan provides. Household choices determine the aggregate demand for plans, $D_j^M(\boldsymbol{\phi}, \boldsymbol{p})$.
4. Health risk is realized and consumers potentially demand healthcare services. Consumers choose their preferred hospital given the hospital characteristics and the out-of-pocket expenditure determined by their plan choice. Consumer choices determine aggregate demand for each hospital h by households enrolled in each plan j, $D_{hj}^H(\boldsymbol{\phi}, \boldsymbol{p})$.

2.1.2 *Hospital Profits*

Hospital system $\mathcal{H}_s$ maximizes profits by setting or negotiating hospital prices for all plans in the market. Profits for the hospital system $\mathcal{H}_s$ are given by:

$$\pi_s^H(\boldsymbol{\phi}, \boldsymbol{p}) = \sum_{h \in \mathcal{H}_s} \sum_{m \in \mathcal{M}} \sum_{j \in \mathcal{J}_m} D_{hj}^H(\boldsymbol{\phi}, \boldsymbol{p})(p_{mh} - c_{mh}^H) \tag{1}$$

where c_{mh}^H is the marginal cost of healthcare provision in hospital h for patients enrolled with insurer m. Hospital marginal costs can vary across insurers in a given hospital, which allows for potential efficiency gains due to vertical integration.

Note that given the timing of our game, premiums are set conditional on hospital prices, $\boldsymbol{\phi} = \boldsymbol{\phi}(\boldsymbol{p})$. For clarity, we express hospital demand as a function of hospital prices and pre-

[2] For simplicity, we assume that p_{mh} is scalar. In the empirical application, we allow the hospital costs to vary across diagnosis and consumer characteristics. For instance, prices for different conditions are p_{mh} weighted by condition-specific constants.

miums, $D^H_{hj}(\boldsymbol{\phi}, \boldsymbol{p})$, although we could express it as a function of hospital prices only, $D^H_{hj}(\boldsymbol{p}) = D^H_{hj}(\boldsymbol{\phi}(\boldsymbol{p}), \boldsymbol{p})$.

2.1.3 Insurer Profits

Insurer m maximizes expected profits by choosing plan premiums for the set of offered plans, given the hospital prices. Profits for the insurer m are given by:

$$\pi^M_m(\boldsymbol{\phi}, \boldsymbol{p}) = \sum_{j \in \mathcal{J}_m} D^M_j(\boldsymbol{\phi}, \boldsymbol{p})(\phi_j - c^M_j) \tag{2}$$

where c^M_j is the expected marginal cost per household enrolled in plan $j \in \mathcal{J}_m$. We abstract from administrative costs, such that the expected marginal cost for the insurer is the share of hospital prices that the insurer expects to cover for each plan. As mentioned above, we focus only on premium setting by insurers, taking the plan menu, their coinsurance rates and network structure as given.

2.1.4 Profits for Vertically Integrated Holdings

Vertically integrated holdings own insurers and hospitals in the market. We denote the set of integrated firms by $\mathcal{V}$. These firms maximize joint profits by setting both hospital prices and plan premiums. In doing so, these firms internalize the effects of changes in premiums and hospital prices in the profits of their integrated insurer and hospitals.

A vertically integrated firm a that controls hospital system $s(a)$ and insurer $m(a)$ maximizes joint profits by setting both hospital prices and plan premiums. Profits for the holding a are given by:

$$\pi^{VI}_a(\boldsymbol{\phi}, \boldsymbol{p}) = \pi^H_{s(a)}(\boldsymbol{\phi}, \boldsymbol{p}) + \pi^M_{m(a)}(\boldsymbol{\phi}, \boldsymbol{p}) \tag{3}$$

where both hospital system and insurer profit functions are the same as defined in equations (1) and (2).

2.1.5 Bargaining over Hospital Prices

If hospital systems and insurers are not vertically integrated, we assume they negotiate over hospital prices in sequential bargaining as in Collard-Wexler et al. (2017). The negotiated hospital price between a non-integrated hospital h and a non-integrated insurer m, p_{mh} is thus given by:

$$p_{mh} = \arg\max_{p_{mh}} \left(\pi^H_s - \pi^H_{s\setminus m}\right)^{(1-\lambda_{ms})} \left(\pi^M_m - \pi^M_{m\setminus s}\right)^{\lambda_{ms}} \tag{4}$$

where $\pi^H_{s\setminus m}$ are profits for hospital system s upon disagreement with insurer m, and $\pi^M_{m\setminus s}$ are the profits for insurer m upon disagreement with hospital system s. The negotiated hospital price maximizes the weighted product of the gains from the relationship between the hospital and the insurer, keeping all other prices constant. The parameter $\lambda_{ms} \in (0,1)$ is the normalized bargaining weight of insurer m relative to hospital system s. Bargaining weights are interpreted as a measure of the relative bargaining power of each player and increase the weight of the player's payoff in price determination: as λ_{ms} increases, gains from trade for insurer m become more relevant, whereas as λ_{ms} decreases, gains from trade for hospital system s become more relevant.

Negotiation over hospital prices can take place between any combination of integrated an non-integrated firms. Integrated firms will in any case take into account implications of negotiated prices for both components of the vertical structure. We generalize equation (4) in order to accommodate all combinations of negotiating firms.[3] The negotiated hospital price between insurer $m(a)$ and hospital $h(b)$, $p_{m(a)h(b)}$ is given by:

$$p_{m(a)h(b)} \quad = \quad \arg\max_{p_{m(a)h(b)}} \quad (\pi^{VI}_a - \pi^{VI}_{a\setminus s(b)})^{\lambda_{m(a)s(b)}}(\pi^{VI}_b - \pi^{VI}_{b\setminus m(a)})^{(1-\lambda_{m(a)s(b)})} \tag{5}$$

where $\pi^{VI}_{a\setminus s(b)}$ are the profits for holding a upon disagreement with the hospital system $s(b)$, $\pi^{VI}_{b\setminus m(a)}$ are the profits for holding b upon disagreement with the insurer $m(a)$, and $\lambda_{m(a)s(b)}$ is the normalized bargaining weight between insurer $m(a)$ and hospital system $s(b)$.[4]

Vertical integration and disagreement profits We analyze in detail the components of disagreement profits for vertically integrated firms, as they provide relevant insights regarding the role of vertical integrations in bargaining outcomes.

Profits for holding a upon disagreement with hospital system $s(b)$ are:

$$\pi^{VI}_{a\setminus s(b)} \quad = \quad \pi^H_{s(a)\setminus s(b)}(\boldsymbol{\phi}, \boldsymbol{p}) + \pi^M_{m(a)\setminus s(b)}(\boldsymbol{\phi}, \boldsymbol{p})$$

where $\pi^H_{s(a)\setminus s(b)}(\boldsymbol{\phi}, \boldsymbol{p})$ are hospital profits for holding a once the hospital system $s(b)$ is excluded from the network of insurer $m(a)$, and $\pi^M_{m(a)\setminus s(b)}(\boldsymbol{\phi}, \boldsymbol{p})$ are the insurer profits of holding a upon disagreement with hospital system $s(b)$.

The term $\pi^M_{m(a)\setminus s(b)}(\boldsymbol{\phi}, \boldsymbol{p})$ captures the standard loss in a vertical relationship when the downstream insurer loses an upstream hospital system from her network, making the network less valuable. However, the term $\pi^H_{s(a)\setminus s(b)}(\boldsymbol{\phi}, \boldsymbol{p})$ is novel and highlights that under vertical integration, disagreement with hospital system $s(b)$ can be beneficial to the holding's own hospital sys-

[3]Negotiations between non-integrated insurers, non-integrated hospitals, and holdings are particular cases of the one presented here.

[4]Note that despite the negotiation involving two potentially integrated firms, disagreement for a negotiating insurer (hospital system) only involves the hospital system (insurer) of the counterpart, rather than both the insurer and the hospital system of the counterpart.

tem, $s(a)$. Incentives reflected in this term have important consequences for enrollees of insurer $m(a)$, for whom hospital system $s(b)$ might be costlier or even unavailable in their plan network. Unlike non-vertically integrated insurers, holding a internalizes that negotiating high hospital prices with competing hospitals may steer demand towards their own hospital system. We call this a *foreclosure effect*.

Analogously, profits for holding b upon disagreement with insurer $m(a)$ are:

$$\pi^{VI}_{b\setminus m(a)} = \pi^{H}_{s(b)\setminus m(a)}(\boldsymbol{\phi}, \boldsymbol{p}) + \pi^{M}_{m(b)\setminus m(a)}(\boldsymbol{\phi}, \boldsymbol{p})$$

where $\pi^{H}_{s(b)\setminus m(a)}(\boldsymbol{\phi}, \boldsymbol{p})$ are hospital profits for holding b upon disagreement with insurer $m(a)$, and $\pi^{M}_{m(b)\setminus m(a)}(\boldsymbol{\phi}, \boldsymbol{p})$ are insurer profits of holding b upon a disagreement between hospital system $s(b)$ and the competing insurer $m(a)$.

The term $\pi^{H}_{s(b)\setminus m(a)}(\boldsymbol{\phi}, \boldsymbol{p})$ captures the standard loss in a vertical relationship when the upstream hospital system loses a downstream insurer, making that hospital system unavailable for the enrollees from the excluded insurer and thus harming hospital profits. On the other hand, the term $\pi^{M}_{m(b)\setminus m(a)}(\boldsymbol{\phi}, \boldsymbol{p})$ is novel and gives another important insight: under vertical integration, disagreement with competing insurer $m(a)$ may be beneficial to the holding's own insurer $m(b)$. This, because the absence of hospital system $s(b)$ from the network of insurer $m(a)$ makes that network less valuable and favors insurer $m(b)$. Unlike non-vertically integrated insurers, holding b internalizes that negotiating high hospital prices with competing insurers may steer demand towards their own insurer. We name this a *worsening your rival network effect*.

The *foreclosure* and *worsening your rival network* effects reduce the value of the agreement for a vertically integrated holding. This suggests that vertical integration creates incentives to increase negotiated hospital prices both between integrated hospitals and competing insurers and between integrated insurers and competing hospitals. This behavior steers demand towards their integrated insurer and hospital system respectively. The degree of consumer substitution at the hospital and plan level shapes the disagreement payoffs and thus determines bargaining leverage, and is therefore crucial for the extent to which this distortion takes place.

2.2 Equilibrium

2.2.1 Equilibrium Negotiated Hospital Prices

Negotiated prices between non-integrated hospitals and insurers are given by a system of equations that solves equation (4), which can be expressed as:

$$\frac{\partial \pi^H_s}{\partial p_{mh}} = -\frac{\lambda_{ms}}{1-\lambda_{ms}} \left(\frac{\pi^H_s - \pi^H_{s\setminus m}}{\pi^M_m - \pi^M_{m\setminus s}} \right) \frac{\partial \pi^M_m}{\partial p_{mh}} \quad \forall m \in \mathcal{M}, h \in \mathcal{H} \tag{6}$$

from where it is clear that as the bargaining power of the hospital increases, this equation converges to the first order condition of a hospital setting prices in a traditional Bertrand-Nash. Whenever bargaining power is shared between the hospital system and the insurer, that constrains hospital prices away from what would be obtained in a Bertrand-Nash setting. Finally, as bargaining power of the hospital system becomes smaller, the equation above becomes closer to the optimality condition of the insurer, which implies that hospital prices become closer to costs.

We generalize equation (6) in order to accommodate different combinations of vertical structures between the two negotiating firms. Let $1_{a\in\mathcal{V}}$ indicate that firm a is vertically integrated. Negotiated prices between potentially integrated insurer $m(a)$ and hospital $h(b)$ are given by a system of equation that solves equation (5), which is given by:

$$\begin{aligned}\frac{\partial \pi^H_{s(b)}}{\partial p_{m(a)h(b)}} + 1_{b\in\mathcal{V}}\frac{\partial \pi^M_{m(b)}}{\partial p_{m(a)h(b)}} \quad = \quad & -\frac{\lambda_{m(a)h(b)}}{1-\lambda_{m(a)h(b)}}\left(\frac{\pi^H_{s(b)} - \pi^H_{s(b)\setminus m(a)} + 1_{b\in\mathcal{V}}(\pi^M_{m(b)} - \pi^M_{m(b)\setminus m(a)})}{\pi^M_{m(a)} - \pi^M_{m(a)\setminus s(b)} + 1_{a\in\mathcal{V}}(\pi^H_{s(a)} - \pi^H_{s(a)\setminus s(b)})}\right) \\ & \times\left(\frac{\partial \pi^M_{m(a)}}{\partial p_{m(a)h(b)}} + 1_{a\in\mathcal{V}}\frac{\partial \pi^H_{s(a)}}{\partial p_{m(a)h(b)}}\right) \quad \forall m\in\mathcal{M}, h\in\mathcal{H} \qquad (7)\end{aligned}$$

which is the standard optimality condition in the bargaining literature but extended to consider the vertical integration incentives. For integrated firms, the marginal effects of a change in hospital prices affects both hospital and insurer profits for the holding. Similar to equation (6), note that this equation also nests hospital price setting in a traditional Bertrand-Nash setting when $\lambda_{m(a)h(b)} = 0$.

Negotiated prices in equation (7) can be rewritten in matrix form. After rearranging and stacking equations, the vector of negotiated prices for the hospital system $s(b)$ is given by:

$$P_{s(b)} = C^H_{s(b)} - (\Omega_{s(b)} + \Lambda_{s(b)})^{-1}(D^H_{s(b)} + \Gamma_{s(b)}) \qquad (8)$$

where vector $P_{s(b)}$ contains negotiated prices between each hospital $h \in \mathcal{H}_{s(b)}$ and each insurer in the market. On the right hand side, vector $C^H_{s(b)}$ contains hospital marginal costs for each hospital and insurer. Thus, hospital prices are in equilibrium set at a mark-up over marginal cost, where the mark-up combines several elements of the model. We proceed to analyze those elements in detail.

The first term of interest is $\Omega_{s(b)}$, which captures the price sensitivity of demand for hospital h from policyholders of insurer m. Each entry in this matrix is given by:

$$\Omega_{s(b)[h,m]} = \sum_{j\in\mathcal{J}_m}\frac{\partial D^H_{hj}(\phi, p)}{\partial p_{m(a)h(b)}}$$

such that it measures demand responses to hospital prices across plans offered by each insurer. As usual, mark-ups of hospital prices over marginal costs are decreasing in price sensitivity of hospital demand.

The matrix $\Lambda_{s(b)}$ captures additional considerations of the price sensitivity of the insurer's holding. Each entry in this matrix is equal to:

$$\Lambda_{s(b)[h,m]} = \frac{\lambda_{m(a)h(b)}}{1-\lambda_{m(a)h(b)}} \sum_{j \in \mathcal{J}_m} [D^H_{jh}(\phi, p) - D^H_{jh\setminus m}(\phi, p)] \frac{\frac{\partial \pi^{VI}_a}{\partial p_{m(a)h(b)}}}{\pi^{VI}_a - \pi^{VI}_{a\setminus s(b)}}$$

where the first term is the relative bargaining ratio, and implies that the less skilled the insurer is relative to the hospital, the larger the hospital mark-up is. The second term captures the marginal change in demand for hospital h upon disagreement with insurer $m(a)$. The larger the change in hospital demand upon disagreement with insurer m, the smaller is the mark-up the hospital charges. The third term is the marginal effect on insurer profits of holding a of an increase in hospital price. The less sensitive are those to an increase in hospital prices, the larger the mark-up the hospital charges.

The third term in equation (8) is aggregate demand for each hospital in the system from all plans offered by each insurer in the market. Each entry in this vector is:

$$D^H_{s(b)[m]} = \sum_{j \in \mathcal{J}_m} D^H_{hj}(\boldsymbol{\phi}, \boldsymbol{p})$$

The final term $\Gamma_{s(b)}$ captures additional incentives for hospital pricing that the hospital faces if vertically integrated, i.e. if $b \in \mathcal{V}$. This term captures the fact that the integrated hospital takes into account the effects on its integrated insurer when bargaining with competing insurers. Each entry in this matrix is equal to:

$$\Gamma_{s(b)[m]} = 1_{b \in \mathcal{V}} \left[\frac{\partial \pi^M_{m(b)}}{\partial p_{m(a)h(b)}} + \left(\pi^M_{m(b)\setminus m(a)} - \pi^M_{m(b)} \right) \left(\frac{\lambda_{m(a)h(b)}}{1-\lambda_{m(a)h(b)}} \right) \left(\frac{-\frac{\partial \pi^{VI}_a}{\partial p_{m(a)h(b)}}}{\pi^{VI}_a - \pi^{VI}_{a\setminus s(b)}} \right) \right]$$

where the first term measures the effect of higher hospital prices to rival insurer $m(a)$ on the integrated insurer $m(b)$. Higher hospital prices for rival insurers are likely to reduce demand for them and steer consumers towards the integrated insurer, thus increasing the insurer profits of holding b. The higher this effect is, the higher the mark-up the hospital will charge. The second term captures the benefits for insurer $m(b)$ upon a disagreement between hospital $s(b)$ and insurer $m(a)$. The larger the change in profits upon disagreement, the larger the mark-up hospital $h(b)$ charges. This effect is stronger if bargaining power of insurer $m(a)$ increases. Moreover, this effect is also stronger if profits of holding a are more sensitive to hospital price $p_{m(a)s(b)}$. Given that a sensitive holding a and a more skilled insurer $m(a)$ would obtain a more favorable price with the hospital system $s(b)$, this term internalizes that effect on the vertically integrated insurer $m(b)$ by increasing the mark-up on hospital price.

