How Much Health Insurer Market Power is Too Much? Theory and Evidence from Quality Competition*

Natalia Serna

October 1, 2025

Abstract

This paper shows that health insurer market power reduces welfare in markets with adverse selection when firms compete on quality and prices are regulated. I test the theory using a structural model of the Colombian health insurance market where quality is defined as the insurers' provider network breadth. Counterfactual simulations show that the social planner would choose network breadth for hospital admissions equal to 60%, twice as broad as the observed equilibrium but not complete. Collusion between insurers yields equilibria even farther from the social planner's. Certain network adequacy rules may help approximate the planner's benchmark.

Keywords: Health insurance, Adverse selection, Quality competition, Provider networks.

JEL codes: I11, I13, I18, L13.

*Stanford University. E-mail: nserna@stanford.edu. The idea for this paper came from discussions with VV Chari and Mark Schankerman. I am deeply grateful to the Colombian Ministry of Health and Social Protection for providing the data for this research. I want to thank Robin Lee, Jeff Gortmaker, and seminar attendees at Harvard for their comments and feedback. The findings do not reflect the views of any institutions involved. All errors are my own.

1 Introduction

Since the seminal work of Glied (2000) and Cutler et al. (2000), health economists have worked to understand the welfare implications of competition in markets with adverse selection. Findings from both the theoretical and empirical literatures in this area suggest strong competition may not always be beneficial for consumers (e.g., Ho and Lee, 2017; Mahoney and Weyl, 2017; Veiga and Weyl, 2016; Trish and Herring, 2015; Dafny, 2010; Cutler and Reber, 1998). These findings highlight the importance of research characterizing optimal competition for different markets as well as the conditions under which market power hurts or improves welfare (Saltzman et al., 2021).

In this paper, I study how much competition is needed in health insurance markets to approximate the outcomes of a social planner. My focus is on a class of markets where insurers compete mainly on quality but where price competition is limited. This market structure typically covers lower-income populations who are unable to pay premiums, for example, Medicaid managed care in the United States (US), Chile's public health insurance program for low-income groups (FONASA Tramo A), the health system of Israel, and, my empirical setting, the health system of Colombia.[1]

The main intuition behind my results is that when insurers compete on both prices and quality, strong competition may reduce social surplus (relative to the planner) because a firm can always offer a cheap, low-quality product, exacerbating inefficient sorting (i.e., stealing consumers who are more sensitive to price than quality and who are potentially profitable). Limiting price competition reduces incentives to offer low-quality products, since this no longer necessarily attracts profitable consumers and instead sacrifices market share. Hence, strong competition is beneficial in the types of markets I analyze and mirrors classic vertical-differentiation results in markets without selection (Shaked and Sutton, 1982). Holding competition fixed, increasing the degree of adverse selection (i.e., a stronger positive correlation between costs and quality valuation) also lowers equilibrium quality and social surplus.

To settle this intuition, I present motivating theory in which insurers compete on

[1]Specifically, in the Medicaid program states cannot charge premiums to individuals with incomes below 150% of the federal poverty line (Guth et al., 2021).

(vertical) quality, receive fixed per-capita transfers from the regulator, and pass-through their costs to enrollees in the form of cost-sharing. I compare the predictions of this model against one where insurers compete on prices and quality, finding that in the former market power may hurt welfare while in the latter it improves welfare. Then, I test the predictions of the theory in the health insurance market of Colombia, where premiums are regulated to be zero.

In the theoretical framework, I capture adverse selection in two ways: by making the composition of demand depend on quality and by making insurers' costs a function of the types of consumers they enroll. I assume quality is a scalar, and start by characterizing the monopolist's optimal quality. Because the monopolist receives fixed transfers from the regulator, it does not internalize any of the value that consumers accrue from high-quality products, which leads to an equilibrium where the monopolist chooses low quality (relative to the social planner).

Then, I solve the social planner's problem, who chooses quality to maximize the sum of consumer surplus, insurer profits, and government spending. Marginal consumers are generally more "profitable" for the social planner than for the monopolist because the planner completely internalizes their valuation for quality. Therefore, equilibrium quality under the social planner is higher than under an insurance monopoly.

Finally, I examine the equilibrium in an insurance duopoly. Although characterizing an oligopoly equilibrium in selection markets when firms compete on both prices and quality (or coverage) is inherently complex and, in many cases, an equilibrium may not exist (Rothschild and Stiglitz, 1976), my setting without price competition eliminates the profitable price-quality menu deviations that would typically lead to equilibrium nonexistence. In this quality-only environment, a pure-strategy Nash equilibrium exists, and duopoly competition raises quality and insurance coverage, increasing social surplus relative to the monopoly and yielding outcomes closer to the social planner's solution.

To test the predictions that stronger competition enhances social surplus and that the social planner would choose higher quality than a market with regulated competition, I use data from the Colombian healthcare system. In this system, private insurers offer a single national health insurance plan. Insurers do not charge premiums or set their own cost-sharing rules, but they can design their provider networks for every health service offered in the plan. Hence, my measure of insurer quality is the fraction of providers that offer a particular service and are covered by the insurer, which I refer to as service network breadth. In this case, insurer quality is a vector of network breadths for multiple services, expanding the scope of the scalar quality considered in the theoretical framework.[2]

My data encompass individual-level enrollment and health claims from all consumers in Colombia's contributory health system between 2010 and 2011, which covers those who pay payroll taxes and their dependents. I also have information on insurers' provider listings for every health service. Using these data, I provide descriptive evidence that aligns with the theoretical framework: exploiting variation in market concentration across markets (driven by the number of insurers participating in every market), I show that insurers' networks of covered providers are generally narrower (i.e., of lower quality) in more concentrated markets, where insurers likely exert market power. To simulate counterfactual scenarios that mirror the social planner and the insurance monopoly from the theoretical framework, I transition to the structural model.