Note that equation (8) nests other models as particular cases. First, note that in the absence of vertical integration ($\mathcal{V} = \emptyset$) and when hospitals have all the bargaining power ($\lambda_{ms} = 0$), we recover the usual Nash-Bertrand conditions for optimal hospital pricing, $P_{s(b)} = C^H_{s(b)} - \Omega^{-1}_{s(b)} D^H_{s(b)}$. Second, if all bargaining power is granted to insurers ($\lambda_{ms} = 1$), then hospital prices are equal to hospital marginal costs, $P_{s(b)} = C^H_{s(b)}$. Finally, allowing for both players to hold some bargaining power ($\lambda_{ms} \in (0,1)$) but in absence of vertical integration ($= \emptyset$), equilibrium hospital prices are set at a mark-up over marginal costs, $P_{s(b)} = C^H_{s(b)} - (\Omega_{s(b)} + \Lambda_{s(b)})^{-1} D^H_{s(b)}$, such that the mark-up depends on price sensitivity matrix augmented by bargaining, similar to that in Gowrisankaran et al. (2015).

2.2.2 *Insurance Pricing by Non-Vertically Integrated Insurers*

Insurers compete in premiums taking negotiated hospital prices as given. Optimal premiums for a non-vertically integrated insurer m are those that maximize insurer profits as introduced in equation (2), which are given by the solution to the following system of first order conditions:

$$\phi^*_j(\boldsymbol{p}) = c^M_j - \frac{1}{\frac{\partial D^M_j(\boldsymbol{\phi},\boldsymbol{p})}{\partial \phi_j}} \left[D^M_j(\boldsymbol{\phi},\boldsymbol{p}) + \sum_{j' \neq j, j' \in \mathcal{J}_m} \frac{\partial D^M_{j'}(\boldsymbol{\phi},\boldsymbol{p})}{\partial \phi_j} (\phi^*_{j'} - c^M_{j'}) \right] \quad \forall j \in \mathcal{J}_m \tag{9}$$

which is the standard Bertrand-Nash pricing for a multiproduct insurer that offers differentiated insurance plans. Optimal premiums are set as a mark-up over marginal cost that depends on two terms: price-sensitivity of demand of plan j to changes in premium of plan j; and price-sensitivity of demand of other plans $j' \in \mathcal{J}_m$ to changes in premium of plan j. If plans are substitutes, then this equation implies that part of reduced demand of a plan due to increases in its premium is recaptured by other plans offered by the insurer. Hence, cross-price effects should increase equilibrium premiums.

2.2.3 *Insurance Pricing by Vertically Integrated Firms*

Vertically integrated insurers face more complex incentives when setting premiums as they internalize the steering effect that different premiums can have on their vertically integrated hospital system. The optimality conditions for the premiums are given by:

$$\begin{aligned} \phi^*_j(\boldsymbol{p}) \quad = \quad & c^M_j - \frac{1}{\frac{\partial D^M_j(\boldsymbol{\phi},\boldsymbol{p})}{\partial \phi_j}} \left[D^M_j(\boldsymbol{\phi},\boldsymbol{p}) + \sum_{j' \neq j, j' \in \mathcal{J}_{m(a)}} \frac{\partial D^M_{j'}(\boldsymbol{\phi},\boldsymbol{p})}{\partial \phi_j} (\phi^*_{j'} - c^M_{j'}) \right. \\ & + \sum_{h \in \mathcal{H}_s} \left(\sum_{j' \in \mathcal{J}_{m(a)}} \frac{\partial D^H_{hj'}(\boldsymbol{\phi},\boldsymbol{p})}{\partial \phi_j} (p_{m(a)h} - c^H_{m(a)h}) \right. \\ & \left. \left. + \sum_{m' \neq m(a), m' \in \mathcal{M}} \sum_{j' \in \mathcal{J}_{m'}} \frac{\partial D^H_{hj'}(\boldsymbol{\phi},\boldsymbol{p})}{\partial \phi_j} (p_{m'h} - c^H_{m'h}) \right) \right] \quad \forall j \in \mathcal{J}_{m(a)} \end{aligned} \tag{10}$$

such that a vertically integrated insurer faces two additional effects on top of the same standard effects captured in equation (9). The new terms are the sum of the effect on the profits of vertically integrated hospitals $h \in \mathcal{H}_s$. The first term captures the effect on hospital profits coming from the set of enrollees in plans of the vertically integrated insurer ($j' \in \mathcal{J}_{m(a)}$), while the second term captures the effect on hospital profits coming from plans from other insurers in the market ($j' \in \mathcal{J}_{m'}; m' \neq m(a), m' \in \mathcal{M}$).

The additional incentive that vertical integration puts in place for premium setting comes from the potential for the insurer to steer demand towards integrated hospitals. Steered demand comes both from the plans of the integrated insurer and from other insurers in the market through substitution across plans.

3 Institutions and Data

3.1 Institutional Background

Health insurance[5] The health insurance system in Chile has a mixed public-private provision. The public insurer is the National Health Fund (*Fondo Nacional de Salud*, FONASA), which is a pay-as-you-go system financed with the contribution of affiliates and public resources. The private sector has a small number of insurers (*Instituciones de Salud Previsional*, ISAPREs), which compete in a regulated environment similar to the U.S. market. FONASA serves around 70 percent of the population and ISAPREs serve roughly 15 percent of the population, while the remaining 15 percent of the population is either enlisted in the Chilean army or uninsured (Bitrán et al., 2010; Duarte, 2012).

Insurance plans offered by both sectors share some common features. They all have separate coinsurance rates for inpatient and outpatient care. Moreover, plans may impose coverage caps for each service, although these caps are rarely met in practice. Moreover, different to the case of the U.S. market, plans in Chile do not include out-of-pocket-maximums as components of contracts. However, health insurance plans offered by the two systems differ in many respects, including hospital access, premiums, coinsurance structure, insurer payment caps, exclusions, risk pricing and quality.

Health insurance is mandatory for active workers. Workers entering into the labor force for the first time must automatically enroll in FONASA. After a month, workers must actively choose whether to stay in FONASA or switch to a plan offered by a private insurer. Regarding switching, consumers are allowed to change across sectors at any point in time, but only once a year within the private sector. After enrolling, workers, and then retirees, are mandated to contribute 7 percent of their taxable income to the public system or to buy a plan that costs at least 7 percent of their

[5]The description of the Chilean insurance markets we present borrows from Duarte (2012) and Atal (2015).

wages in the private sector, with a cap of $264 per month.[6]

Private health insurance ISAPREs were introduced by the government in 1981, in a context of broader privatization and market-oriented policies. Starting from negligible market shares, private insurers developed a wide variety of products to attract consumers, mainly from the top of the income distribution.

The private health insurance market includes 13 insurers during the period we study. These insurers can be split into two groups: six *open* insurers available to all workers, and seven *closed* insurers available only to workers of specific industries or firms. Open insurers account for almost 96 percent of the private market and are the most relevant ones in terms of consumer choice, so we restrict our analysis to them.

Insurance contracts in the private market are mostly individual arrangements between the insurer and the consumer. In rare cases, employers offer collective plans to their employees. We do not include them in our analysis. Contracts are yearly, and once consumers enroll in a contract they must remain under it for at least one year. After that period, consumers are allowed to switch to a different plan, insurer or to the public sector. There is guaranteed renewability, in that if a consumer does not switch, the plan coverage is automatically renewed and the insurer cannot deny coverage under the plan.

Contracts offered by the private sector are regulated in their structure and are composed of the following elements. First, they have a monthly premium P which is a combination of a base-price P_B and a risk-rating factor f so that $P = P_B \times f$, where f is a gender-specific step function of age. Second, insurers choose a base price for each plan, which can be adjusted yearly.[7] Third, each plan has separate coinsurance rates for inpatient and outpatient care. Coinsurance rates are constant across claims for the same service. Fourth, plans may specify a coverage cap for each service, which is equivalent to having the coinsurance rate become one beyond that expenditure level. This maximum payment is constant across claims for the same service.

Payments from insurers to hospitals operate in a fee-for-service system. Copayments that policyholders pay for a given service and plan are computed as a function of plan attributes as follows:

$$copayment = price - \min\{price \times (1 - coinsurance), cap\}$$

such that the marginal price faced by consumer increases after the coverage cap established for

[6] All amounts in the paper are measured in U.S. dollars for Dec, 30th, 2014.

[7] Risk-based pricing is allowed in the private market, but regulated since 2005. First, base-prices are chosen at the plan and not at the individual level. Second, each insurer is allowed to utilize only two f functions. Third, the increase in the price of a given plan cannot be higher than 1.3 times the average increase in plan base prices across all plans offered by an insurer. However, plan proliferation is evident from the data, as around 40 percent of health insurance plans in the market serve only one consumer, and the average number of consumers per plan is 28 (Atal, 2015). This proliferation suggests that insurers possibly implement some form risk pricing through that mechanism.

the service is reached.

Regarding hospital networks, health insurance plans typically offer either unrestricted networks or tiered networks.[8] Unrestricted network plans provide the same coverage in all hospitals. Tiered networks offer differentiated coverage across different sets of private hospitals. In contrast, tiered network plans specify offer differentially generous coverage across hospitals in the market, similar to the PPO plans in the U.S. Hospitals cannot deny healthcare to patients and thus all consumers are allowed to attend all hospitals, although the services may receive zero coverage from their insurer.

Private insurers in the Chilean market are allowed to engage in risk selection through rejecting applications based on pre-existing medical conditions. In contrast, the public insurer cannot deny coverage, which has led to a relative concentration of risky consumers in the public sector. Nevertheless, private insurers cannot deny the renewal of insurance to already insured consumer following changes in their risk profile due to realized health conditions.

Finally, private insurers provide better coverage in the private healthcare system, which is generally considered to provide higher quality service than public hospitals in terms of waiting time, medical resources avaialbility, and medical outcomes. For further discussion on the interaction between the public and private insurance systems, see Appendix B.

Healthcare providers The healthcare provider system in Chile has a mixed public-private provision. The public hospital network is more extensive than the private hospital network, with 185 public hospitals relative to the 85 private hospitals in 2012 (Clínicas de Chile, 2012). However, recent trends show that public hospital capacity slightly decreased by 0.8 percent between 2005 and 2012, while private hospital capacity increased by 24 percent over the same period (Clínicas de Chile, 2012). Most of this increase comes from capacity investments by hospitals already in the market rather than from entry of new hospitals. We focus on the capital city of Santiago, which is the largest market for health services concentrating more than a third of the private hospitals and around half of the private hospitals' capacity in the market (Galetovic and Sanhueza, 2013).

The Chilean healthcare market is remarkably segmented between the private and public sectors. Private insurers primarily cover admissions to private hospitals, whereas the public insurer mostly covers admissions to public hospitals. In fact, 97 percent of payments by private insurers are collected by private hospitals, while the remaining 3 percent is collected by public hospitals (Galetovic and Sanhueza, 2013). Therefore, we focus on the interaction between private insurers and private hospitals.

We focus on inpatient care, which represents more than half of healthcare expenditure in the market. This segment is composed by remarkably less hospitals than the outpatient care sector

[8] Few plans offer restricted networks, similar to HMO plans in the U.S. They are rarely observed in the data and not offered publicly. We do not consider them in our analysis.

and thus is likely less competitive and thus more affected by vertical integration. For inpatient care, we are able to track admissions by diagnosis and hospital at the individual level for the population of consumers in the market.

Vertical Integration Strictly speaking, the Chilean law forbids an insurer to have ownership and control over a hospital. However, the law does not prohibit a third firm to own insurance providers and hospitals simultaneously. Hence, companies have circumvented the regulation by establishing vertical relations through *holdings* that own both insurers and hospitals. In practice, large health insurers have acquired hospitals through their respective holding, although the vertically integrated healthcare providers remain open to receive patients from all insurers in the market.

Multiple vertical mergers between insurers and hospitals took place in the last 20 years. By 2012, 48 percent of the capacity of private hospitals was controlled by holdings with some ownership over a health insurance provider (Galetovic and Sanhueza, 2013). Table 1 shows a list of ownership linkages between insurers and hospitals in the market we study as recorded by Copetta (2013).[9] Two large insurers have vertical linkages with three hospitals each in Santiago. Namely, Banmédica and Vida Tres are two insurers owned by the same holding that owns Clínica Santa María, Clínica Dávila, and Clínica Vespucio; while Consalud owns Clínica Avansalud, Clínica Bicentenario, and Clínica Tabancura. Additionally, Colmena also has some vertical linkages with one hospital in our dataset: Clínica UC San Carlos.[10]

3.2 Data

3.2.1 Administrative Records

We combine different sources of administrative data provided by the regulatory agency in the health insurance market (*Superintendencia de Salud*, SS). By law, insurers must report detailed data on claims at the individual level. The claims data contain identifiers for consumer, insurer, insurance plan, hospital, and services provided. Moreover, it also includes the total cost of the hospital bill, the amount covered by the insurer and out-of-pocket copayment paid by the consumer. We use the universe of claims during the $2013 - 2016$ period.

Besides claims data, we also have access to the characteristics of the health insurance plans offered by private insurers in the 2013-2014 period. We have detailed data on premiums, copayment

[9] The list of linkages we provide is limited to the market we study. However, private insurers also display vertical linkages with a number of hospitals located in other geographic markets (Tobar et al., 2012; Copetta, 2013; Galetovic and Sanhueza, 2013). We assume that geographic markets are essentially independent and therefore focus only on vertical linkages between insurers and hospitals in the market we analyze, Santiago.

[10] The case of Colmena is unclear, as the insurer's holding only controls 50 percent. We prefer to be conservative and did not consider this single hospital-insurer pair as vertically integrated.

rates, and coverage caps. It also includes information on whether the plan offers a restricted or unrestricted network and whether it was available in each market at each point in time. Furthermore, we can match plans and their enrollees to obtain basic demographics of policyholders and their dependents.

We employ the administrative data described above to assemble the dataset we use for our analyses. We focus on the capital city of Santiago, which is by far the largest market of the country. Moreover, we select the 12 largest providers in Santiago, which account for 76 percent of the admissions in the data. The rest of the hospitals are remarkably small and we group them in the outside option along with public hospitals. All these hospitals receive patients from all insurers in the market. The list of hospitals we include in our sample is provided in Table 3-B.

Admissions We exploit administrative claims data to construct a dataset of hospital admissions. We exploit individual claim data to identify unique medical episodes of inpatient care that we label as *admissions*. The admission data contain detailed financial and medical information. Financial information consists of the total amount of the hospital bill, the amount of insurance reimbursement, and consumer copayments. Medical information includes the medical diagnosis and the list of associated claims on different services provided by the hospital. We code admissions according to their associated diagnosis using ICD-10 codes, resulting in medical episodes that cover 16 diagnoses groups.[11] These diagnoses account for 90 percent of admissions in the data and as much as 92 percent of hospital revenue. Finally, we add to this dataset consumer insurance plan attributes along with consumer covariates, such as age, income, gender and number of dependents. We describe the construction of this dataset is in detail in appendix A. After several steps of data cleaning, the estimating dataset is left with 641,392 admissions between 2013 and 2016.[12]

Insurance plans Our administrative data on health insurance plans contain detailed characteristics of 68,625 coded plans. However, many of these differently coded plans share their main features, including the offering insurer, the coverage rates conditions and the network structure. Furthermore, many of them have a small number of policyholders and the distribution of policyholders per plan is remarkably skewed, with the average and the median number of policyholders

[11]The list of diagnosis we include in the estimating dataset covers infections and parasites, neoplasms, blood diseases, endocrine, nervous system, ocular diseases, ear diseases, circulatory, respiratory, digestive, skin diseases, musculoskeletal, genitourinary, pregnancy, perinatal, and congenital malformation.

[12]We face important limitations that preclude us from using outpatient claim data. The main problem is that those services are provided by entities typically different from hospitals (mostly groups of physicians or other firms such as laboratories). It is not feasible to track the identity of these providers. The market for outpatient care is composed of multiple firms and therefore likely much more competitive than the market for inpatient care. Moreover, it is a market where health services are more basic and therefore less differentiated. Connecting this to our model, if enrollees obtain the same outpatient care offered by physicians (and other firms) in other private locations different from hospitals in our sample, then outpatient care does not depend upon the agreement between hospitals and insurers. Under that assumption, outpatient care costs cancel out in the Nash-product and are irrelevant for the marginal value of the relationship in our bargaining setting.

per plan being 32 and 2, similar to what Atal (2015) finds.

We group plans to obtain a more tractable and realistic list of choices. The variables we use in our clustering procedure are the insurance provider, the inpatient and outpatient coverage rates, whether the plan sets a coverage cap, whether the plan offers unrestricted or tiered network, and the decile in the base premium distribution. This procedure reduces the number of coded plans to 4,358 for the 2013-2016 period. Even for this smaller number of plans, the distribution of policyholders is skewed. We provide more details on the construction of choice set for the plan choice model in section 4.3.

3.2.2 Descriptive Statistics

Table 2 provides summary statistics for insurance data. Table 2-A displays policyholders attributes and shows that the average policyholder is 40 years old, has an income of $1,600 and pays $160 in insurance premiums every month.[13] We also find that there is substantial variation in the household composition of policyholders, with 34 and 22 percent being single males and single females respectively, while the remaining 43 percent of the enrollees have at least one dependent.

Moreover, Table 3-B displays insurance plans attributes, and shows that the coverage rates are on average 85 and 72 percent for inpatient and outpatient respectively. Moreover, 87 percent of the plans impose a coverage cap and 86 percent offer at least one preferential provider. Finally, Table 3-C summarizes the market shares and monthly premiums paid by policyholders in Santiago.[14]. We also document substantial variation in premiums across insurers, with the difference between the highest and the lowest average premium being 66 percent of the average premium in the market. Furthermore, we document significant variation in premiums within an insurer, which is partly explained by the ability of insurers to adjust premiums by gender, age and number of dependents of the policyholder.

Table 3 presents summary statistics for our admission data. Table 3-A displays statistics for admission characteristics across patients, and shows that the average admission bill in the data is close to $3,800, of which almost a third is paid by the patient while the insurer covered the remaining two thirds. However, we also document a significant variation in terms of the total bill and insurer coverage across admissions. Also, near 38 percent of admissions take place at preferential hospitals within the patient insurance plan. The average patient is 37 years old, although the data span from infants to elderly. Finally, 70 percent of the patients have dependents, and 14 and 17 percent are single males and single females, respectively.

[13] This amount of contribution is on average slightly larger than the mandatory 7 percent because voluntary additional contributions are allowed

[14] Market shares in our sample track closely national market shares. According to the regulator, insurer market shares in 2015 were 19.3 percent for Banmédica, 16.2 percent for Colmena, 19.6 percent for Consalud, 21.2 percent for Cruz Blanca, 16.4 percent for Masvida, 3.9 for Vida Tres and 3.3 for other insurers (Superintendencia de Salud, 2015).

Table 3-B documents market shares by hospitals and dispersion in hospital prices within and across hospitals. Four of the hospitals in the sample have market shares between 10 and 13 percent, while the rest have market shares of 5 percent or lower. Moreover, the outside option has a market share of 24 percent, which combines both minor private hospitals and all public hospitals in the market. We document substantial dispersion in the total amount billed by the hospitals. For example, Clínica Alemana and Clínica Las Condes charge average prices that are more than twice as those charged by Clínica Dávila and Clínica Vespucio. This heterogeneity is likely explained by several dimensions of differentiation, such as location, infrastructure, real and perceived quality, among others.

Finally, Table 4 presents the breakdown of hospital admissions by health insurance provider in the admission data. Among all vertically integrated hospitals, we find that integrated insurers are in fact the dominant source of admissions, representing between 40 and 70 percent of the hospital admissions. Nevertheless, all integrated hospitals do receive a substantial share of patients from insurers to which they are not integrated.

3.3 Stylized Facts on Vertical Integration

In this subsection, we present stylized facts regarding vertical integration in Chile. We study how different outcomes of interest correlate with vertical integration by hospitals and insurers. For this, we leverage the fact that our data identify both the hospital and the insurer for each admission. We exploit different sources of variation that allow for comparing outcomes under different integration regimes. We emphasize we do not make a claim of causality of our estimates. Rather, we just aim at illustrating stylized correlations in the data that are suggestive of the role of vertical integration in shaping outcomes in this market.

3.3.1 Vertical Integration and Payments

We start by examining whether vertical integration correlates with the resulting payments of the admissions. Our identification strategy in this case is to exploit within-hospital variation in outcomes of admissions of patients coming from integrated versus non-integrated insurers, while controlling for a rich set of covariates. The estimating equation is:

$$\log(y_{idjh}) = \beta VI_{m(j)h} + X_{ij}'\gamma + \tau_d + \eta_{m(j)} + \zeta_h + \varepsilon_{idjh} \tag{11}$$

where $\log(y_{idjh})$ is the outcome of interest for patient i in an admission for diagnosis d under plan j in hospital h; $VI_{m(j)h}$ is an indicator of whether the insurer m and the hospital h are vertically integrated; and X_{ij} is a vector of controls that includes patient i demographics (gender, age, income, number of dependents, an indicator for independent worker and dummies for county of residence), and plan j attributes (plan premium, coinsurance rate for inpatient and outpatient admissions, and indicators for whether the plan has a coverage cap and a preferential provider).

Moreover, we control for time-invariant heterogeneity by including diagnosis, insurer and hospital fixed effects, denoted by τ_d, $\eta_{m(j)}$ and ζ_h respectively. We cluster standard errors at insurer-hospital level.

Table 5 displays results from estimating equation (11) using as a dependent variable the full amount of the hospital bill, the total amount of patient out-of-pocket copayments, and the amount covered by the insurance provider. Each column shows estimates using increasingly richer specifications, with column (5) being our preferred one. Panel A displays results for the effect of vertical integration on the logged total bill of the admission. Estimates from our preferred specifications show that the hospital bill is 4 percent lower for vertically integrated admissions relative to non-integrated admissions, conditional on a rich set of controls. Estimates in Panel B show that patient copayments are 18 percent lower for vertically integrated admissions, while estimates in Panel C show that amount paid by the insurance provider is 8 percent higher in the vertically integrated admissions.[15]

Our estimates show thus that, on average, hospital bills are lower in admissions of patients from vertically integrated insurers within a vertically integrated hospital. Also, we observe higher amounts of coverage on those admissions. Accordingly, out-of-pocket copayments are lower for patients insured by an insurer that is vertically integrated with the hospital where the admission occurs.

While lower copayments may suggest that vertical integration is beneficial to consumers, this is not necessarily the case. For instance, one could argue that integrated firms are increasing copayments to patients from independent insurers to favor switching from other insurers to their integrated insurance company. Also, the behavior of integrated insurers in the health insurance market could differ from that of independent insurers in ways that may affect consumers, such as changes in plan premiums or changes in network structure, which are not captured by this descriptive analysis. These estimates are thus insufficient to assess the welfare implications of banning vertical integration. In fact, a structural model is required to compute counterfactual equilibrium prices under alternative vertical market structures and their consequences on consumer welfare and insurers and hospitals profits.

3.3.2 Vertical Integration and Hospital Performance

A common argument for vertical integration in health markets is that it may enhance health costs control. The rationale is that an integrated hospital may internalize the economic costs for the integrated insurer, while a non-integrated hospital may incur in moral hazard and be less efficient in the provision of healthcare services. In this subsection, we explore this hypothesis along two dimensions.

[15] We explore heterogeneity on the effects of vertical integration by holding, diagnosis and hospitals. We find qualitatively similar results regarding direction of the effects of vertical integration with some variation in their magnitudes.

We start by studying whether, within a hospital, those admissions from patients insured by an insurer integrated with the hospital are offered fewer health services than those from patients insured by insurers not integrated with the hospital. Finding evidence for that would suggest that vertical integration causes cost efficiencies. We study this margin by estimating equation (11) using the number of claims per admission as a dependent variable and controlling for the same vector of variables as in section 3.3.2, which includes hospital and diagnosis fixed effects along with insurer and patient controls. Table 6-A displays results from these regressions. Most specifications show no difference in the number of claims per admission across integrated and non-integrated insurers. These results provide suggestive evidence against a reduction of moral hazard in the number of health services provided upon admission as a channel for cost efficiencies as a result of vertical integration.

We now further explore whether patients in vertically integrated admissions receive a different medical treatment relative to similar non-integrated admissions. This analysis relies on the hypothesis that vertically integrated hospitals may internalize the economic costs for the integrated insurer, and thus offer different treatment depending on whether the patient insurer is integrated with the hospital. Finding this sort of behavior could be interpreted as evidence of efficiency gains due to vertical integration as it prevents unnecessary medical services.

We explore potential *cost-control behavior* in the provision of health services in which physicians have more discretion. Evidence that admissions from integrated insurers are less often treated with these services than those for non-integrated insurers would suggest this could be a channel through which vertical integration achieves cost efficiencies. The health services on which we focus are C-sections and ultrasound during pregnancy, hemogram tests in digestive diagnosis, and chest X-ray and cross section imaging in respiratory diagnosis.[16] Table 6-B displays the results from estimating a probit version of equation (11) using an indicator for each of those claims as the dependent variable. In each case, the sample is restricted to admissions under the respective diagnosis. Our results display heterogeneity in the association between vertical integration and the provision of these services. On the one hand, we find that admissions from integrated insurers tend to provide fewer C-sections and hemograms. The former is consistent with evidence for this behavior in the U.S (Cutler et al., 2000; Johnson and Rehavi, 2016). On the other hand, we find the opposite effect for chest X-rays and no significant effect on ultrasounds and imaging.

Our estimates suggest that there may be a relationship between vertical integration and the particular health services provided to patients upon admission. Thus, we cannot reject the hypothesis that vertically integrated hospitals are sensitive to the economic incentives associated with the costs of their integrated insurer. Moreover, the fact that most of these estimates are negatives is related to the traditional view of vertical integration causing efficiency gains.

[16] C-sections provide a particularly convenient setting for this test as, upon delivery, a physician must either implement a C-section or proceed with a natural birth. We thus know for that case what the alternatives were for the physician, which is not as clear for the other services we study.

Overall, these results suggest that vertical integration may affect hospital and physician behavior. The change in performance indicates that we should consider potential losses in hospital efficiency when simulating changes in market structure, along with other potential changes in costs upon integration.[17] In this line, while we do not explicitly model hospital behavior, in our counterfactuals in section 5 we allow for different amounts of cost increases when simulating scenarios where vertical integration is banned.

3.3.3 *Integrated Hospitals and Hospital Choices*

Our model highlights that vertically integrated firms face incentives to set prices in order to steer demand towards their hospitals and insurers. In this subsection, we empirically investigate if the data are consistent with this behavior.

We focus on policyholders that switch to vertically integrated insurers to study whether the availability of integrated hospitals affects their hospital choice. We start by identifying policyholders that switched insurance providers in our time span. The choice set of hospitals for these customers is constant over time. However, the status of whether the hospital was integrated to the individual's insurer may change over time due to the switching behavior of each policyholder. We exploit that variation to study the role of vertical integration in hospital choice.

We exploit the differential timing in switching within the subpopulation of switchers and estimate the following event study regression:

$$y_{iht} = \alpha_{ih} + \delta_t + \sum_{\tau} \beta_\tau D_{ih\tau} + \varepsilon_{iht} \tag{12}$$

where y_{iht} is the outcome of interest for patient i in hospital h at year t. The main explanatory variables are the indicators $D_{ih\tau} = 1\{h \in \mathcal{H}_{m(is_i)}, \tau = s_i - t\}$, where $\mathcal{H}_{m(is_i)}$ is the set of hospitals integrated with the chosen insurer, and s_i is the date at which patient i switched to the chosen insurer. Each dummy variable indicates whether hospital h was integrated to patient's chosen insurer τ periods before year t. The coefficients of interest are β_τ, which measure the effect of change in the vertically integrated status on different outcomes of interest τ years after the patient switched insurers. This equation includes both patient-hospital fixed effects α_{ih} to control for differences in outcomes across hospitals that are constant through time; and time fixed effects δ_t to control for differences in outcomes across time that are constant across patients and hospitals. The coefficient in the year before the patient switches is normalized to zero.

Having a hospital become integrated within the patient's choice set is correlated with hospital choices. Figure 1 displays results from estimating equation (12) for two outcomes. Figure 1-a shows that on the year in which the patient switches to insurers, the probability of choosing a hos-

[17] For example, vertical integration in the healthcare industry could arguably trigger managerial synergies and other increasing economies of scale and scope.

pital integrated with the new insurer is almost ten percent higher than the previous year. Second, Figure 1-b shows that expenditure in hospitals integrated to the new insurer chosen by the patient increases by more than $300 on the year of the switch relative to the previous year. Both effects remain in place two years after the patient switches insurers.

These results should be interpreted with caution for two reasons. First, it might be the case that patients switched insurers precisely to have better access to the vertically integrated hospitals of their insurer of choice. Second, the magnitude of the coefficients does not imply that the number of hospital admissions or the expenditure increase. In fact, our findings may merely reflect reassignment of admissions or expenditure from non-integrated to integrated hospitals. Finally, this analysis does not determine the aspect of the chosen insurance plan that drives changes in hospital choice, which could either be network structure, changes in prices faced by the policyholder or other. All in all, we interpret these findings as that there is a correlation between having an integrated hospital in the choice set and choosing that hospital.

4 Estimation of the Model

In this section, we describe the estimation of the model presented in section 2. The objective of the exercise is to recover the relevant primitives of the model in order to implement a counterfactual analysis to assess equilibrium and welfare effects of vertical integration. In particular, the objects of interest are preferences over insurance plans and hospitals, hospital costs and bargaining weights. In the estimation we combine the advantages of our rich data and setting with a number of assumptions we adopt for tractability.

The estimation procedure follows sequential steps in which we subsequently recover different components of the model. In the first step, we estimate negotiated prices, resource intensity weights and health risk. In the second and third steps, we use discrete choice models to estimate demand for hospitals and insurance plans, respectively. Finally, in the fourth step we estimate hospital marginal costs and bargaining weights exploiting moment conditions implied by our model. Each step employs estimates from previous steps, which determines the order of the estimation procedure.

4.1 Negotiated Prices, Resource Intensity Weights and Health Risk

While our data contain hospital prices for each admission, we construct an additional set of prices for our empirical applications. There are conceptual and empirical reasons to proceed in this way. The first reason for this is that our bargaining model operates over a scalar price rather than a vector. This feature is common to many bargaining models (Horn and Wolinsky, 1988; Gowrisankaran et al., 2015; Ho and Lee, 2017b) and allows to flexibly compute heterogeneous prices across medical conditions. Second, the hospital choice model we estimate requires prices for all the combinations of diagnoses, hospitals, insurers, and plans in the market, but we only observe prices from the actual admissions. Hence we estimate prices to impute in those unobserved combinations in the data and to construct the full choice sets for consumers in plans with little utilization or few enrollees.[18]

To estimate unobserved admission prices, we decompose observed hospital prices for each insurer-hospital combination into a scalar negotiated price specific to that combination and a resource intensity weight. We denote the negotiated price between insurer m and hospital h at time t by p_{mht} and the resource intensity weight by $\omega_{\kappa(i)d}$. Resource intensity weights vary across diagnosis d and consumer type $\kappa(i)$. In particular, we assume that observed prices are given by $\rho_{ihmdt} = \omega_{\kappa(i)d} p_{mht} e^{\varepsilon_{imhdt}}$, where ε_{imhdt} is an iid mean zero shock to the price of an admission. This shock is unobservable to firms at the negotiating stage of the game, and only becomes observable when the patient receives healthcare services. This formulation is similar to that in Gowrisankaran et al. (2015) and Ho and Lee (2017b), who follow the form adopted by the Center for Medicaid and Medicare Services (CMS) of reimbursing providers on the basis of DRG weights.

The estimating equation we utilize to recover negotiated prices and resource intensity weights is:

$$\log \rho_{ihmdt} = \log \omega_{\kappa(i)d} + \log p_{mht} + \varepsilon_{ihmdt} \tag{13}$$

where $\kappa(i)$ denotes the gender-age combination of the consumer. As weights are relevant only up to scale, we normalize one of them to unity. To fully leverage the information contained in the data we use the normalized condition to difference out negotiate prices and estimate weights using diagnosis-consumer group fixed effects. Recovering negotiated prices is then a direct evaluation of the previous equation, using estimates for weights. Appendix A.2 discusses this estimation in further detail.

Table A.1 displays estimated weights, while estimated prices are compared to actual prices in Figure A.1. For the rest of the paper, we denote hospital prices for a given insurer, diagnosis and consumer type by $p_{jhdt} = \omega_{\kappa(i)d} p_{mhd}$, where j denotes a plan offered by insurer m in which consumer i is enrolled. As explained below, plans are consumer-type specific hence j captures both the insurer m and the consumer type $\kappa(i)$.

The specification we adopt for the estimation of negotiated prices and resource intensity weights in equation (13) has relevant implications. First, the assumption that weights are not hospital-specific implies that efficiency can only be priced on average. This means that a hospital that specializes in a particular set of health conditions cannot charge differentially higher or lower prices in those specific conditions only. As the set of hospitals we focus on are large general hospitals, we believe this loss of generality is limited. Second, we assume that weights are common knowledge, which seems appropriate in a mature market like the one we study. This is also the reason why we

[18]For consistency, we use imputed prices for all consumers when estimating the hospital demand. Recent papers in the literature have adopted a similar approach (e.g. Cooper et al. 2015; Curto et al. 2017).

label the multipliers as resource intensity weights, as we model them as a common scale that maps average hospital resource utilization for each condition. Finally, this assumption restricts the way prices change over time, as weights are time invariant. We are not aware of any significant technological change in inpatient care during our sample period that might cause significant variation over time of the distribution of weights. Nevertheless, it is worth pointing out that this functional form does not capture all variation in observed prices. Our coarse definition of diagnoses is what mostly determines the extent of fit between predicted and actual prices. Given that the focus of this paper resides mostly on the supply side, it appears to be a justifiable restriction.

In addition to negotiated prices and resource intensity weights, we estimate admission probabilities. These probabilities are used to compute the distribution of insurer costs, hospital revenues, and consumer expected utility. We use a frequency estimator for the population of policyholders in order to estimate admission probabilities. We allow for heterogeneity across diagnoses, patient gender and age. We assume that admission probabilities are constant through time throughout our sample period. Table A.2 shows estimated probabilities by diagnosis and consumer group.