I borrow the model and estimates from Serna (2024). On the demand side, new consumers select their insurer based on expected out-of-pocket costs and provider network breadth. Out-of-pocket costs vary across insurers because, although coinsurance rates are fixed, health service prices are negotiated between each insurer and their in-network providers. On the supply side, insurers compete by simultaneously choosing their provider network breadths across multiple services to maximize the net present value of their profits. Demand estimates show substantial adverse selection on service network breadth: sicker, relatively unprofitable individuals have higher willingness-to-pay for network breadth in services they are more likely to claim compared to healthy, relatively profitable individuals. Cost estimates show that insurers enjoy economies of scale in the number of covered providers and some also enjoy economies of scope from offering relatively high network breadth across multiple services. Economies of scale and

[2]One limitation of the theoretical model is that quality competition when quality is a scalar inevitably results in a pooling situation in which healthier consumers are made worse off by the presence of sick consumers (Rothschild and Stiglitz, 1976). The structural model relaxes this assumption and allows me to test how insurer competition impacts equilibrium quality. In this case, separating equilibria could exist where healthy consumers value quality in one service but sick consumers value quality in another service.

scope are useful to pin down pure strategy Nash equilibria in the counterfactual exercises.

Using the model estimates, I begin by simulating a counterfactual scenario in which the social planner chooses the vector of service network breadth for each insurer to maximize consumer surplus subject to insurers' participation constraints (zero profit condition). My findings show that the social planner would choose much broader networks than the observed scenario. For example, network breadth for general medicine and hospital admissions would be twice as broad as in the observed equilibrium, moving from 0.3 to 0.6 for both services. In this case, long-run consumer surplus would increase by about 19%, with equal gains for individuals with and without diagnoses. Notably, provider networks under the social planner are not complete because of the health system's fixed administrative costs. Thus, the social planner faces a trade-off between balancing administrative costs and offering comprehensive provider network coverage.

To explore whether a decentralized equilibrium can move market outcomes closer to the social planner's, I simulate a counterfactual scenario in which insurers maximize joint profits. My findings indicate that, irrespective of which insurers collude, imperfect competition generates an equilibrium in which networks are narrower than in the observed scenario and therefore farther away from the social planner's solution. For instance, simulations of the model assuming the bottom five insurers collude predict that average network breadth would fall between 3% and 16% depending on my assumptions about the merged firm's cost structure. This suggests that network coverage improves with stronger insurer competition in markets without premiums and that the observed scenario—where 12 insurers compete—is not far from a situation in which the number of firms halves and these firms have market power.

Finally, given the challenges of designing regulations that promote insurer competition, in the last part of the paper I investigate the impact of policies that target quality directly. I examine a network adequacy rule that forces insurers to offer the same network breadth for general medicine and hospital admissions in an attempt to implement the planner's solution. My findings show that average network breadth would increase 17% for hospital admissions and decrease slightly for the rest of services, resulting in marginal gains in consumer surplus. Therefore, while the network adequacy rule enhances hospital coverage, it does not fully implement the social planner's solution.

Most of the empirical evidence and theory on competition in markets with adverse selection has focused on markets where firms compete on prices and quality. This paper makes an important contribution to the literature by analyzing selection markets with quality-only competition, which are also widespread across countries. On the theory side, I build on Stiglitz and Yun (2013), Veiga and Weyl (2016), and Mahoney and Weyl (2017) to characterize optimal quality under several assumptions about insurer competition. While I do not explore the effects of perfect competition between insurers, Azevedo and Gottlieb (2017) and Fang and Wu (2018) characterize this type of equilibrium in markets where firms compete on prices. Moreover, my paper relates to MacLeod (2021) by examining the choices of a social planner who maximizes consumer welfare in the presence of adverse selection.

On the empirical side, in markets where firms compete mainly on prices, some papers have found that, given adverse selection, competition can either improve (e.g., Ho and Lee, 2017; Dafny et al., 2015) or have ambiguous effects on welfare (e.g., Cuesta and Tebaldi, 2025; Cuesta and Sepúlveda, 2021); while given strong competition, the welfare costs of changing adverse selection can be small (e.g., Saltzman et al., 2021; Cutler and Reber, 1998). Others have also shown that increased adverse selection can unravel insurance markets (Kong et al., 2024) and that price regulation such as restrictions on risk rating can decrease welfare (Bundorf et al., 2012).

Complementing this work, I show how competition and adverse selection interact in markets where firms compete on quality, concluding that competition is always beneficial for welfare. These findings stand in relation to work examining the effects of hospital competition on quality of care (e.g., Propper et al., 2004; Brekke et al., 2011; Gaynor et al., 2013; Cooper et al., 2011) as well as the effects of insurer competition on quality scoring mechanisms (Vatter, 2025).

The rest of this paper is organized as follows. Section 2 presents a theoretical model of insurer competition on quality. Section 3 summarizes the empirical setting and data. Section 4 presents the structural model and estimates. Section 5 shows results of a centralized equilibrium where the social planner chooses network breadth. Section 6 derives equilibrium network breadth when insurers maximize joint profits. Section 7 provides results of a network adequacy rule. And Section 8 concludes.

2 Motivating Theory

To examine how insurer competition affects quality, I develop a simple model of competition where quality is measured as the breadth of the insurer's network of covered providers. Suppose there is a unit mass of consumers. Each consumer is characterized by a unit-dimensional type $\theta \in \mathbb{R}$. The consumer's type follows a distribution $F(\theta)$ with continuously differentiable density function $f(\theta) > 0$. The consumer's type denotes their sickness level, so higher θ means the individual is in worse health. Consumers can choose from a set of insurers $\{1, ..., j, ..., J\}$ that offer network breadth $H_j \in [0, 1]$.[3] For simplicity, I assume network breadth is a scalar—although I will relax this assumption in my empirical application in Section 4.