4.2 Demand for Healthcare

To evaluate how vertical integration affects the way consumers choose hospitals, and therefore the value insurance should assign to them, we need a model of healthcare demand. We proceed by specifying a model of hospital choice conditional on the diagnosis and insurance plan of the patient. In this line, a consumer who faces some medical condition chooses a healthcare provider from the set of hospitals available in his plan network. We model this discrete choice as depending on the out-of-pocket expenses of the treatment and on distance to hospitals. Moreover, we control for unobserved preferences over hospitals and allow for observable heterogeneity in preferences.

Let the utility of consumer i of choosing hospital h under insurance plan j for diagnosis d be given by:

$$u_{ijhd}^{H} = \alpha_i^H c_{hj} p_{jhd} + \beta_v v_{ih} + \delta_{h\kappa(i)d}^{H} + \varepsilon_{ijhd}$$

where $\kappa(i)$ and p_{jhd} are the consumer type and weighted negotiated price described in the previous section; c_{hj} is the coinsurance rate faced by the consumer at hospital h given his plan choice j; and v_{ih} is the distance from the consumer's residence to hospital h. Additionally, $\delta_{h\kappa(i)d}^{H}$ is the mean utility of hospital h from attributes other than price and distance for consumers of type $\kappa(i)$ under diagnosis d, which captures unobserved hospital attributes. Finally, ε_{imhd} is an idiosyncratic preference shock assumed to follow an iid T1EV distribution.

When estimating the model, we allow consumers to choose among the main hospitals in the market, as described in section 3.2.1. However, consumers also have the outside option of choosing a hospital from the public system. We specify the utility of this outside option as:

$$u^H_{ij0d} = \alpha^H_i c_{j0} p_{j0d} + \vartheta_{l(i)} + \varepsilon^H_{ij0d}$$

where p_{j0d} is the price of the public option and $\vartheta_{l(i)}$ is a county fixed effect to account for heterogeneity in the outside option across consumer locations in the market.

Assuming ε^H_{ij0d} is an iid T1EV preference shock, this utility function yields the following choice probability conditional on diagnosis d and insurance plan j:

$$\sigma^H_{ijh|d} = \frac{\exp(\alpha^H_i (c_{hj} p_{jhd} - c_{j0} p_{j0d}) + \beta_v v_{ij} + \delta^H_{h\kappa(i)d} - \vartheta_{l(i)})}{1 + \sum_{k \in \mathcal{H}} \exp(\alpha^H_i (c_{jk} p_{jkd} - c_{j0} p_{j0d}) + \beta_v v_{ik} + \delta^H_{k\kappa(i)d} - \vartheta_{l(i)})}$$

In our specification, we allow for heterogeneity in price sensitivity as follows:

$$\alpha^H_i = D'_{age,i} \alpha^H_{age} + D'_{HH,i} \alpha^H_{HH} + \alpha^H_{income} income_i \tag{14}$$

where $D_{age,i}$ and $D_{HH,i}$ are vectors of indicators for the age and household composition of the consumer, respectively. We construct bins for age groups consistent with the definitions of $\kappa(i)$ and let household characteristics indicate the consumer gender, marital status, and whether she has dependents.[19] Finally, $income_i$ corresponds to the taxable income of the consumer, which we observe in the data.

We estimate this model via maximum likelihood using detailed admission level data described in section 3.2.1. These data contain information on admission characteristics, patient attributes and insurance coverage of the patient. We measure the distance between households and hospitals as the linear distance between the centroid of the county of residence of the household and hospitals locations, which provides substantial variation among consumers and hospitals.

Identification There are three relevant threats for identification of the coefficients of interest. First, the potential correlation between healthcare services prices and unobservable attributes of hospitals in the market, $\delta^H_{h\kappa(i)d}$ (e.g., quality). If the latter is not controlled for, then our estimates of price sensitivity would suffer from the classical endogeneity issues of demand estimation, as they would capture preferences for those unobserved attributes. We deal with this concern by using predicted prices as estimated in the previous section for demand estimation, limiting the correlation between hospital prices and unobserved hospital characteristics at the insurer level only. To tackle this remaining endogeneity concern we exploit our detailed individual data on hospital choices to include a rich set of fixed effects in the estimation which control for unobserved

[19]For estimation, we treat single male as the base category and do not include it in the regression. In that specification, coefficients on age group dummies measure price sensitivity for single males, while dummies for single female and consumers with dependents are shifters to coefficients on age group dummies.

hospital attributes.[20] Second, consumers location in the market could be correlated with hospital location and unobserved attributes. Given that options for outpatient treatment are broader and mostly different from our hospital sample, and that inpatient events are fairly rare in a consumer lifetime, we assume that the location of consumers residences is exogenous to the unobserved hospital characteristics.[21] Third, consumer selection into insurance plans could potentially be driven by hospital unobserved attributes. Given all previously mentioned controls and that plans differ almost exclusively on coinsurance rates, we believe this to be of minimal concern.

Results The estimated parameters are presented in Table 7-A. Each column displays results for a different specification, across which we vary the level of the fixed effects added to account for unobserved hospital attributes $\delta^H_{h\kappa(i)d}$. Column 1 shows results for a model that does not include any fixed effects, while columns 2 through 6 include increasingly richer sets of fixed effects. The difference between column 1 and the rest is notorious: price coefficients in α^H_0 more than double after sequentially adding fixed effects across patient types. This pattern suggests that not accounting for unobserved hospital attributes significantly attenuates estimated price sensitivity. For the remainder of the paper, we adopt estimates from column 6, a specification that includes the richest set of fixed effects by allowing for $\delta^H_{h\kappa(i)d}$ to vary across combinations of hospital, diagnosis and age group of the consumer. Overall, our estimates show that consumers are price sensitive, with young single males and lower-income consumers being more so. Additionally, we estimate consumers to value hospitals closer to their residence. Table 7-B summarizes implied price elasticities. Our preferred specification in column 6 yields average and median price elasticities of -1.41 and -1.1. Finally, Figure 2-a shows that most of the consumers display elasticities between 0 and -6.

4.3 Demand for Insurance

Consumers choose insurance plans before the realization of health risk. We develop a model of insurance plan choice in the private market. Households choose among available plans based on plan premiums, hospital networks, and the quality and costs of healthcare in the event of different diagnoses. We use our estimates of hospital demand to construct the expected utility from the hospital network provided by each insurance plan. Under the assumptions stated above, the expected utility to individual i from the hospital network provided by insurance plan j is (up to a constant) given by:

$$EU^H_{ij} = \sum_{d\in\mathcal{D}} \gamma_{d\kappa(i)} \log \sum_{h\in\mathcal{H}} \exp(\alpha^H_i(c_{hj}p_{jhd} - c_{j0}p_{j0d}) + \beta_v v_{ih} + \delta^H_{h\kappa(i)d} - \vartheta_i) \tag{15}$$

[20] In estimation, we control for unobserved characteristics at the level of hospital and consumer demographics, which implies that for hospital prices to be endogenous, it would need to be correlated with variation in hospital unobservables across insurers conditional on consumer demographics and plan characteristics, which we consider unlikely.

[21] Additionally, the location decision of hospitals is likely to be less flexible as access routes for ambulances and permits are likely to be predominant in the decision.

where $\gamma_{d\kappa(i)}$ is the probability of consumer type $\kappa(i)$ of being diagnosed with condition d.

The decisionmaker in the model is the household head, who takes into account the expected utility derived from the insurance for all family members. Implicit in this construction is the assumption that all household members are equally weighted, although we allow for the coefficient on the sum of expected utilities to vary with household compositions. We let the utility household f derives from choosing insurance plan j to be:

$$u_{fj}^M = \alpha_f^M \phi_{fj} + \beta_f \sum_{i \in f} EU_{ij}^H + \delta_{m(j)\kappa(f)}^M + \varepsilon_{fj}^M \tag{16}$$

where ϕ_{fj} is the premium charged to household f if choosing plan j, $\delta_{m(j)\kappa(f)}^M$ is the mean utility that households of type $\kappa(f)$ obtain from plan attributes other than premiums and the access to healthcare services (e.g., quality of customer service), and ε_{fj}^M is an idiosyncratic preference shock that follows an iid T1EV distribution.[22]. Under these assumptions, the choice probability of plan m by household f, conditional on being enrolled with a private insurer is given by:

$$\sigma_{fj}^M = \frac{\exp(\alpha_f^M \phi_{fj} + \beta_f \sum_{i \in f} EU_{ij}^H + \delta_{m(j)\kappa(f)}^M)}{\sum_{k \in \mathcal{J}} \exp(\alpha_f^M \phi_{fk} + \beta_f \sum_{i \in f} EU_{ik}^H + \delta_{m(k)\kappa(f)}^M)}$$

We estimate the plan choice model by maximum likelihood. We allow for observable heterogeneity on the price coefficient and the coefficient for the expected utility of hospital networks. Our estimation uses the same structure of observable heterogeneity considered in the hospital demand specified in equation (14), and allows preferences to vary according to age, household composition and household income. As discussed in section 3.2.1, we reduce the size of the choice sets due to the large number of plans and consumers contained in our plan choice and contract-level data. Hence, we estimate the model using the five most populous insurance plans for each time, insurer and consumer-type combination. Thus, we include up to 40 plans per insurer-year and let consumers choose among the 30 most popular plans offered in that market each year.[23] Appendix A.3 details the exact construction of the plan choice sets and the definition of insurance plan in this context.

Identification A first concern with this strategy is that premiums could be correlated with unobserved plan attributes. Similar to recent literature on health insurance markets (e.g. Gowrisankaran et al. 2015; Ho and Lee 2017b), we rely on our rich set of observable characteristics and on fixed effects to attenuate the potential correlation between premiums and specific time-varying plan

[22]Recall that consumers must spend 7% of their taxable income (up to a cap) on health insurance as discussed in Section 3.1. However, as this amount applies equally to all choices, it cancels out and is therefore omitted from the equation above

[23]We also allow consumers to re-enroll in their current insurance even if it was no longer offered, given that guaranteed renewability is in place in the market by regulation.

unobservables. Moreover, adding expected utility from the plan as an additional plan attribute also alleviates this concern by controlling for potential unobservables. In line with this argument, the price coefficient estimates presented in Table 8-A are indeed sensitive to the inclusion of the insurer fixed effect. As such, our preferred specification includes insurer fixed effects. A second concern with this strategy is that expected utility of the plan could also be correlated with plan unobservable attributes. Adding fixed effects in estimation alleviates this concern, under the same arguments as it does for premiums. Moreover, a large part of the variation in expected utility from the plan is driven by arguably exogenous variation in hospital and households locations, which also limits endogeneity concerns.

Results Table 8-A shows the estimates of the plan choice model. Preference coefficients have the expected signs and display an interesting pattern of heterogeneity. We find that younger households, those composed by single females, and those with dependents are more price-sensitive. In contrast, wealthier households are less price sensitive. As expected, we estimate that households have a preference for plans offering a higher expected utility from healthcare services. Table 8-B shows that estimated premium elasticities are mostly negative, with an average elasticity of -1.17. Figure 2-b displays the heterogeneity in estimated premium elasticities, with most of them being between -6 and 0.

4.4 Marginal Costs and Bargaining Weights

We now turn to the estimation of the supply side parameters of the model. The structural parameters of our model are hospital marginal costs and bargaining weights in the negotiation between insurers and hospitals. In this section, we describe how we estimate both sets of parameters and present results for them. Estimation of these parameters utilizes estimates of negotiated prices, hospital demand and insurance demand introduced in previous sections. In particular, we condition on the vector of negotiated prices $\boldsymbol{p}$, which are considered as *observed* for estimation of marginal costs and bargaining weights. The estimation procedure builds upon the optimality conditions for insurer premiums and negotiated hospital prices in equations (10) and (7) respectively to propose a GMM estimator.

First, the conditions for optimal premium setting given by equation (10) provide a fixed-point problem of the form $\boldsymbol{\phi}^* = \Phi(\boldsymbol{\phi}^*, \boldsymbol{p}, \boldsymbol{c})$, where $\boldsymbol{p}$ is the vector of negotiated prices and $\boldsymbol{c}$ is the vector of hospital marginal costs.[24] Conditional on negotiated prices and a vector of marginal costs, we can thus solve for the optimal vector of premiums, which we denote $\boldsymbol{\phi}^*(\boldsymbol{c})$.

Second, the solution to the bargaining problem allows us to back up the hospital marginal costs. We rewrite equation (7) as a function of marginal costs $\boldsymbol{c}$, negotiated prices $\boldsymbol{p}$, plan premiums

[24] As pointed out in section 2, marginal costs enter in first order conditions for premium setting due to the vertical integration between some insurers and hospitals in the market.

$\boldsymbol{\phi}$, the vector of bargaining weights $\boldsymbol{\lambda}$ as:

$$\boldsymbol{c} = \boldsymbol{p} + (\Omega(\boldsymbol{\phi}, \boldsymbol{c}) + \Lambda(\boldsymbol{\phi}, \boldsymbol{c}, \boldsymbol{\lambda}))^{-1}(D^H(\boldsymbol{\phi}) + \Gamma(\boldsymbol{\phi}, \boldsymbol{c}, \boldsymbol{\lambda})) \tag{17}$$

and denote the solution to the fixed point problem in this equation as $\boldsymbol{c}^* = C(\boldsymbol{\phi}, \boldsymbol{\lambda})$. We impose more structure on the cost function $C(\cdot)$ to improve efficiency and tractability in the estimation procedure [25]. Indeed, we assume that the marginal costs of hospitals have the following specification:

$$\boldsymbol{c} = \eta^h + \eta^t + \zeta$$

where η^h and η^t are respectively hospital and time indicators, and ζ is a random vector of mean zero cost shocks. This specification thus decomposes hospital marginal costs in year-specific, hospital-specific and random component. This projection is supported by the intuition that efficiencies per unit of treatment should be hospital specific, especially in inpatient care, as opposed to healthcare providers actively verifying the patients insurance before choosing a treatment plan.

We estimate the structural parameters of the supply side of the model using a GMM estimator that exploits the two fixed point problems introduced above. Given a positive semi-definite weighting matrix W, and a matrix of suitable instruments Z, our GMM estimates solve the following program:

$$\min_{\boldsymbol{c},\boldsymbol{\lambda},\boldsymbol{\phi}} \quad g(\zeta)' W^{-1} g(\zeta) \tag{18}$$

$$\text{s.t} \quad g(\zeta) = Z'\zeta$$

$$\boldsymbol{c} = \eta^h + \eta^t + \zeta$$

$$\boldsymbol{c} = C(\boldsymbol{\phi}, \lambda) \tag{19}$$

$$\boldsymbol{\phi} = \boldsymbol{\phi}^*(\boldsymbol{c}) \tag{20}$$

The moment conditions used in the GMM estimation correspond to the exclusion restrictions of the marginal cost residual ζ. As pointed out by Gowrisankaran et al. (2015), the program is a non-linear instrumental variables problem in which negotiated prices, implicitly in $C(\cdot)$, are endogenous as they are determined after the marginal cost error ζ is realized. To address this endogeneity concern, we need instruments Z that arguably affect negotiated prices yet are independent of marginal cost shocks. In our application, Z includes the average expected utility from the network offered by other insurers and the set of marginal cost fixed effects. Expected utility from competitors' networks affects prices as it is correlated with the degree of competition in the market in which bargaining takes place. However, they are exogenous to marginal costs faced by insurers, conditional on insurer fixed effects. These instruments are similar in spirit to instruments

[25] Notice that $C(\cdot)$ and $\Phi(\cdot)$ use estimates of hospital and insurance demand to compute outcomes in scenarios of disagreement, in which either one plan is removed from the consumers choice set or one hospital system is removed from the plan hospital network.

used by Berry et al. (1995) and Gowrisankaran et al. (2015).

We simplify the program by replacing constraints in equations (19) and (20) in the moment conditions. These constraints correspond to the set of fixed point problems that pin down the values of marginal costs and premiums conditional on bargaining weights. Therefore, the GMM problem can be rewritten as:

$$\begin{aligned} \min_{\lambda} \quad & g'W^{-1}g \\ s.t \quad & g = Z'(\boldsymbol{\eta}'\boldsymbol{\eta})^{-1}\boldsymbol{\eta}'C(\Phi(\lambda),\lambda) \end{aligned} \tag{21}$$

where $\Phi(\lambda) = \boldsymbol{\phi}^*(\boldsymbol{c}(\lambda))$.

The GMM procedure comprehends a two nested fixed point problems, one for premiums and another for marginal costs. The algorithm starts with an initial guess for λ. Next, a guess of $\boldsymbol{c}$ is created and used to solve the fixed point $\boldsymbol{\phi} = \boldsymbol{\phi}^*(\boldsymbol{c})$. Third, that value of $\boldsymbol{\phi}$ is evaluated in $C(\boldsymbol{\phi},\boldsymbol{\lambda})$ to update the value of marginal costs. These steps iterate until reaching a fixed point solution of the marginal costs and the premiums. The resulting $\boldsymbol{c} = C(\boldsymbol{\phi},\boldsymbol{\lambda})$ is used to compute $\zeta = (\boldsymbol{\eta}'\boldsymbol{\eta})^{-1}\boldsymbol{\eta}'C(\Phi(\lambda),\lambda)$ and calculate the objective function to inform the optimizer and update the value of the bargaining weight, $\boldsymbol{\lambda}$. The procedure is repeated until finding the bargaining weight vector that minimizes the GMM objective function. For a detailed discussion about the estimation algorithm, see appendix C.1.

Identification The identification of the bargaining weights $\boldsymbol{\lambda}$ comes from variation in negotiated prices between different hospital-insurer combinations and across time (as we have a panel of negotiations), given the assumptions that allow us to backup marginal costs using costs $C(\Phi(\lambda),\lambda)$ and premiums $\Phi(\lambda)$.

As the previous literature has emphasized, identification of bargaining weights requires additional structure. For instance, Gowrisankaran et al. (2015) and Ho and Lee (2017b) assume that the bargaining weights are insurer specific only[26]. In our estimation we let bargaining weights to be fixed for each pair of hospital systems and insurers, as the identification comes from the variations in negotiated prices within system-insurer over time that is not common to all negotiations. As a concrete example, holding all else fixed, a change in the demand for hospitals of system s from insurer m between year t_1 and t_2 implies a specific change in negotiated prices in the model. Adjustments in the bargaining weights minimize systematic differences between the predicted and observed demands. Analogously, as our estimator determines hospital markups (through marginal costs), unexplained markup variation across time identify the bargaining weights.

We acknowledge the possibility of multiple solutions to the two nested fixed point problems we have to solve to find bargaining weights, $\boldsymbol{\lambda}$, and marginal costs, $\boldsymbol{c}$. However, we explore dif-

[26]It's worth noting that these papers use cross-sectional data and therefore lack the time variation we exploit.

ferent starting values in the optimization procedure and, whenever we achieve convergence, we obtain similar estimates. Hence, although we have not shown uniqueness, our empirical results have been robust to this concern.

Results Table 9 summarizes our GMM estimates for bargaining weights and marginal costs. Table 9-A shows that vertically integrated hospitals achieve on average a larger fraction of the marginal surplus of relationships with insurers. Moreover, estimates also show that non-integrated insurers have lower bargaining power when negotiating with vertically integrated hospitals than when negotiating with non-integrated hospitals. Finally, hospitals maintain this advantage even when negotiating with a competing holding's insurer.

Table 9-B displays estimates of marginal costs, negotiated prices and hospital mark-ups. Our estimates imply that vertically integrated hospitals have significantly lower marginal costs than non-integrated ones. It is important to clarify that our model is silent regarding the causality of this result. It might be that vertical integration lowers hospital marginal costs, or it could be that insurers integrate with particularly efficient hospitals to obtain higher mark-ups.[27] Our estimates imply that despite having lower negotiated prices on average, differences in costs are large enough as to allow integrated hospitals to obtain higher mark-ups than non-integrated hospitals. We estimate that hospital mark-ups are on average 40 percent, but reach 49 percent for integrated hospitals and 31 for non-integrated hospitals. We see this as a reflection of the market power held by vertically integrated structures, as they strongly leverage this feature to obtain better results in the bargaining stage. Our counterfactuals in the next section explore different scenarios of cost efficiencies to test the robustness of our welfare calculations.[28]

5 Equilibrium Effects of Vertical Integration

We study equilibrium effects of banning vertical integration between insurers and hospitals in the health market. We use our estimated model to solve for equilibrium behavior of all market participants under the scenario in which vertically integrated firms are exogenously broken up. This change in the market structure induces changes in hospital negotiated prices and plan premiums. Consumers react to these price changes in both markets by adjusting their hospital and insurance demand. We compute hospital profits, insurer profits and consumer surplus in both scenarios in order to measure welfare effects of vertical integration in this market.

[27] As discussed in section 3.2.2, it is important to note that two non-vertically integrated hospitals are essentially outliers in terms of prices, as they charge remarkably higher prices than competitors in the market. That difference is likely correlated with difference in quality and thus cost. In that lines, having those two hospitals among non-integrated hospitals may be what partly drives differences in estimates marginal cost across these groups.

[28] Notice that we do not identify fixed and sunk costs in the hospital industry or the health insurance sector. Therefore, we do not make statements regarding the overall profitability of the health sector. As these costs are not contingent on agreement with a particular partner, fixed and sunk costs in the industry are irrelevant for the bargaining stage of the game.

5.1 Simulation details

The objective of the exercise is to measure the effects of vertical integration, keeping relevant primitives of the model fixed. In particular, we keep preferences over hospitals and insurers, most of the bargaining weights and hospital marginal costs fixed across both scenarios.

The only change we allow for in these primitives is an adjustment in bargaining weights of firms that were integrated under the baseline market structure, as those firms engage in bargaining as independent firms in the counterfactual scenario. We set bargaining weights to 0.5 in these cases. Hence, in our simulated scenario, previously integrated firms will bargain with the same relative bargaining power. We consider this value a natural starting position given that negotiators are coming from the same holding, and also because our estimates are overall around this value.

Additionally, we keep hospital marginal costs constant across both scenarios. This assumption is consistent with the view that inpatient marginal costs in hospitals are, in principle, determined by efficiency and productivity that is inherent to each healthcare provider. However, we explore the role that potential cost efficiencies caused by vertical integration could play in our calculations in section 5.3 below.

5.2 Results

Table 10 displays results from counterfactual simulations of banning vertical integration. We start by discussing our findings for hospitals in Table 10-A. The first two rows show results for hospitals integrated at the baseline. We find that those hospitals would decrease negotiated prices with non-integrated insurers by 9.7 percent, while negotiated prices with their integrated partners at the baseline would essentially remain the same in equilibrium once vertical integration is banned. These results are related to the *worsening rivals network effect*, as it suggests that vertically integrated firms negotiate higher prices with non-integrated insurers to steer demand into their hospitals and insurers, a behavior predicted by our model. As a result of this change in relative prices, the market share of hospitals integrated at the baseline with independent insurers increases by a sizable 13.5 percent and the share with the formerly integrated insurer decreases by 6.4 percent.

Table 10-A also shows that non-integrated hospitals would lose profits on average, as they now bargain in a more competitive and less distorted market, with cheaper competing hospitals. Nevertheless, the dispersion in profits is large, with some non-integrated providers substantially benefiting from this new scenario. Finally, we find evidence suggestive of *foreclosure effects* in that non-integrated hospitals decrease their prices to vertically integrated insurers by almost 5% and increase their shares from these insurers by more than 7%. These findings are consistent with the idea that integrated insurers have incentives to negotiate relatively higher prices with non-integrated hospitals to steer patients towards their integrated hospitals.

Table 10-B presents results for the insurance market. We find that vertically integrated insur-

ers decrease their plan premiums by 11 percent on average, primarily because of pass-through of lower payments to hospitals, which decrease by 2 percent due to lower hospital prices. The additional change accounts for the re-optimization of the insurers who no longer take into account hospital profits for premium setting.[29] Overall, the results for the insurance market indicate that in the absence of vertical integration, insurers may decrease premiums and obtain lower profits. These premium reductions suggest that double marginalization was a second order concern in this market.

Table 10-C shows the effect of eliminating vertical integration on consumer surplus. Consumers obtain benefits from the insurance and healthcare markets. However, in our nested specification of demand, utility from insurance plans captures benefits from both markets by including the expected utility of hospital networks as a plan attribute, and thus we focus on insurance demand for computing effects on consumer surplus.[30] We find that consumers from all demographic groups benefit from banning vertical integration, with increases in consumer surplus that range between 0.5 and 1.5 percent relative to that under the baseline market structure. Heterogeneity in estimated preferences discussed in section 4.3 induces substantial heterogeneity across consumer groups in the level of welfare effects. However, in most of the cases we find that gains on consumer surplus are on average between a fourth to a full month of premiums per year. Thus, consumers would be willing to pay such amount for banning vertical integration.

5.3 Cost Efficiencies and Vertical Integration

Vertical integration might cause cost efficiencies, as discussed in section in 3.3.2. In order to explore this margin, we evaluate how calculations for welfare effects of vertical integration would vary under a range of counterfactual hospital cost increments upon breaking up vertical linkages. The exercise essentially repeats the counterfactual simulation implemented in previous sections under alternative assumptions for hospital costs.

The first row in Table 11 shows that if vertical integration has no effect on marginal costs, then banning it would results in consumers benefiting by roughly $32 million over a year, creating a total welfare increase of $25 million. As we introduce cost efficiencies from vertical integration, welfare increases from banning it decrease. In particular, we find that under cost efficiencies of 10 percent banning vertical integration would still be welfare improving. However, we find that cost efficiencies from vertical integration of 20 percent would be more than enough to reverse this

[29] For this calculation, we compare profits that the integrated insurer obtains at baseline from the insurance market only to those it obtains in the counterfactual scenario from the same market.

[30] In particular, we use the usual log-sum formula that measures consumer surplus in demand models where preference shocks follow an iid T1EV distribution:

$$CS_f = \frac{1}{\alpha_f^M} \log \sum_{k \in \mathcal{J}} \exp(-\alpha_f^M \phi_{fk} + \beta_f \sum_{i \in f} EU_{ik}^H + \delta_{m(k)\kappa(f)}^M) + \iota$$

where ι is the Euler-Mascheroni constant.

result. Under such scenario, hospitals, insurers and consumers would be worse off in absence of vertical integration due to the loss of cost efficiencies. Figure 3 emphasizes this result and shows that the effect of banning vertical integration is decreasing in the level of cost efficiencies induced by vertical integration. This effect is driven mostly by consumer surplus. an interesting pattern that this figure shows is that the effect of banning vertical integration on hospital profits and insurer profits is mostly constant across different levels of cost efficiencies. This suggests that most cost efficiencies are passed-through to consumers in the form of lower hospital prices. This in turn explains why effects of banning vertical integration on consumer surplus are decreasing in the level of cost efficiencies.

5.4 Discussion

We have shown how banning vertical integration would affect equilibrium outcomes in the market we study. We find that hospital prices and plan premiums would likely decrease, and that welfare would increase unless there were large efficiency gains from vertical integration.

We discuss some limitations of our counterfactual exercise given by the assumptions and simplifications we have made. First, we focus on inpatient care and abstract from outpatient care. As the nature of outpatient care is significantly different, there might be additional effects arising from changes to the market structure through channels we do not study. For instance, if outpatient care was significantly affected by banning vertical integration either through lower prices or due to losses of cost efficiencies, our simulations would fail to account for the welfare implications of changes in that segment of the market. However, the market for outpatient care operates under a more competitive environment with several additional providers, and under a separate contractual structure.

Another limitation is the fact that we do not allow insurers to make adjustments along margins of insurance contract design diffrent than premiums, such as the plan menu, coinsurance rates or network structure. One could argue that in the absence of vertical integration, some plans may disappear and new plans with new characteristics can arise. In our case, insurers re-optimize in the counterfactual scenario by modifying premiums over a wide range of differentiated plans. Hence, it is possible for insurers to virtually remove certain plans by setting premiums at high enough levels. Nevertheless, it is possible that in absence of vertical integration, new plans with features not observed in our sample might dampen the losses of insurers and improve patient welfare.[31] Given the additional tools for insurers to do better in the absence of vertical integration, benefits of vertical integration might be relatively smaller than those found in our results.

Overall, our results should be taken as a first approximation of the short run implications of banning vertical integration in the inpatient care market. We believe the focus should be placed on the effects of foreclosure and worsening rivals' networks as these effects might play an important

[31]Given that the market has guaranteed renewability, any consumer plan switch must be welfare improving.

role in the antitrust analysis of vertically integrated markets as a source of distortions that may harm efficiency.

6 Conclusion

This paper studies the equilibrium effects of vertical integration between insurers and hospitals in health markets. Our paper contributes to a recent stream of research that studies equilibrium implications of competition and market structure of the healthcare and insurance markets (Gowrisankaran et al., 2015; Ho and Lee, 2017b). Moreover, it contributes to a sparse literature of empirical studies of vertical integration, where theoretical implications are ambiguous and structural work is often needed to quantify the cost and benefits of different policies (Crawford et al., 2017).

We develop a model of bargaining between hospitals and insurers, in which these players may be integrated. We identify the effects through which vertically integrated players use negotiated prices to steer demand to their related firms. In fact, we discuss how vertical integration places incentives for integrated firms to increase negotiated price with rival hospitals in order to steer demand to their hospital, and to negotiate higher prices with rival insurers in order to steer demand to their insurer. We label these novel forces *foreclosure effects* and *worsening your rival network effect*.

We estimate our model using exceptionally rich data from the Chilean health market. Almost half of the healthcare sector is vertically integrated with insurers, which provides a suitable setting for our study. Moreover, administrative data provide individual level information on hospital and insurer choices for the population of consumers in the private market. We start by estimating demand for hospitals and insurance plans. Then, we exploit moment conditions implied by our model to estimate bargaining weights and hospital marginal costs. Using our estimates, we study the equilibrium consequences of banning vertical integration. We find that firms integrated at baseline would reduce hospital prices and premiums, consistent with our theoretical predictions. Our main result is that, unless vertical integration induces relatively large hospital cost efficiencies, banning vertical integration in the health market increases overall welfare. In such scenario, while hospital and insurer profits would on average decrease, consumer surplus would increase and more than compensate such decreases.

We see clear avenues to extend and improve our work. First, we plan to extend the analysis to include potential switchers from the public sector, thus allowing us to study potential effects along the extensive margin of insurance choice. Changes in the population of enrollees in the private sector may affect our welfare calculations. Second, endogenizing the choice of other dimensions of contract design is a natural extension to our current model, where insurers are only allowed to adjust premiums. A third extension would be to include outpatient care in the analysis, which represents an relevant source of expected costs for the insurer and a relevant dimension for plan choice for consumers.

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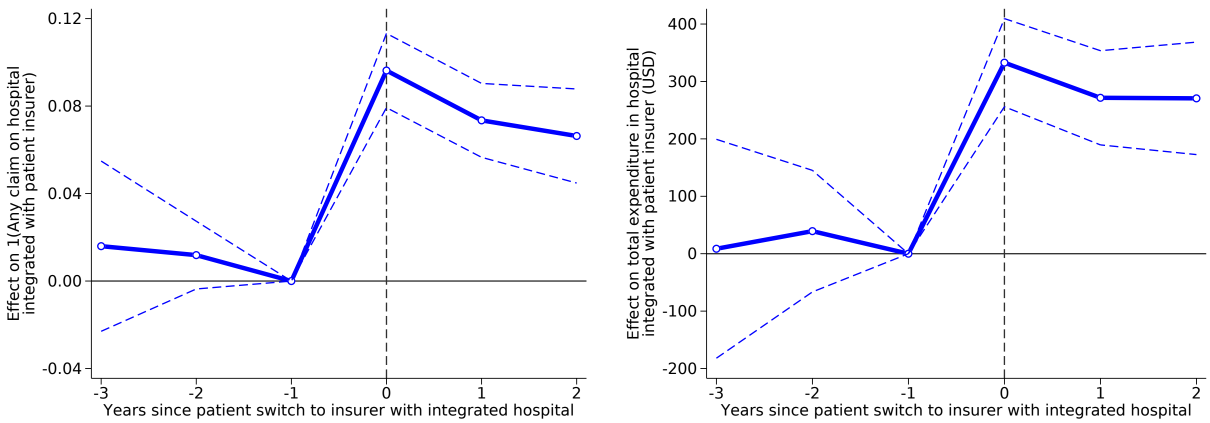
Figure 1: Relationship between integration and hospital choices

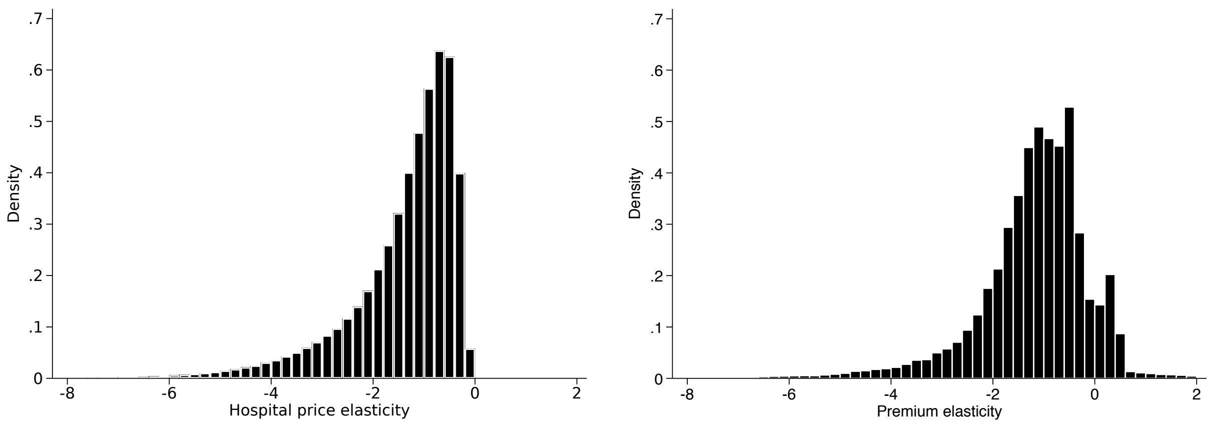


(a) Any claims in integrated hospital

(b) Expenditure in integrated hospital

Notes: This figure displays event study estimates from Equation (12). Each dot is a coefficient estimate for a year around patients switching insurer. Dashed lines indicate 95 percent confidence intervals.