The expected medical cost of a type-θ consumer is $c(H_j, \theta)$, which is twice-continuously differentiable and monotonically increasing in both terms. Additionally, assume that $c_{HH}(H_j, \theta) > 0$, $c_{\theta\theta}(H_j, \theta) > 0$, and $c_{H\theta}(H_j, \theta) > 0$. The expected medical cost increases more rapidly with health status under a broad network than a narrow network presumably because the broad-network insurer covers higher-quality providers that charge higher prices for the same procedure relative to a narrow-network insurer. This cost also increases with network breadth because broad-network insurers have limited outside options when they bargain with providers relative to narrow-network insurers. The structure of the expected medical cost captures adverse selection because different consumer types have different costs conditional on network breadth. The cost structure also captures (ex-post) moral hazard because the medical cost depends on network breadth conditional on the consumer type.

The consumer pays a fraction r of her expected medical cost. This coinsurance rate is fixed exogenously and does not vary across insurers. Consumer θ's utility function for

[3] Network breadth defined as the fraction of providers that the insurer covers can also be interpreted as a measure of insurer quality.

contract H_j is:

$$U(H_j, \theta) = u(H_j, \theta) - rc(H_j, \theta)$$

where $u(H_j, \theta)$ is also twice-continuously differentiable and monotonically increasing in both terms. Moreover, assume that demand increases more rapidly with network breadth and the consumer's type compared to the out-of-pocket cost, $u_H(H_j, \theta) > rc_H(H_j, \theta)$ and $u_\theta(H_j, \theta) > rc_\theta(H_j, \theta)$. This guarantees that in equilibrium a non-zero mass of consumers enrolls.

Suppose individuals can choose to stay uninsured, the utility of which equals zero. Consumers buy insurance if $U(H, \theta) \geq 0$. This inequality defines a set of buyers $B(H_j)$ with cutoff type $\theta^*(H_j)$ such that $\theta \in B(H_j) = [\theta^*(H_j), 1]$. The cutoff type is implicitly defined by:

$$u(H_j, \theta^*(H_j)) = rc(H_j, \theta^*(H_j))$$

Insurers offer one level of network breadth to all enrollees and make per-enrollee profits equal to $\pi(H_j, \theta) = R(\theta) - (1 - r)c(H_j, \theta)$. $R(\theta)$ is an imperfect risk-adjusted transfer from the government such that $R_\theta(\theta) > 0$ and $R_\theta(\theta) < (1 - r)c_\theta(H_j, \theta)$. Moreover, assume that it is always profitable to serve the healthiest consumer under a broad network $R(0) > (1-r)c(1, 0)$, but unprofitable to serve the sickest consumer under a narrow network $R(1) < (1 - r)c(0, 1)$.

Monopoly. The monopolist's problem is to choose network breadth to maximize profits given by:

$$\Pi(H) = \int_{B(H)} \pi(H, \theta) f(\theta)\, d\theta$$

The first order condition (FOC) of this problem is:

$$\frac{d\Pi}{dH} = -\underbrace{(1 - r)\mathbb{E}\left[c_H(H, \theta)|B(H)\right]}_{\text{Average marginal cost}} - \underbrace{\left[R(\theta^*) - (1 - r)c(H, \theta^*)\right]}_{\text{Profitability of marginal consumer}} \underbrace{\left(\frac{rc_H(H, \theta^*) - u_H(H, \theta^*)}{u_\theta(H, \theta^*) - rc_\theta(H, \theta^*)}\right)}_{\text{Selection effect}}$$

The first term on the right-hand side of the FOC captures the change in insurer costs among existing enrollees after a change in network breadth. The second term captures the impact of attracting new (marginal) consumers, weighted by their profitability. Given the assumption that $u_H(H,\theta) > rc_H(H,\theta)$, if the marginal consumer is unprofitable, then the monopolist will lower its network breadth to avoid this consumer. Denote by H^*_{mon} the monopolist's optimal network breadth.

Social planner. A social planner who maximizes the sum of consumer surplus and insurer profits, minus government spending has the following objective function:

$$W(H) = \int_{B(H)} [w(H,\theta) - c(H,\theta)] f(\theta) d\theta$$

where $w(H,\theta)$ is consumer surplus. In this objective function, risk-adjusted payments cancel out because they are linear transfers from the government to the insurer. The FOC of the planner's problem is:

$$\frac{dW}{dH} = \underbrace{-\mathbb{E}[c_H(H,\theta)|B(H)] + \mathbb{E}[w_H(H,\theta)|B(H)]}_{\text{Average marginal surplus}} - \underbrace{\left[w(H,\theta^*) - c(H,\theta^*)\right]}_{\text{Surplus of marginal consumer}} \underbrace{\left(\frac{rc_H(H,\theta^*) - u_H(H,\theta^*)}{u_\theta(H,\theta^*) - rc_\theta(H,\theta^*)}\right)}_{\text{Selection effect}}$$

To interpret this expression, suppose there are no externalities across consumers, so that $w = u$. The social planner internalizes the value of providing network breadth to participating consumers through the term $\mathbb{E}[u_H(H,\theta)|B(H)]$, which contrasts with the monopolist's solution where this term is zero. The contribution of marginal consumers to welfare differs from their contribution to private profits because the insurer receives risk-adjusted transfers from the government that do not necessarily reflect the consumer's willingness-to-pay for network breadth or their health status.[4] This means that even with incomplete insurance generosity the following applies:

Proposition 1. *Given the conditions on the utility and cost functions, $H^*_{planner} > H^*_{mon}$ and $\theta^*(H^*_{planner}) < \theta^*(H^*_{mon})$.*

where $H^*_{planner}$ is the optimal network breadth for the social planner. The proof is provided in Appendix 1. The condition indicates that with a monopolist insurer, network breadth is underprovided, fewer consumers buy insurance than is socially efficient, and these consumers are relatively sicker compared to the social planner's solution. The

[4]In countries that use risk adjustment, the formula typically does not account for the insurer's quality other than through the correlation between the consumer's type and their valuation for quality.

comparison between the two equilibria in proposition 1 contrasts with markets in which firms can compete on prices, since there the selection distortion has the same impact on equilibrium quality for the monopolist and the social planner.