Figure 2: Healthcare price elasticities and plan premium elasticities

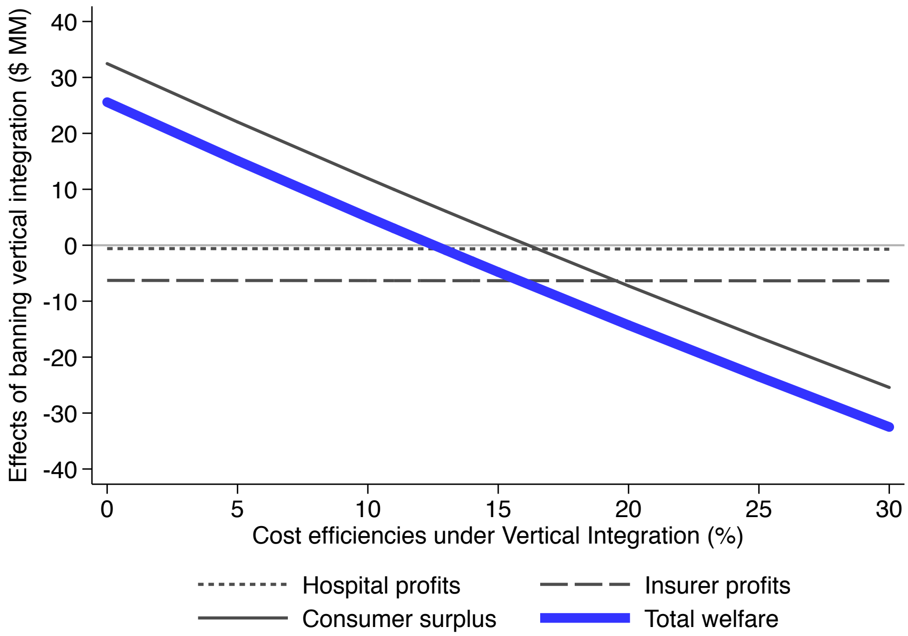


(a) Hospital price elasticity

(b) Plan premium elasticity

Notes: This figure displays histograms of estimated price elasticities for healthcare services and premium elasticities for plans. Estimates for the former come from a logit demand model estimated across diagnosis. Individual elasticities are calculated as $\hat{\eta}_{ij} = \hat{\alpha}^H c_m p_{jm}(1 - \hat{s}_{ij})$, where $\hat{s}_{ij}$ is the predicted choice probability of hospital j by consumer i. Estimated coefficients used for these calculations are those from a model with hospital-diagnosis-age fixed effects, as in column 6 of Table 7. Estimates for the latter come a logit demand model for plans. Individual elasticities are calculated as $\hat{\eta}_{fj} = \hat{\alpha}^M_f \phi_{fj}(1 - \hat{s}_{fj})$, where $\hat{s}_{fj}$ is the predicted choice probability of plan j by household f. Estimated coefficients used for these calculations are those from a model with insurer fixed effects, as in column 2 of Table 8.

Figure 3: Healthcare price elasticities and plan premium elasticities



Notes: This figure shows the effect of banning vertical integration on equilibrium outcomes for different levels of cost efficiencies due to vertical integration in hospitals integrated at baseline. Gray lines show effects on hospital profits, insurer profits and consumer surplus. The blue line shows the aggregate effect on welfare.

Table 1: Vertical Relationships between Insurers and Hospitals

Insurer	Hospital
Banmedica/Vida Tres	Clinica Santa Maria Clinica Davila Clinica Vespucio
Consalud	Clinica Tabancura Clinica Avansalud Clinica Bicentenario

Notes: If the controller holding owns more than 50 percent the healthcare provider and more than 98 percent of the insurer, we consider both firms to be vertically integrated. The list is incomplete as the ownership information is only partially known. Source: Copetta (2013).

Table 2: Descriptive Statistics for Plans Dataset

	Panel A - Policyholders attributes					
Variable	N	Mean	SD	p10	p50	p90
Paid premium	1,104,344	0.16	0.09	0.08	0.14	0.27
Policyholder age	1,104,344	40.38	13.41	26.00	37.00	60.00
Policyholder income	1,104,344	1.61	1.13	0.00	1.54	3.03
Single male	1,104,344	0.34				
Single female	1,104,344	0.22				
Has dependents	1,104,344	0.43				

	Panel B - Plan attributes					
Attribute	N	Mean	SD	p10	p50	p90
Inpatient coverage rate	4,358	85.35	23.67	70.00	90.00	100.00
Outpatient coverage rate	4,358	71.83	21.73	60.00	70.00	90.00
Has coverage cap	4,358	0.87				
Has preferential provider	4,358	0.86				

	Panel C - Insurer market shares and premiums					
	Market	Paid premium				
Insurer	share	Mean	SD	p10	p50	p90
Banmédica	20.42	0.15	0.09	0.07	0.12	0.26
Colmena	17.11	0.19	0.11	0.11	0.17	0.32
Consalud	13.72	0.14	0.07	0.06	0.12	0.23
Cruz Blanca	19.63	0.16	0.08	0.08	0.14	0.26
Masvida	25.50	0.15	0.06	0.09	0.14	0.24
Vida Tres	3.63	0.27	0.16	0.13	0.21	0.47

Notes: This table displays descriptive statistics for our estimating plans dataset. Panel A displays statistics across all policyholders in the sample. Panel B displays statistics for plan attributes across al plans in the sample. Panel C displays market shares and premiums paid by policyholders for each insurer in the market. All prices are measured in thousands of U.S. dollars for Dec, 2014.

Table 3: Descriptive Statistics for Admissions Dataset

	Panel A - Admission attributes					
Variable	N	Mean	SD	p10	p50	p90
Full price	641,392	3.79	6.21	0.08	2.25	8.61
Copayment	641,392	1.22	3.03	0.00	0.33	3.25
Coverage	641,392	3.05	4.91	0.34	1.94	6.29
Preferential hospital	641,392	0.38	0.49	0.00	0.00	1.00
Patient age	641,392	37.43	19.44	6.00	37.00	64.00
Policyholder income	641,392	1.88	1.22	0.00	1.95	2.95
Single male	641,392	0.14				
Single female	641,392	0.17				
Has dependents	641,392	0.69				

	Panel B - Hospital market shares and prices					
	Market	Full price				
Hospital	share	Mean	SD	p10	p50	p90
Clínica Alemana	13.03	6.80	7.91	0.89	4.96	13.50
Clínica Avansalud	4.20	2.70	3.39	0.81	2.04	4.95
Clínica Bicentenario	3.82	3.13	4.98	0.75	2.14	6.30
Clínica Dávila	10.98	3.38	5.48	0.63	2.12	6.22
Clínica Indisa	9.87	4.32	4.62	1.18	3.61	7.26
Clínica Las Condes	7.51	8.09	10.39	1.39	5.59	16.56
Clínica Santa María	12.23	5.01	6.71	0.87	3.48	9.69
Clínica Tabancura	2.79	4.37	4.92	0.95	2.99	9.39
Clínica UC	1.37	4.28	6.83	0.32	2.77	8.70
Clínica UC San Carlos	2.34	5.07	5.25	1.22	4.02	8.79
Clínica Vespucio	2.67	2.91	3.57	0.95	2.21	5.16
Hospital U. de Chile	5.14	2.98	5.91	0.58	1.89	5.85
Other	24.05	0.52	1.25	0.01	0.13	1.58

Notes: This table displays descriptive statistics for our estimating admissions dataset. Only admissions on the hospitals in the sample are considered for these statistics. Panel A displays statistics across all hospitals in the sample. Panel B displays statistics for market shares and full prices by hospital. All prices are measured in thousands of U.S. dollars for Dec, 2014.

Table 4: Share of Hospital Admissions by Patient Insurer

Hospital	Insurer						VI share
	Banmédica	Colmena	Consalud	Cruz Blanca	Masvida	Vida Tres	
Clínica Alemana	15.24	37.53	5.56	24.34	7.57	9.77	0.00
Clínica Avansalud	10.05	10.34	52.62	22.26	3.12	1.61	52.62
Clínica Bicentenario	6.30	6.55	63.17	21.80	1.89	0.29	63.17
Clínica Dávila	67.89	5.21	12.24	9.43	1.86	3.38	71.27
Clínica Indisa	11.57	25.46	8.46	24.28	27.61	2.62	0.00
Clínica Las Condes	17.98	37.42	5.33	21.12	9.06	9.09	0.00
Clínica Santa María	44.73	17.88	4.59	17.45	6.14	9.21	53.94
Clínica Tabancura	12.14	17.25	43.38	18.71	4.57	3.95	43.38
Clínica UC	0.43	11.13	22.36	65.14	0.78	0.15	0.00
Clínica UC San Carlos	7.84	64.03	3.20	15.49	5.90	3.54	64.03
Clínica Vespucio	63.30	6.30	16.64	9.63	2.51	1.62	64.92
Hospital U. de Chile	21.60	9.34	46.20	19.78	1.81	1.26	0.00

Notes: This table displays a breakdown of the share of admissions in each hospital in our dataset by the insurer of the patient. Shares from integrated insurers are displayed in red. The last column displays the share of admissions each hospital receives from integrated insurers.

Table 5: Reduced Form Estimates of Vertical Integration on Payments

	(1)	(2)	(3)	(4)	(5)
	Panel A - OLS estimates on log(Total bill)				
Vertically integrated	0.278	0.004	0.008	-0.035**	-0.040**
	(0.198)	(0.023)	(0.023)	(0.016)	(0.017)
Observations	639,080	639,080	639,080	639,080	639,080
R-squared	0.018	0.600	0.631	0.635	0.642
	Panel B - OLS estimates on log(Patient copayment)				
Vertically integrated	-0.160**	-0.066**	-0.067**	-0.182***	-0.182***
	(0.080)	(0.031)	(0.032)	(0.031)	(0.030)
Observations	646,692	646,692	646,692	646,692	646,692
R-squared	0.011	0.178	0.204	0.303	0.314
	Panel C - OLS estimates on log(Insurer coverage)				
Vertically integrated	0.037	0.040*	0.045**	0.088***	0.081***
	(0.088)	(0.022)	(0.021)	(0.029)	(0.030)
Observations	646,692	646,692	646,692	646,692	646,692
R-squared	0.001	0.117	0.173	0.221	0.233
Hospital FEs	N	Y	Y	Y	Y
Diagnosis FEs	N	N	Y	Y	Y
Insurer controls	N	N	N	Y	Y
Patient controls	N	N	N	N	Y

Notes: This table displays results from estimating Equation (11) using logged total bill, patient copayment, insurance coverage and number of claims per admission as dependent variables. Each column includes a different set of control variables. The insurer controls included insurer fixed effect, plan premium, coinsurance rate for inpatient and outpatient admissions, and dummies for whether the plan has a coverage cap and a preferential provider. Patient controls include gender, age, income, number of dependents, an indicator for independent worker and fixed effects by county of residence. Standard errors are clustered by insurer-hospital and displayed in parentheses. *** $p<0.01$, ** $p<0.05$, * $p<0.1$.

Table 6: Reduced Form Estimates of Vertical Integration on Medical Outcomes

	(1)	(2)	(3)	(4)	(5)
	Panel A - OLS estimates on log(Number of claims)				
Vertically integrated	0.217**	-0.065*	-0.025	0.062	0.056
	(0.092)	(0.039)	(0.033)	(0.062)	(0.062)
Observations	646,692	646,692	646,692	646,692	646,692
R-squared	0.009	0.108	0.234	0.254	0.256
Hospital FEs	N	Y	Y	Y	Y
Diagnosis FEs	N	N	Y	Y	Y
Insurer controls	N	N	N	Y	Y
Patient controls	N	N	N	N	Y
	Panel B - Probit estimates on discretional claims				
	C-Section	Ultrasound	Hemogram	Chest X-ray	Imaging
Vertically integrated	-0.043**	-0.388	-0.101***	0.084***	0.029
	(0.019)	(0.283)	(0.015)	(0.022)	(0.051)
Observations	76,752	55,852	119,959	63,036	62,920
Hospital FEs	Y	Y	Y	Y	Y
Diagnosis FEs	Y	Y	Y	Y	Y
Insurer controls	Y	Y	Y	Y	Y
Patient controls	Y	Y	Y	Y	Y

Notes: Panel A shows OLS results from estimating Equation (11) using number of claims per admission as dependent variable. Each column in Panel A includes a different set of control variables. Standard errors are clustered by insurer-hospital and displayed in parentheses. Panel B shows probit estimates of vertical integration indicator on the probability of certain claims. Each column in Panel B consider a different claim as a dependent variable. The considered special claims strongly rely on physician request. Robust standard errors are displayed in parentheses. Insurer controls included insurer fixed effect, plan premium, coinsurance rate for inpatient and outpatient admissions, and dummies for whether the plan has a coverage cap and a preferential provider. Patient controls include gender, age, income, number of dependents, an indicator for independent worker and fixed effects by county of residence. *** $p<0.01$, ** $p<0.05$, * $p<0.1$.

Table 7: Healthcare Preferences and Elasticities Estimates

	(1)	(2)	(3)	(4)	(5)	(6)
Panel A - Preferences estimates						
α^H - Hospital price						
Age ≤ 25	-0.642***	-1.655***	-1.996***	-1.781***	-2.056***	-2.045***
	(0.008)	(0.009)	(0.010)	(0.009)	(0.010)	(0.010)
Age $\in (25, 45]$	-0.754***	-1.551***	-1.830***	-1.660***	-1.880***	-1.867***
	(0.007)	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)
Age $\in (45, 60]$	-0.756***	-1.493***	-1.673***	-1.223***	-1.543***	-1.245***
	(0.007)	(0.008)	(0.008)	(0.009)	(0.009)	(0.009)
Age > 60	-0.693***	-1.409***	-1.538***	-1.157***	-1.418***	-1.179***
	(0.007)	(0.008)	(0.008)	(0.008)	(0.009)	(0.008)
Single female	0.094***	0.156***	0.225***	0.154***	0.222***	0.185***
	(0.008)	(0.007)	(0.008)	(0.007)	(0.007)	(0.007)
Dependents	0.113***	0.197***	0.229***	0.191***	0.228***	0.204***
	(0.006)	(0.006)	(0.007)	(0.006)	(0.007)	(0.006)
Income	0.149***	0.128***	0.135***	0.124***	0.133***	0.127***
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
β_v - Distance to hospital	-0.100***	-0.098***	-0.101***	-0.099***	-0.102***	-0.100***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Panel B - Price elasticities						
Mean	-0.378	-1.212	-1.421	-1.188	-1.409	-1.409
SD	0.402	0.953	1.107	0.951	1.104	1.104
p10	-0.860	-2.457	-2.878	-2.416	-2.854	-2.853
p50	-0.257	-0.931	-1.096	-0.908	-1.086	-1.087
p90	-0.060	-0.356	-0.421	-0.342	-0.415	-0.415
Observations	8,338,096	8,338,096	8,338,096	8,338,096	8,338,096	8,338,096
Hospital FEs	N	Y	N	N	N	N
Hospital-diagnosis FEs	N	N	Y	N	Y	N
Hospital-age FEs	N	N	N	Y	Y	N
Hospital-diagnosis-age FEs	N	N	N	N	N	Y

Notes: Panel A in this table displays coefficients from the logit demand model for hospitals. The price coefficient is allowed to vary across age groups, household composition and income. We treat single male as the base category and do not include it in the regression. Therefore, coefficients on age group dummies measure price sensitivity for single males, while coefficient on dummies for single female and consumers with dependents are shifters of price sensitivity for those groups relative to single males. Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. Panel B in this table displays summary statistics for estimated price elasticities from a logit demand model estimated across diagnosis. Individual elasticities are calculated as $\hat{\eta}_{ih} = \hat{\alpha}_i^H c_{hj} p_{hj}(1 - \hat{s}_{ih})$, where $\hat{s}_{ih}$ is the predicted choice probability of hospital h by consumer i.

Table 8: Insurance Preferences and Elasticities Estimates

	(1)	(2)	(3)	(4)
	α^M - Plan premium		β - Expected utility from healthcare	
Panel A - Preferences estimates				
Age ≤ 25	-17.640***	-13.607***	4.039***	4.980***
	(0.182)	(0.209)	(0.096)	(0.103)
Age $\in (25, 45]$	-13.059***	-12.132***	6.044***	6.372***
	(0.055)	(0.060)	(0.040)	(0.048)
Age $\in (45, 60]$	-13.150***	-13.055***	5.860***	6.395***
	(0.064)	(0.069)	(0.046)	(0.053)
Age > 60	-8.768***	-8.712***	2.624***	3.000***
	(0.065)	(0.068)	(0.041)	(0.045)
Single female	-5.081***	-6.040***	-0.058	0.591***
	(0.070)	(0.076)	(0.049)	(0.050)
Dependents	-4.900***	-6.460***	-3.756***	-3.669***
	(0.0704)	(0.051)	(0.038)	(0.043)
Income	4.406***	4.873***	0.433***	0.464***
	(0.017)	(0.019)	(0.008)	(0.008)
Panel B - Premium elasticities				
Mean	-1.247	-1.173		
SD	1.121	1.237		
p10	-2.404	-2.445		
p50	-1.104	-1.035		
p90	-0.146	0.042		
Observations	18,155,118	18,155,118	18,155,118	18,155,118
Insurer FEs	N	Y	N	Y

Notes: Panel A in this table displays coefficients from the logit demand model for plans. Both the premium and expected utility of healthcare coefficients are allowed to vary across age groups, household composition and income. Columns (1) and (3) display results from a model without insurer fixed effects, while columns (2) and (4) display results from a model with insurer fixed effects. Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. Panel B in this table displays summary statistics for estimated price elasticities from a logit demand model for plans estimated across diagnosis. Individual elasticities are calculated as $\hat{\eta}_{fj} = \hat{\alpha}^M_f \phi_{fj}(1 - \hat{s}_{fj})$, where $\hat{s}_{fj}$ is the predicted choice probability of plan j by household f.