Price competition. In the model with price-quality competition, consumers buy insurance if:

$$u(H,\theta) - rc(H,\theta) - p \geq 0.$$

The cutoff type $\theta^*(H,p)$ solves the indifference condition $u(H,\theta^*) - rc(H,\theta^*) - p = 0$ and defines the set of buyers $\theta \in B(H,p) = [\theta^*(H,p), 1]$. In this case the monopolist's profit is

$$\Pi(H,p) = \int_{B(H,p)} \left[p + R(\theta) - (1-r)c(H,\theta)\right] f(\theta)\, d\theta.$$

And the FOCs of its profit maximization problem are:

$$\begin{aligned}
\frac{\partial \Pi}{\partial p} &= (1 - F(\theta^*)) - \left[p + R(\theta^*) - (1-r)c(H,\theta^*)\right] \frac{d\theta^*}{dp} = 0,\\
\frac{\partial \Pi}{\partial H} &= -(1-r)\mathbb{E}[c_H(H,\theta)|B(H,p)] - [p + R(\theta^*) - (1-r)c(H,\theta^*)]\frac{d\theta^*}{dH}.
\end{aligned}$$

Substituting the price FOC into the quality FOC yields:

$$\frac{\partial \Pi}{\partial H} = -(1-r)\mathbb{E}[c_H(H,\theta)|B(H,p)] - (1 - F(\theta^*))\frac{d\theta^*}{dH}\frac{dp}{d\theta^*},$$

where $d\theta^*/dH < 0$ and $d\theta^*/dp > 0$. The condition above indicates that the monopolist will choose broader networks compared to when prices are regulated, since at any θ the monopolist can charge a price that extracts part of the consumer surplus. This suggests some degree of market power may be beneficial in markets with both price and quality competition.

Duopoly. Now consider the case of an insurance duopoly without price competition. Two insurers $j \in \{a,b\}$ compete by choosing network breadth $H_j \in [0,1]$. The consumer type $\theta'(H_a, H_b)$ that is indifferent between enrolling with a and b satisfies:

$$u(H_a, \theta'(H_a,H_b)) - rc(H_a, \theta'(H_a,H_b)) = u(H_b, \theta'(H_a,H_b)) - rc(H_b, \theta'(H_a,H_b))$$

Denote the consumer that is indifferent between the two firms as the "marginal" consumer. Let $\theta^*(H_a, H_b)$ be the lowest type willing to enroll with insurer a, defined implicitly by:

$$u(H_a, \theta^*(H_a, H_b)) = rc(H_a, \theta^*(H_a, H_b))$$

Denote this lowest type as the "minimum" consumer. Define the set of buyers for each insurer as $B_a = \{\theta : \theta \in [\theta^*(H_a, H_b), \theta'(H_a, H_b)]\}$ and $B_b = \{\theta : \theta \in [\theta'(H_a, H_b), 1]\}$. Note that I have implicitly assumed consumers have stronger preferences for insurer b and consumers of very high type will always prefer to buy insurance. While these assumptions are not without loss of generality, they are reasonable for a wide range of empirical applications. For instance, making consumers have stronger preferences for one insurer will have similar equilibrium implications as assuming insurers have different cost structures. Insurer j's profit function is:

$$\Pi_j(H_j, H_{-j}) = \int_{B_j} \Big[R(\theta) - (1-r)c(H_j, \theta)\Big] f(\theta) d\theta$$

Define $\Delta f_\theta = f_\theta(H_a, \theta') - f_\theta(H_b, \theta')$ for any function f. The FOC for each insurer is:

$$\begin{aligned}\frac{d\Pi_a}{dH_a} = &-\underbrace{(1-r)\mathbb{E}[c_H(H_a, \theta)|B_a]}_{\text{Average marginal cost}} - \underbrace{\big[R(\theta^*) - (1-r)c(H_a, \theta^*)\big]}_{\text{Profitability of minimum consumer}} \underbrace{\left(\frac{rc_H(H_a, \theta^*) - u_H(H_a, \theta^*)}{u_\theta(H_a, \theta^*) - rc_\theta(H_a, \theta^*)}\right)}_{\text{Selection effect}} \\ &+ \underbrace{\big[R(\theta') - (1-r)c(H_a, \theta')\big]}_{\text{Profitability of marginal consumer}} \underbrace{\left(\frac{rc_H(H_a, \theta') - u_H(H_a, \theta')}{\Delta u_\theta - r\Delta c_\theta}\right)}_{\text{Competitive effect}}\end{aligned}$$

$$\frac{d\Pi_b}{dH_b} = -\underbrace{(1-r)\mathbb{E}[c_H(H_b, \theta)|B_b]}_{\text{Average marginal cost}} - \underbrace{\big[R(\theta') - (1-r)c(H_a, \theta')\big]}_{\text{Profitability of marginal consumer}} \underbrace{\left(\frac{rc_H(H_b, \theta') - u_H(H_b, \theta')}{r\Delta c_\theta - \Delta u_\theta}\right)}_{\text{Competitive effect}}$$

To analyze the impact of competition on equilibrium network breadth consider insurer a's FOC. If insurer b reduces its network breadth, it will lose its relatively healthy enrollees, thus $\theta'(H_a, H_b)$ increases, raising a's market share. At the same time, if b reduces its network breadth, this may increase the minimum consumer willing to participate in the market $\theta^*(H_a, H_b)$, reducing a's market share and making its pool of enrollees relatively sicker. If the *minimum* consumer type is profitable, then insurer a's best response is to increase its network breadth to incentivize this consumer to enroll (selection effect). However, if the *marginal* consumer is less profitable than a's existing enrollees, a's best response would be to lower its network breadth (competitive effect). This shows that the impact of competition on insurer a's network breadth choices will depend on the relative magnitudes of the selection and competitive effects.

For insurer b, a decrease in a's network breadth will increase its market share, shifting the enrollee composition towards healthier types. If the marginal consumer is profitable, then b's best response is to increase its network breadth. The following propositions compare equilibrium network breadth under the different scenarios considered so far.

Proposition 2. *The insurance duopoly has a Nash equilibrium in which $H_b^* \geq H_a^*$.*

Proposition 3. *Let $\overline{H}^*_{comp} = (1/2)(H_b^* + H_a^*)$, then given the conditions on the utility and cost functions, $H^*_{planner} > \overline{H}^*_{comp} > H^*_{mon}$.*

The proofs of propositions 2 and 3 are provided in Appendix 1. These propositions indicate that on *average* competition generates an equilibrium in which networks are broader than the monopolist's solution when there are no prices. This aligns with findings in Mahoney and Weyl (2017) where strong competition moves market outcomes away from the undersupply of insurance caused by adverse selection. It also relates to Veiga and Weyl (2016) who find that when firms compete on prices and quality strong competition may not always be welfare-enhancing. If insurers can choose both prices and quality, competition implies that an insurer can offer a cheap, low-quality product, exacerbating sorting inefficiencies. In my setting, this pricing channel does not exist, thus an insurer that offers a low-quality product will only sacrifice its market share.

Nash equilibrium in the duopoly market exists precisely because competition is constrained to be only on quality. In the Rothschild and Stiglitz (1976)'s model where firms can choose prices and quantities, firms can have profitable small price-quantity deviations depending on the composition of consumer types, which means an equilibrium may not always exist. Appendix 2 describes equilibrium existence in the Rothschild and Stiglitz (1976) model when firms cannot choose prices.

The type of competition described in my model is also fundamentally different from competition in negative prices. Price competition—whether through positive premiums or rebates—enables insurers to extract part of consumers' utility and thus align revenues more closely with willingness-to-pay. Instead, when revenues come only from regulated transfers, insurers cannot capture consumer surplus directly. Allowing for negative premiums makes the equilibrium a problem of sorting and rent extraction, whereas forbidding them turns it into a problem of quality distortions under imperfect transfers.

Parametric specification. Here I provide a parametric specification and graphical representation of my model under the assumption that insurers choose binary network breadth $H_j \in \{0, 1\}$, where $H_j = 0$ denotes a narrow network and $H_j = 1$ denotes a broad network. I use the following inputs:

$$\begin{aligned}
u(H_j, \theta) &= 1 + 0.5H_j + \log(2\theta) \\
c(H_j, \theta) &= 0.2 + 0.2H_j + (2 + 0.2H_j)\theta^2 \\
R(\theta) &= 0.4 + 0.4\theta^2 \\
F(\theta) &= U[0, 1] \\
r &= 0.5
\end{aligned}$$

Note that the functional form for $u(H_j, \theta)$ requires θ to be defined over $[\epsilon, 1]$ for a small ϵ otherwise utility is indeterminate. The top panels of Figure 1 depict the marginal consumer under each network in the dashed black line. This marginal consumer is higher (i.e., relatively sicker) when networks are narrow because only sick consumers derive sufficient value from enrolling. The middle panels present the monopolist's revenue and cost curves and extend the marginal consumer from the top panels. A visual comparison of the monopolist's profits across the two scenarios reveals that the profit maximizing choice of network breadth is $H = 0$. Given the binary nature of the game, this solution shows that as long as the monopolist makes a profit, there exists an equilibrium where one low-quality contract is offered and only the "high types" enroll.

The bottom panels of Figure 1 depict the social planner's problem, extending the marginal consumer and reproducing in blue the welfare function (absent externalities) and in red the total cost curve. Here too a visual inspection indicates that social surplus is higher under a broad network than a narrow network because, unlike the monopolist, the social planner internalizes the full value of providing network breadth.