Table 9: Estimated Bargaining Weights and Marginal Costs

Negotiating firms		(1) Mean	(2) SD	(3) p10	(4) p50	(5) p90
Panel A - Hospital Bargaining Weights - $1-\lambda$						
All Hospitals and Insurers		0.561	0.241	0.246	0.580	0.974
Non-VI hospital and Non-VI insurer		0.490	0.213	0.246	0.500	0.920
Non-VI hospital and VI insurer		0.535	0.175	0.266	0.590	0.782
VI hospital and Non-VI insurer		0.603	0.323	0.143	0.631	0.987
VI hospital and VI insurer from different holdings		0.668	0.137	0.478	0.767	0.767
Panel B - Marginal costs and markups	Outcome	Mean	SD	p10	p50	p90
All Hospitals	Marginal cost	1.820	1.020	0.629	1.590	3.450
	Negotiated price	2.940	1.210	1.730	2.640	5.100
	Mark-up	0.400	0.189	0.150	0.394	0.686
Integrated hospitals only	Marginal cost	1.150	0.437	0.579	1.260	1.840
	Negotiated price	2.310	0.595	1.710	2.130	3.260
	Mark-up	0.494	0.177	0.275	0.502	0.713
Non-integrated hospitals only	Marginal cost	2.500	1.000	0.856	2.450	3.860
	Negotiated price	3.570	1.330	1.820	3.330	5.550
	Mark-up	0.306	0.151	0.099	0.333	0.483
Integrated hospital to own V.I. insurer only	Marginal cost	1.150	0.444	0.584	1.260	1.840
	Negotiated price	2.160	0.537	1.760	1.930	3.160
	Mark-up	0.448	0.233	0.192	0.473	0.699
Integrated hospital to other insurers	Marginal cost	1.150	0.437	0.579	1.260	1.840
	Negotiated price	2.340	0.605	1.700	2.210	3.270
	Mark-up	0.506	0.159	0.317	0.502	0.721

Notes: Non-VI stands for non-integrated, and VI stands for vertically integrated. Panel A displays summary statistics for the estimates of hospital bargaining weights (i.e. $1-\lambda_{ms}$). Each row provides statistics for a different combinations of negotiators. Panel B displays summary statistics for the estimated hospital marginal costs; the estimated negotiated prices as estimated in Subsection 4.1, and the implied hospital mark-up different for different subsample of hospitals.

Table 10: Counterfactual Simulation of Banning Vertical Integration

	(1)	(2)	(3)	(4)
	Panel A - Healthcare market			
Hospitals	Δ% Hospital prices	Δ% Market shares	Δ% Hospital profits	
VI Hospital at baseline, to VI Insurer	-0.01%	-6.37%	0.24%	
VI Hospital at baseline, to Non-VI Insurer	-9.77%	13.51%	-6.33%	
Non-VI Hospital at baseline, to VI Insurer	-4.94%	7.13%	-5.38%	
Non-VI Hospital at baseline, to Non-VI Insurer	5.24%	-8.94%	-1.58%	
Baseline average	$3.05	1.67%	$2,816	
	Panel B - Insurance market			
Insurers	Δ% Plan premiums	Δ% Hospital payments	Δ% Market shares	Δ% Insurer profits
VI Insurers at baseline	-11.39%	-1.97%	4.42%	-6.17%
Non-VI Insurers at baseline	-1.15%	-4.58%	-2.25%	-2.13%
Baseline average	$0.87	$0.28	0.20%	$27,276
	Panel C - Consumer surplus			
Consumers	Share of market	Δ Consumer Surplus	Δ% Consumer surplus	
Female - 0–24	1.42%	$36.69	1.30%	
Female - 25–44	23.20%	$83.50	1.33%	
Female - 45–60	9.25%	$63.84	1.33%	
Female - 60+	7.02%	$104.1	1.48%	
Male - 0–24	4.85%	$33.15	0.83%	
Male - 25–44	41.9%	$138.62	0.63%	
Male - 45–60	8.00%	$90.19	0.88%	
Male - 60+	4.30%	$1016.73	0.50%	
Weighted average		$143.80	0.95%	

Notes: This table displays results from a counterfactual in which vertical integration is banned in the market and all vertical linkages are removed. Non-VI stands for non-integrated, and VI stands for vertically integrated. Panel A displays outcomes in the healthcare market, in which shares are weighted by resource intensity weights. Changes are market-size weighted averages per hospital, averaged by the level indicated on the leftmost column. Profits and prices are in USD thousands, with profit being hospital annual averages. Panel B displays yearly averages over insurers, weighted by the market size. Premiums are averaged at the plan level, while share, costs and profits correspond to insurer level averages. Baseline values are expressed in thousands of dollars, with profits being total yearly values averaged over all insurers. Panel C shows consumer surplus change per person both in dollars and in percentage at a yearly level.

Table 11: Counterfactual Simulation: Welfare Effects under Hospital Cost Efficiencies

	(1)	(2)	(3)	(4)	(5)
		Scenarios for change in hospital cost upon banning VI			
Outcome	Baseline	No efficiencies	+10% in costs	+20% in costs	+30% in costs
Hospital profits	\$33.41	-\$0.60	-\$0.63	-\$0.67	-\$0.71
Insurer profits	\$136.38	-\$6.29	-\$6.32	-\$6.35	-\$6.36
Consumer surplus	\$4825.06	\$32.47	\$11.95	-\$7.25	-\$25.42
Total welfare	\$4994.85	\$25.58	\$4.99	-\$14.28	-\$32.49

Notes: This table displays the changes in welfare due to the prohibition of vertical integration in the market. Numbers displayed are for yearly values, measured in millions of dollars. The leftmost column shows the increments in hospital marginal costs in the counterfactual simulation, with respect to the estimated baseline values.

A Data Appendix

A.1 Construction of Admissions Dataset

Denote plans data by P, claims data by C. The estimating dataset is constructed following steps given by:

1. Keep all plans in P in 2013 and 2014.
2. Recover preferential providers for each plan from C, using years 2008 to 2016. We keep the three most relevant preferential providers of each plan.
3. Merge preferential providers from C by plan name to plans in P. Only 6% of the plans in P are not in C, equivalent to 0.1% of the claims in C. We drop them.
4. Construct plan identifiers by collecting plans with the same insurer, inpatient and outpatient coinsurance rate, whether it has a coverage cap or not, in the same base price decile, and with the same preferential providers. From now on, this is the definition of plans.
5. Merge plans identifiers in P to each claim in C for 2013 to 2016.
6. Construct events as a collection of claims.
7. Define main provider as one of 12 main providers (Alemana, Avansalud, Bicentenario, Dávila, Indisa, Las Condes, Santa María, Tabancura, UC, UC San Carlos, Vespucio, UChile). These provider account for 76% of events in C. Collect all other providers in another category, "other".
8. Assign each event to a main provider.
9. Collapse claims in each event to a single, event-level, observation. We construct price paid and full price for each event.
10. Recover effective coinsurance rate by plan, for preferential and non-preferential providers.
11. Merge consumer covariates. Drop if no consumer information, few cases.
12. Select estimating data. Keep only plans with more that 100 policyholders and claims for more than 10 diagnosis.
13. Define markets as the combination of year, plan and diagnosis. Drop markets with claims from 3 main providers or less in C.

A.2 Estimation of Negotiated Prices and Resource Intensity Weights

Let $d = 0, k = 0$ be our normalized condition weight in equation (13), such that $w_{(d=0)(k=0)} = 1$ and note that for any other hospital $\tilde{h}$ insurer $\tilde{m}$ and time $\tilde{t}$ the following holds:

$$\log p_{mh\kappa(i)dt} - \log p_{\tilde{m}\tilde{h}\kappa d\tilde{t}} + \log p_{\tilde{m}\tilde{h}00\tilde{t}} = \log \rho_{mht} + \varepsilon$$

Where ε is also mean zero as it is the summation of mean zero independent shocks.

Note that as all the components of the left-hand-side are observable in the data, we can consistently estimate the log of the negotiated price $\log \rho_{mht}$ via the mean of these variables. An important consequence of this is that now the number of observations used to form each estimator is equal to the number of observations for the tuple $mh\kappa dt$ times the number of all observations that belong to the group given by κd. Note that if all plans had the same number of observations for each consumer-type and condition then this would be equivalent to simply demeaning the panel by the group κd. As this is not the case, it can be seen as version where each observation is weighted proportionally to the number of observations in the group.

When estimating this equation we first bin ages in the groups $\{[0, 25), [25, 45), [45, 60), 60+\}$ and then normalize to unity the weight associated to cancer for women that belong to the third age group. The results shown in table A.1 are similar independently of which group is normalized as long as it contains sufficient observations (not shown here). Given that the number of prices estimated is very large we do not present here the full results. Instead, figure A.1 shows that the average price per insurer-hospital-year is estimated fairly accurate when comparing it to the observed prices.

A.3 Construction of Insurance Plans Choice Sets

The construction of the plan demand estimation panel builds upon the hospital demand panel and the associated estimates. The main issue this code has to tackle is the overwhelming computation cost of calculating network expected utilities for each consumer and their dependents for each plan in each year, i.e computing equation 15. The algorithm proceeds as follows:

1. Load the hospital demand panel and filter the columns relevant for either equation 15 or 16. Split income into deciles in order to create a large yet finite number of consumer types. Consumer types will determine groups that share the same expected utility of networks as they agree over all hospital and plan utility dimensions.
2. Load the payer and dependent panels for the year 2013-2017. Merge and reduce to the consumers that belong to plans for which we have sufficient information to compute conditional hospital demands. This is the same filter applied in the hospital demand panel formation.
3. Define plan demand markets as combinations of year, gender, age group and whether the

consumer has dependents. Split plans into independent plans over markets and compute their market share. For each insurer-market keep the 5 most populous plans. Expand the consumer and dependent data such that each individual now has all options available in his market.

4. Operating in batches of consumers, add for each plan all available hospitals. Expand to include all diagnoses. Using the estimated medical risk, resource intensity weights and negotiated price, compute equation 15 for all possible combinations of consumer-plan-hospital-diagnosis. Collapse over payer-plans (i.e, sum dependents expected utility if necessary) and update consumers that share the same utility type as the ones just computed in order to reduce computation time.

5. Finally, for each market restrict the choice set of consumer to only include their current plan and plans currently being commercialized. This removes less than 2% of alternatives and leaves no consumer with less than 5 alternatives.

B How do Public and Private Sectors Interact?

The public and private health systems seem to operate in practice in a remarkably isolated fashion. For instance, most of the consumers that purchase insurance in the private sector are also provided healthcare services mostly by private sector hospitals. A substantial 97% of all payments by private insurers are collected by private hospitals, while only 3% are collected by public hospitals (Galetovic and Sanhueza, 2013). Research on sorting across sectors points towards the remarkable differences in premium structures across sectors as the most relevant determinant of consumers' choice between public and private insurance (Pardo and Schott, 2012, 2013).

In terms of the evolution of their market shares through the period of study, Figure B.1 shows that through the period of study there has been a slight increase in the market share of the public insurer, from 66% to 76%, while the market share of private insurers has remained almost unchanged at around 18%. The increase in the public insurer market share originates mostly from reducing the share of consumers with either no insurance or other forms of insurance. An interesting margin of study in this market is that of switching across the private and public sector. Data availability only allows for looking at switching out of the private sector. Duarte (2011) provides preliminary evidence showing that (i) the amount of switching across sectors is low, and that (ii) the public sector operates as a safety net, as one of the major determinants of a consumer decision to switch is losing a job.

There are some aspects that are worth studying in further detail in term of the relationship between these two sectors. First, there are some remarkable differences and interactions in terms of regulation. Second, additional policies and regulations have been enacted during the period of study of this paper. Understanding the extent to which they may affect the effects of vertical integration on market outcomes is key in order to properly interpret the results from our paper.

Constraints on plan design Insurance plans chosen by the public sector constraint plan design by private insurers. This constraint operates through coverage caps set by FONASA for groups C and D. Concretely, private insurers are mandated to offer coverage caps that are at least as large as those offered by FONASA. Therefore, private insurers' coverage caps are updated annually following the the public insurer updates, which are implemented every April. Presumably, private insurers optimally adjust premiums as well as a response to this change in coverage caps induced by the public insurer.

Differences in risk pricing A notable feature that distinguishes the public and private system in this market is the differential ability of the latter to implement risk pricing or risk selection. As mentioned above, FONASA's only distinction across consumers is based on income and, to a second order, family size. However, they do not offer different plans across other dimensions. On the other side, while regulation limits the extent of risk pricing by private insurers, they can still price differently across age and gender. Moreover, private insurers are able to reject applications from consumers based on pre-existing conditions. Finally, the large number of plans available in the market suggest that such variety could be a vehicle through which private insurers implement some form of risk pricing. The result of these differences is cream skimming: the concentration of risky consumers is lower in the private than in the public sector.

***Ley Larga* de Isapres** Through law 20,015, enacted in May, 2005, the government introduced a number of regulations to the private insurance sector. The focus of these was to reduce the extent for risk pricing by private insurers. Two relevant constraints on pricing that were introduced by this law were already described above: (i) the number of risk-rating functions (i.e. f in section 3.1) was limited to 2 per insurer, and (ii) the extent to which premiums could be adjusted through time was limited to 1.3 of the average premium change, in order to reduce the extent for risk reclassification. Additionally, this law arguably increased the cost of vertical integration. This, as it explicitly established that insurers are not allowed to participate in the provision of healthcare services. This is the reason why vertical integration in this market is organized through common ownership of insurers and hospitals by *holdings*, rather than through direct ownership of hospitals by insurers.

AUGE-GES plan Through law 19,966, enacted in September, 2004, the government made mandatory the coverage of a list of health conditions dictated by the Ministry of Health. This regulation implied that since June, 2005, both public and private insurers are required to provide adequate treatment and insurance for consumers under conditions included in the list. The four elements considered by the law were (i) *access* to adequate treatment, (ii) certification of the *quality* of treatment hospitals, (iii) *financial protection* of consumers through imposing thresholds below which there is a 20% copayment rate and beyond which such rate is set to 0%, and (iv) *opportunity*, by imposing maximum wait times for consumers to be treated by the system. The list started by including 25 conditions since July, 2005, and then was extended to 40 and 56 by July, 2006 and July, 2007 respectively.

C Model Appendix

C.1 GMM Estimation Algorithm

The GMM estimation algorithm builds upon equation 21. The general procedure of the estimation was described in section 4.4. In this appendix we provide additional details regarding the specifics of our implementation.

The general structure of the algorithm is

$t = 0$ - Initialize variables and load data

$t \geq 1$ - Recover a guess of bargaining weights from a non-linear solver

- t_1 - Compute the GMM objective function
  - $t_1^{'}$ - Evaluate $\boldsymbol{c}' = C(\boldsymbol{\phi}^*(\boldsymbol{c}), \lambda)$
    - $t_1^{''}$ - Evaluate $\boldsymbol{\phi}' = \Phi^*(\boldsymbol{\phi}, \boldsymbol{p}, \boldsymbol{c})$
    - $t_2^{''}$ - If $||\boldsymbol{\phi}' - \boldsymbol{\phi}||_2 \leq \epsilon_\phi$ break loop, otherwise set $\boldsymbol{\phi} = \boldsymbol{\phi}'$ and return to $t_1^{''}$
  - t_2' - If $||\boldsymbol{c}' - \boldsymbol{c}||_2 \leq \epsilon_c$ break loop, otherwise set $\boldsymbol{c} = \boldsymbol{c}'$ and return to t_1'.
- t_2 - Assess if the change in the GMM objective function is below tolerance. If so break, otherwise update solver and return to t_1 with $t = t + 1$.

There are two important implementation details that are worth mentioning. First, this code needs to recurrently access multiple data sets in order to compute the different steps. Furthermore, often datasets need to be accessed in different orders or specific values need to be lookup. For example, the bargaining first order conditions requires computing the derivative of premiums with respect to negotiated prices, this implies iterating over premiums and looking up whether they belong to integrated insurer and if so to which hospital system. As our code builds upon nested fixed-points which need to be evaluated often tens of thousand of times, these operations need to be extremely fast. In order to tackle this problem we rely heavily on pointer-based operations and hash-table lookups. For this purpose, we code our GMM in C and use highly optimized linear algebra routines whenever available.

Second, our implementation of the equilibrium premium is substantially more developed than what we presented in 10. We chose to present the simple first order condition in order to make the main text more intuitive, however we implement an equation that brings the code closer to the solution. In order to present this equation we need to further extend our notation.