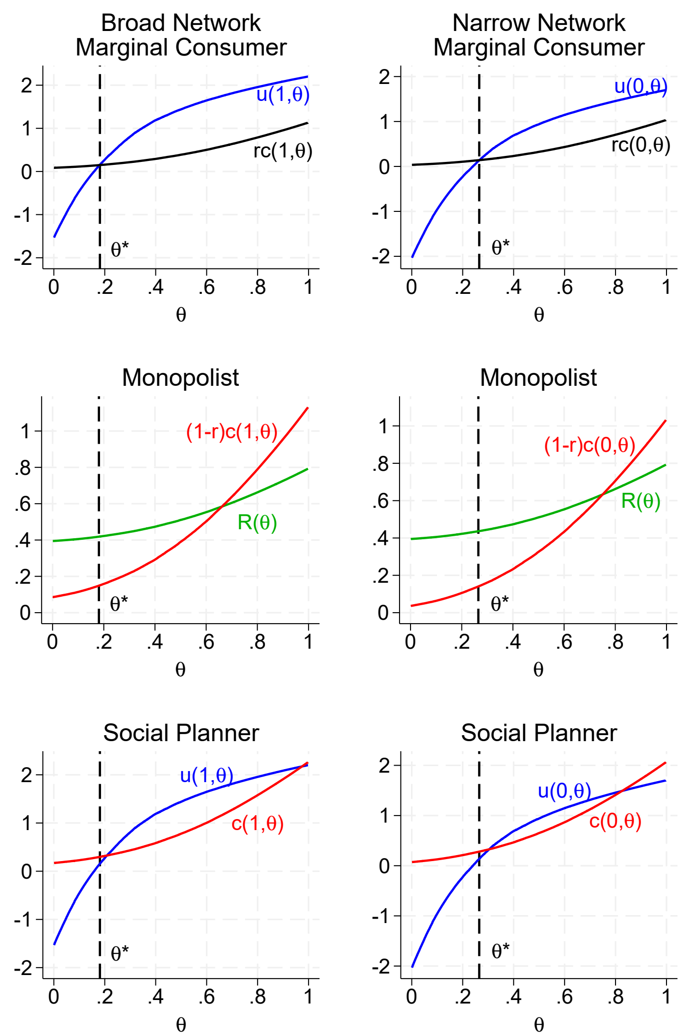


FIGURE 1: Monopolist's and Social Planner's Problem

Note: The first column of the figure shows the utility and cost curves under a broad network for consumers in the top panel, the monopolist insurer in the middle panel, and the social planner in the bottom panel. The second column shows the utility and cost curves under a narrow network in the same scenarios. θ^* denotes the marginal consumer who is willing to purchase insurance.

Network breadth defined as an index over the unit interval summarizes potentially complex bilateral negotiations between insurers and providers over healthcare prices and network inclusions. This representation of the bargaining game captures relevant features of a bargaining environment, such as allowing insurers' cost to increase with the inclusion of a provider if enrollment rises and to decrease with the exclusion of a provider if providers are substitutable. However, summarizing insurers' networks with a single index does not capture other elements of the bargaining game, such as changes in insurers' and providers' disagreement payoffs.

Another potential limitation of the results presented in this section is the assumption of unit-dimensional quality. In reality firms may be differentiated along multiple dimensions of quality. For example, in health insurance, firms may differ in their provider networks, prior authorization requirements, claim denials, etc. If consumers of different type have different preferences over each dimension of quality, then we could have a separating equilibrium even in the insurance monopoly. In my empirical application I relax this assumption by allowing firms to differ across multiple dimensions of quality.

3 Data and Descriptive Evidence

3.1 Background

In the following sections, I apply the theoretical framework to the Colombian health insurance market. This market is divided into two main schemes: contributory and subsidized. The contributory scheme covers individuals who pay payroll taxes along with their dependents, while the subsidized scheme is designed for low-income households. Colombia's insurance system operates under a managed care competition model, where private insurers offer a single national health insurance plan that has near-universal coverage. Premiums are set to zero, and both cost-sharing and benefits are heavily regulated. In the contributory scheme, individuals pay coinsurance rates and copays that are indexed to their monthly income, whereas healthcare is free for those in the subsidized scheme, aside from minimal copays for doctor visits.[5]

[5] In 2011, for individuals with incomes below 2 times the monthly minimum wage (MMW) the coinsurance rate is 11.5% of the health service price, the copay is 1,900 COP, and the out-of-pocket maximum is

Private insurers are responsible for collecting payroll taxes and remitting contributions to the central government, which subsequently redistributes funds to the insurers using a risk adjustment formula. The formula compensates insurers (ex-ante) for their enrollees' sex, age, and geographic location, but it does not account for specific diagnoses. Additionally, while the government provides ex-post compensations for certain chronic diseases, both forms of risk adjustment are insufficient for effectively managing risk selection incentives.[6]

While insurers are prohibited from charging premiums or establishing their own cost-sharing rules, they compete for enrollees by determining which providers to cover and the number of providers available for each health service offered under the national insurance plan. For example, an insurer may choose to provide coverage for cardiac care at a particular provider while excluding renal care. Insurers also negotiate health service prices with in-network providers. Although the government has implemented some network adequacy rules for specific services such as primary care, oncology, and urgent care, these rules do not encompass all the services covered in the national plan. Overall, health service coverage in Colombia is extensive.

Consumers are free to choose any of the insurers that operate in their municipality of residence, and insurers typically participate in the majority of municipalities within a state.[7] Although there is no designated open enrollment period, consumers are allowed to switch insurers if they have been enrolled with their incumbent insurer for at least 12 (non-continuous) months. When making these enrollment decisions, consumers consider

57.5% of the MMW. For individuals making between 2 and 5 times MMWs, the coinsurance rate is 17.3%, the copay is 7,600 COP, and the out-of-pocket maximum is 230% of the MMW. Finally, for individuals who earn more than five times the MMW, the coinsurance rate is 23%, the copay is 20,100 COP, and the out-of-pocket maximum is 460% of the MMW.

[6]Using health claims and enrollment data from year $t-2$, the government calculates the ex-ante risk adjustment transfers for year t by computing the average annual health care cost per risk pool. Risk pools are defined by a combination of sex, age group (1-4, 5-14, 15-18, 19-44, 45-49, 50-54, 55-59, 60-64, 65-69, 70-74, 75+), and municipality of residence (insurers get 6% more for individuals who reside in the main capital cities of the country and 10% more for those who reside in peripheral areas like the amazon). The ex-post risk adjustment mechanism is known as the High-Cost Account. This is a zero-sum mechanism that compensates insurers with an above-average share of enrollees with chronic diseases with funds coming from insurers with a below-average share. The chronic diseases considered in this mechanism are: renal disease (since 2007), HIV-AIDS (since 2016), and certain cancers (since 2010).

[7]Municipalities in Colombia are similar to counties in the U.S. and states are similar to Metropolitan Statistical Areas.

the set of providers that each insurer covers in their state of residence. Switching insurers is rare in this market: only about 6% of all individuals switched their insurer between 2010 and 2011. Moreover, in 2011, only 4 out of the 23 insurers in the contributory scheme also operated in the subsidized scheme.

3.2 Data

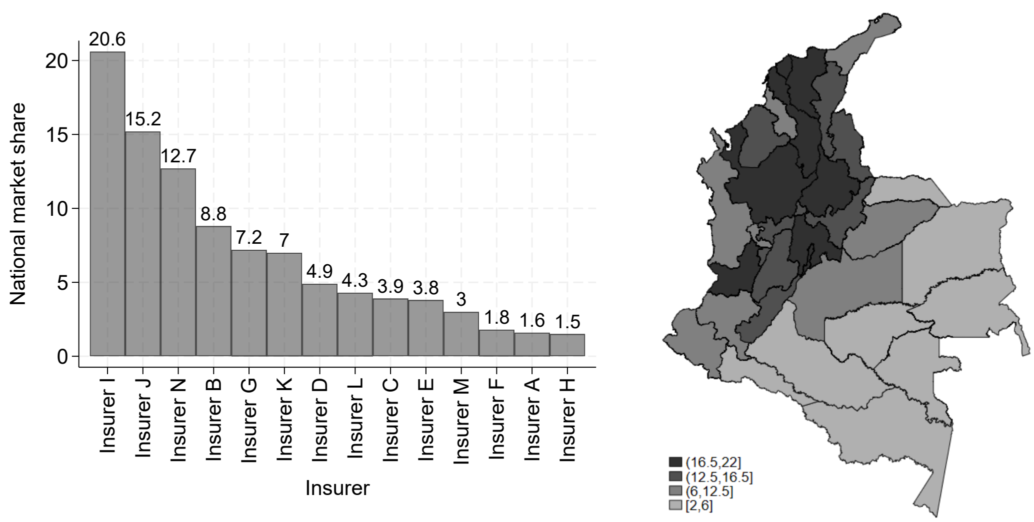
I use individual-level enrollment and health claims data from all participants in Colombia's contributory scheme from 2010 to 2011, which includes approximately 24 million enrollees. The enrollment files provide detailed information on each enrollee's sex, age, municipality of residence, insurer, and length of enrollment within a year. These data enable me to calculate the ex-ante risk-adjusted transfers that each insurer received for its enrollees since the government's formula is public.

The health claims data includes the date the claim was filed, the insurer that processed the claim, the provider that delivered the service, the associated health service, diagnosis codes, and the negotiated price for each health service. Using this information, I can determine the consumers' health status by analyzing the diagnoses they received throughout the year, as well as compute insurers' total healthcare cost incurred in each individual. Anonymized individual identifiers are the same across datasets allowing me to merge enrollment with claims.

In addition to the enrollment and claims data, I have obtained provider listings from the National Health Superintendency for insurers participating in the contributory scheme from 2010 to 2011. These listings detail the hospitals, clinics, and physician practices covered by each insurer, along with the specialties for which they are in network. I match the specialties in these provider listings with the relevant procedure codes in the health claims data based on the anatomical areas they pertain to. Examples of services include cardiac care, renal care, and hospital admissions. A complete list of these services is provided in Appendix Table 1.

The provider listings report the Colombian Tax Identification Number (TIN) for every provider. Each TIN may be associated with multiple facilities, each of which is assigned a unique provider identifier from the Colombian Ministry of Health and Social Protection. This provider identifier in turn matches the health claims data. I complement the information from the provider listings by incorporating providers from the claims data that do not appear in the listings but have submitted at least 10 claims for a specific insurer-service.

Using this final list of in-network provider-services, I calculate each insurer's service network breadth as the fraction of providers in a market that offer a particular service and are covered by the insurer.[8] I define markets as Colombian states, recognizing that enrollees in more remote municipalities often travel to their state's capital city for care, thereby accessing their insurer's network in their state of residence. Insurers are required to cover at least one provider for each health service included in the national insurance plan. However, because consumers can access networks across different markets, some insurers may choose not to cover certain services in specific markets, potentially for profit-driven motives.



(A) National Market Shares (B) Number of Insurers

FIGURE 2: Description of Markets

Note: Panel A presents the national market share on the full sample of enrollees of the top 14 insurance companies in the contributory system in 2011. Panel B presents the number of active insurers in every state in 2011. Darker colors represent higher numbers.

Throughout the analysis, I assume service network breadth is the primary choice variable for insurers in this health system, as both premiums and cost-sharing are subject

[8]In the construction of service network breadth, providers that do not deliver a particular service are excluded from the denominator of that service.

to strict regulation. This characterization of the networks assumes providers are homogeneous conditional on the services they provide. As an example in the US, my model assumes that Stanford hospital and UCSF hospital, both of which can provide brain surgery, are homogeneous in the provision of this service, but allows these two hospitals to differ from other providers that cannot render brain surgeries. In counterfactuals, the model also allows insurers discretion over whether to cover a service at all, since under alternative market conditions it is possible that $H = 0$ is the only solution for the insurer's profit maximization problem.

Using service network breadth as a summary measure of insurer quality is appropriate in the Colombian setting, since there is relatively minimal variation in quality across providers for a specific service, as illustrated in Appendix Figures 2 and 3. The first figure shows the distribution of residuals from a regression of provider market shares on market-by-service fixed effects. There is relatively little remaining variation in service-level market shares across providers suggesting their demand is homogeneous after conditioning on the service. The second figure shows the distribution of provider fixed effects from a regression of average service prices on provider and service fixed effects. This figure also shows that there is no substantial variation in prices across providers—something you would expect to see if variation in quality were meaningful.[9]

During the sample period, 23 insurers participated in the contributory scheme, and 14 of these accounted for approximately 97% of enrollees. My analysis focuses on these 14 insurers. Figure 2 illustrates the structure of the contributory scheme in 2011. Panel A shows that the market is highly concentrated, with the three largest insurers covering 49% of enrollees. Notably, half of Colombian states had fewer than seven insurers, and around eight states exhibited an insurance duopoly, as shown in Panel B.