Let I denote the set of markets and define $\mathcal{J}_m^i$ the set of plans insurer m offers in some market $i \in I$. Also, denote $\mathcal{J}^i$ the complete set of plans offered in market i, i.e $\mathcal{J}^i = \cup_{m \in M} \mathcal{J}_m^i$. Furthermore, $\sigma_{j|k}^M(\boldsymbol{\phi}, \boldsymbol{p})$ denotes the share of plan j if plan k were removed from the market, keeping all else constant. As we assume that insurers optimize at a mean consumer level in each market, we can identify each plan with its relevant consumer. Denote α_j^M the mean premium sensitivity of consumers in the market in which plan j is offered. Furthermore, we denote $\delta_k^M = \alpha_f^M \phi_{fk} + \beta_f \sum_{i \in f} EU_{ik}^H + \delta_{m(k)\kappa(f)}^M$ for the mean consumer f of plan k.

Using this, it can be shown that the equilibrium premium of a plan j being offered in market i by insurer m can be written as

$$\phi_j^* = \pi_{m|j}^M + \mathbb{1}\{m \in \mathcal{V}\} \tilde{\pi}_{s(m)|j,i}^H + c_j^M - \frac{1}{\alpha_j^M}(1 + W(\tilde{\lambda}_j)) \tag{22}$$

Where $\mathbb{1}\{m \in \mathcal{V}\}$ indicates if insurer m is vertically integrated with some system $s(m)$ and c_j^M is the expected cost of plan j. $\pi_{m|j}^M$ corresponds to the profit of insurer m if it were to remove plan j from the market

$$\pi_{m|j}^M = \sum_{r \in \mathcal{J}_m} \sigma_{r|j}^M (\phi_r - c_r^M)$$

Furthermore, $W(\cdot)$ is the Lambert W function and $\tilde{\lambda}_k$ is:

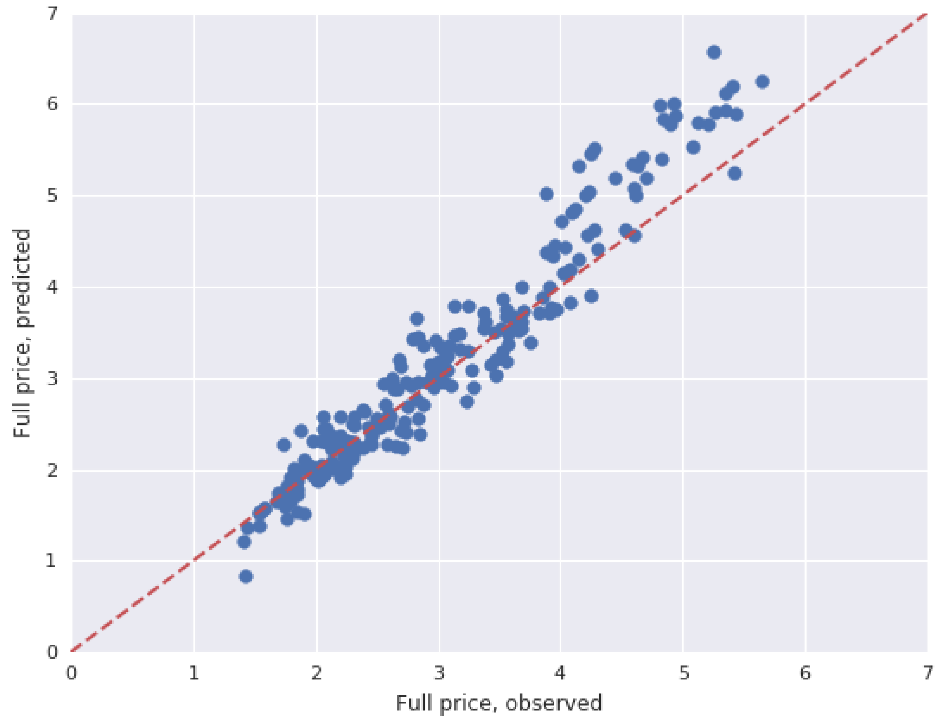
$$\bar{\lambda}_j = \frac{\exp(\alpha_j^M \pi_{m|j}^M + \alpha_j^M c_j - 1 + \delta_j^M - \alpha_j^M \phi_j + \mathbb{1}\{m \in \mathcal{V}\} \alpha_j^M \tilde{\pi}_{s(m)|j,i}^H)}{\sum_{k \in \mathcal{J}^i \setminus \{j\}} \exp(\delta_k^M)}$$

Finally, the vertical integration effect is given by

$$\begin{aligned} \tilde{\pi}_{s(m)|j,i}^H = & \sum_{l \in M} \sum_{h \in H_s} \left(\sum_{k \in \mathcal{J}_l^i} \sigma_{k|j}^M \sum_{d \in D} \gamma_{di} \omega_{di} \sigma^H(ikh|d) \right) (p_{lh} - c_{lh}^H) \\ & - \sum_{h \in H_s} \sum_{d \in D} \gamma_{di} \omega_{di} \sigma_{ijh|d}^H (p_{hj} - c_{hj}^H) \end{aligned}$$

The benefit of the reformulation presented in equation 22 is that ϕ_j is only present on the left hand side. This helps the convergence of the fixed point equation and allows easier computation of the derivatives of the premium with respect to other premiums and prices.

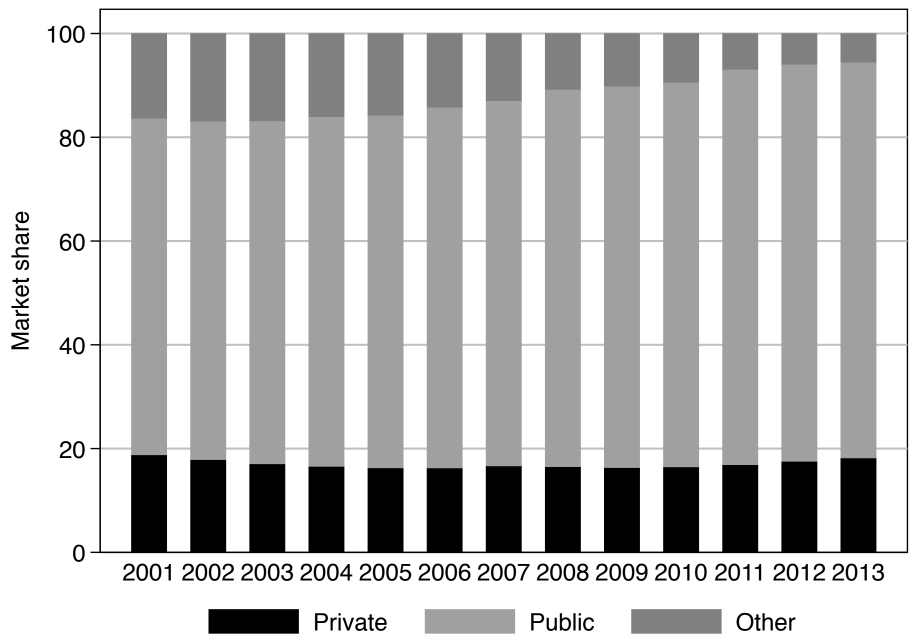
Figure A.1: Observed and predicted prices



(a) Comparison

Notes: This figure shows the comparison between predicted and observed mean prices for each combination of insurer-provider-year. Recall that predicted prices are constructed using estimates from Equation (13).

Figure B.1: Insurance market shares in across sectors



Notes: This figure displays the evolution of market shares of different types of health insurance in Chile.

Table A.1: Diagnosis cost intensity weights by demographic group, in logs

	Panel A: Females				Panel B: Males			
	0-25	26-45	46-60	60+	0-25	26-45	46-60	60+
Diagnosis								
I - Infections and parasites	-0.447	-0.213	-0.012	0.194	-0.451	-0.187	-0.175	0.105
	[-0.52, -0.37]	[-0.31, -0.12]	[-0.17, 0.15]	[0.00, 0.37]	[-0.50, -0.37]	[-0.30, -0.02]	[-0.37, -0.00]	[-0.21, 0.34]
II - Neoplasms	-0.492	-0.169	0.000	-0.070	-0.603	-0.241	0.006	0.099
	[-0.56, -0.44]	[-0.20, -0.13]	-	[-0.10, -0.03]	[-0.65, -0.55]	[-0.28, -0.20]	[-0.04, 0.05]	[0.06, 0.13]
III - Blood diseases	-0.685	-0.547	-0.920	0.180	-0.521	0.009	0.101	-0.198
	[-1.12, -0.28]	[-1.11, 0.16]	[-1.43, -0.45]	[-0.46, 0.67]	[-1.25, 0.29]	[-0.63, 0.63]	[-0.98, 0.91]	[-1.30, 0.72]
IV - Endocrine	0.313	0.866	0.858	0.653	-0.097	0.880	0.678	0.187
	[0.23, 0.42]	[0.81, 0.92]	[0.78, 0.92]	[0.50, 0.82]	[-0.20, 0.03]	[0.81, 0.94]	[0.59, 0.78]	[0.04, 0.36]
VI - Nervous system	-0.522	-0.508	-0.519	-0.516	-0.570	-1.024	-1.044	-0.916
	[-0.59, -0.44]	[-0.59, -0.44]	[-0.58, -0.44]	[-0.61, -0.42]	[-0.64, -0.49]	[-1.08, -0.98]	[-1.10, -0.99]	[-0.97, -0.84]
VII - Ocular diseases	-0.541	-0.393	-0.181	-0.092	-0.446	-0.398	-0.254	-0.204
	[-0.62, -0.46]	[-0.47, -0.32]	[-0.23, -0.11]	[-0.16, -0.03]	[-0.50, -0.38]	[-0.45, -0.33]	[-0.34, -0.18]	[-0.27, -0.13]
VIII - Ear diseases	-0.128	-0.075	-0.051	-0.279	-0.146	-0.041	-0.040	-0.054
	[-0.33, 0.04]	[-0.43, 0.23]	[-0.32, 0.21]	[-0.69, 0.01]	[-0.29, -0.03]	[-0.28, 0.26]	[-0.36, 0.23]	[-0.58, 0.38]
IX - Circulatory	-0.012	0.185	0.266	0.327	-0.043	0.140	0.403	0.524
	[-0.13, 0.11]	[0.14, 0.24]	[0.21, 0.32]	[0.28, 0.38]	[-0.12, 0.02]	[0.09, 0.19]	[0.36, 0.45]	[0.47, 0.57]
X - Respiratory	-0.144	0.091	0.225	0.316	-0.150	0.230	0.295	0.319
	[-0.17, -0.11]	[0.06, 0.14]	[0.17, 0.28]	[0.25, 0.38]	[-0.18, -0.12]	[0.19, 0.26]	[0.24, 0.35]	[0.25, 0.38]
XI - Digestive	0.057	0.230	0.312	0.366	0.062	0.338	0.357	0.415
	[0.02, 0.10]	[0.20, 0.26]	[0.28, 0.34]	[0.34, 0.41]	[0.02, 0.10]	[0.31, 0.37]	[0.33, 0.40]	[0.38, 0.45]
XII - Skin diseases	-0.467	-0.726	-0.519	-0.766	-0.443	-0.474	-0.607	-0.664
	[-0.60, -0.35]	[-0.89, -0.59]	[-0.74, -0.34]	[-1.02, -0.41]	[-0.56, -0.32]	[-0.61, -0.33]	[-0.86, -0.30]	[-1.01, -0.33]
XIII - Musculoskeletal	0.283	0.259	0.319	0.402	0.394	0.473	0.416	0.427
	[0.23, 0.33]	[0.22, 0.29]	[0.29, 0.35]	[0.36, 0.44]	[0.35, 0.43]	[0.45, 0.51]	[0.39, 0.45]	[0.37, 0.48]
XIV - Genitourinary	-0.108	-0.049	0.068	-0.112	-0.364	-0.077	-0.005	0.051
	[-0.15, -0.06]	[-0.08, -0.02]	[0.03, 0.11]	[-0.18, -0.05]	[-0.40, -0.33]	[-0.11, -0.05]	[-0.04, 0.03]	[0.01, 0.10]
XV - Pregnancy	-0.400	0.102	-0.174	-0.639	-	-	-	-
	[-0.44, -0.34]	[0.07, 0.13]	[-0.25, -0.09]	[-0.79, -0.48]	-	-	-	-
XVI - Perinatal	-1.086	-1.225	-1.110	-2.467	-1.084	-0.893	-0.515	-0.465
	[-1.17, -0.99]	[-1.52, -0.87]	[-2.38, 0.17]	[-3.26, -1.54]	[-1.16, -1.02]	[-2.12, 0.68]	[-2.15, 0.82]	[-1.73, 0.71]
XVII - Congenital malformation	0.281	0.252	0.435	0.378	0.081	0.098	-0.096	0.637
	[0.18, 0.37]	[0.09, 0.37]	[0.22, 0.58]	[-0.02, 0.66]	[0.01, 0.15]	[-0.06, 0.30]	[-0.36, 0.16]	[0.24, 1.10]

Notes: This table displays diagnosis cost intensity weights by gender and age group. These cost weights are used for constructing hospital prices. Number in braces correspond to 90% confidence intervals, estimate via 100 bootstrap draws.

Table A.2: Diagnosis probabilities by demographic group

	Age group													
Diagnosis	0-2	3-5	6-10	11-15	16-20	21-25	26-30	31-35	36-40	41-45	46-50	51-55	56-60	61+
Panel A: Females														
I - Infections and parasites	0.009	0.004	0.002	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.002
II - Neoplasms	0.004	0.005	0.004	0.004	0.005	0.004	0.006	0.009	0.014	0.021	0.029	0.034	0.041	0.058
III - Blood diseases	0.000	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001
IV - Endocrine	0.002	0.000	0.000	0.001	0.002	0.002	0.003	0.004	0.005	0.004	0.004	0.004	0.004	0.003
VI - Nervous system	0.003	0.001	0.001	0.001	0.002	0.001	0.002	0.002	0.003	0.003	0.004	0.005	0.006	0.006
VII - Ocular diseases	0.001	0.001	0.001	0.001	0.002	0.005	0.008	0.009	0.007	0.005	0.007	0.010	0.014	0.025
VIII - Ear diseases	0.001	0.001	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.001
IX - Circulatory	0.002	0.001	0.000	0.000	0.001	0.001	0.002	0.003	0.003	0.004	0.005	0.007	0.009	0.019
X - Respiratory	0.037	0.032	0.013	0.005	0.007	0.004	0.004	0.004	0.003	0.003	0.003	0.003	0.004	0.010
XI - Digestive	0.012	0.007	0.006	0.008	0.010	0.008	0.010	0.012	0.012	0.011	0.012	0.015	0.018	0.023
XII - Skin diseases	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.002
XIII - Musculoskeletal	0.001	0.001	0.001	0.003	0.004	0.003	0.003	0.005	0.006	0.008	0.010	0.014	0.018	0.022
XIV - Genitourinary	0.006	0.003	0.002	0.001	0.004	0.004	0.005	0.009	0.011	0.012	0.011	0.010	0.010	0.014
XV - Pregnancy	0.030	0.000	0.000	0.000	0.009	0.018	0.044	0.078	0.056	0.016	0.002	0.001	0.001	0.001
XVI - Perinatal	0.052	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
XVII - Congenital malformation	0.006	0.002	0.001	0.001	0.001	0.001	0.000	0.001	0.001	0.001	0.000	0.001	0.001	0.001
Panel B: Males														
I - Infections and parasites	0.010	0.005	0.002	0.001	0.001	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.005
II - Neoplasms	0.004	0.006	0.005	0.004	0.006	0.007	0.008	0.011	0.013	0.018	0.026	0.037	0.064	0.134
III - Blood diseases	0.001	0.001	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.001	0.001	0.002
IV - Endocrine	0.003	0.000	0.000	0.000	0.001	0.001	0.002	0.003	0.004	0.005	0.005	0.005	0.005	0.006
VI - Nervous system	0.003	0.002	0.002	0.001	0.002	0.002	0.003	0.006	0.008	0.009	0.012	0.014	0.014	0.015
VII - Ocular diseases	0.001	0.001	0.001	0.001	0.002	0.009	0.016	0.019	0.016	0.013	0.014	0.016	0.018	0.037
VIII - Ear diseases	0.001	0.002	0.001	0.000	0.000	0.000	0.000	0.000	0.001	0.001	0.001	0.001	0.001	0.001
IX - Circulatory	0.002	0.001	0.001	0.001	0.002	0.003	0.003	0.005	0.006	0.010	0.015	0.022	0.029	0.060
X - Respiratory	0.046	0.039	0.016	0.005	0.007	0.007	0.007	0.008	0.008	0.007	0.007	0.008	0.009	0.022
XI - Digestive	0.016	0.009	0.008	0.009	0.010	0.012	0.014	0.018	0.022	0.025	0.030	0.035	0.040	0.059
XII - Skin diseases	0.001	0.001	0.001	0.001	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.004
XIII - Musculoskeletal	0.001	0.002	0.001	0.002	0.006	0.008	0.010	0.014	0.018	0.021	0.024	0.026	0.027	0.029
XIV - Genitourinary	0.011	0.020	0.011	0.005	0.006	0.006	0.008	0.009	0.012	0.015	0.017	0.018	0.024	0.043
XV - Pregnancy	0.033	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.001	0.000	0.000	0.000	0.001	0.001
XVI - Perinatal	0.072	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
XVII - Congenital malformation	0.009	0.004	0.002	0.002	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.002

Notes: This table displays diagnosis probabilities by gender and age group. These probabilities are used for calculating the expected utility from healthcare services from insurance plans.