The considerable levels of market concentration in the contributory scheme raise the question of how competition affects insurers' network coverage decisions. The theoretical model presented earlier suggested that low competition can lead to provider networks that are narrower than socially desirable because insurers do not internalize any of the

[9]In Colombia there are only around 40 top-tier academic medical centers. If providers differed substantially in their quality conditional on the service, as in the US, using service network breadth to characterize insurers' contracts would provide a lower bound on consumer surplus.

value to consumers of offering broad networks. In Colombia, insurers can have market power by targeting the most profitable consumers using their networks and effectively "locking them in." Table 1 presents evidence of significant consumer inertia in line with these market power incentives. In the full sample of enrollees (column 1), only 1% to 6% of consumers switched their insurer between 2010 and 2011. For enrollees with full enrollment spells in both years (column 2), which I denote as the "continuously enrolled" hereafter, switching rates are even lower, ranging from 0.4% to 4%.

Table 1: Switch-in Rates

Insurer	All enrollees (1)	Continuously enrolled (2)
Insurer A	0.032	0.030
Insurer B	0.037	0.028
Insurer C	0.026	0.016
Insurer D	0.046	0.038
Insurer E	0.045	0.031
Insurer F	0.037	0.026
Insurer G	0.056	0.039
Insurer H	0.024	0.016
Insurer I	0.024	0.014
Insurer J	0.025	0.010
Insurer K	0.029	0.008
Insurer L	0.046	0.018
Insurer M	0.028	0.008
Insurer N	0.017	0.004

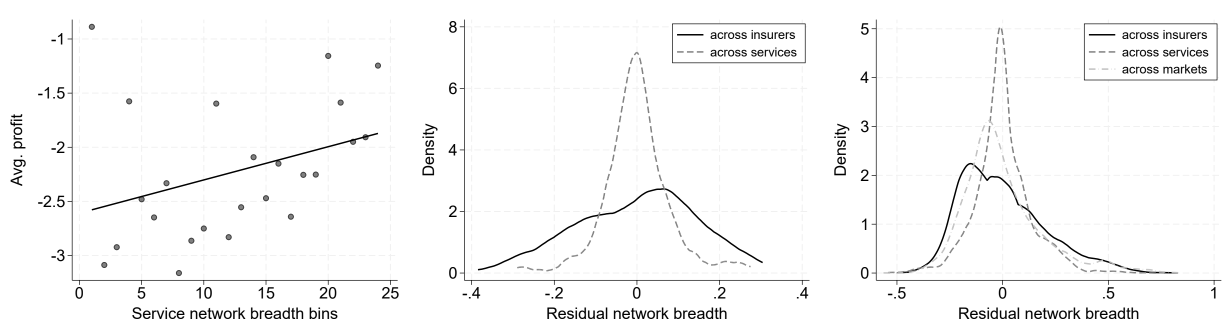
Note: Table shows the fraction of consumers that switch into each insurer in 2011 relative to 2010. Column (1) uses the full sample of enrollees without taking into account their enrollment spells. Column (2) conditions on enrollees with continuous enrollment spells in each year, that is, consumers who are enrolled 365 days.

3.3 Service Network Breadth and Market Structure

Figure 3 describes my measure of service network breadth. Panel A shows that insurers' network coverage decisions seem to be influenced by profit motives. This panel presents the average profit per enrollee—calculated as the risk-adjusted transfer minus total healthcare costs—across different bins of service network breadth conditional on individuals who file claims. Highly profitable individuals who do not file claims are excluded from this figure. Making any claim is associated with lower profits and services with higher profits are associated with broader networks.

Panel B further illustrates that network breadth varies substantially across services and insurers, suggestive of selection incentives. This panel presents the distribution of residuals from a regression of service network breadth on service fixed effects (relying on variation across insurers) and insurer fixed effects (relying on variation across services) conditional on the largest market, the capital city of Bogotá. An observation in this regression is an insurer-service in 2011. By focusing on a single market, this figure eliminates potential variation in network breadth that arises from differences in the set of insurers that participate in every market and, instead, depicts whether differences across insurers arise from the set of services they decide to cover. The fact that the distribution of residuals has greater variance when controlling for the service suggests there is some non-random selection into insurers. This variation in residual service network breadth, given the stringent regulation of premiums and cost-sharing, stems from differences in both consumer preferences and insurers' cost structures, as discussed in Serna (2024).

Panel C uses information from all markets to determine whether market structure influences network breadth decisions. In this case, residual network breadth varies more across markets than across services, suggesting the degree of competition may also play a role in insurers' choices. Interestingly, the distribution of residuals that is identified from variation in network breadth across insurers in Panel C is shifted to the left relative to Panel B, indicating that after accounting for the competitive structure, insurers generally choose narrower networks.



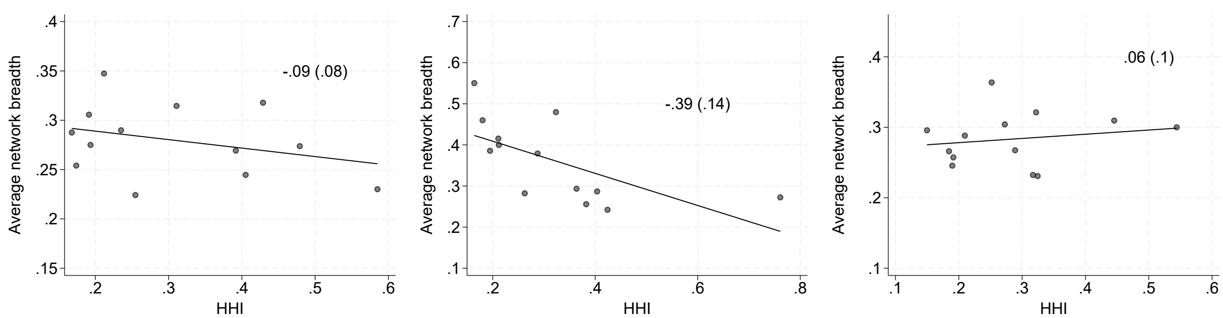
(A) Network Breadth (B) Residual Networks, Bogotá (C) Residual Networks, All Markets

FIGURE 3: Distribution of Network Breadth

Note: Panel A shows the distribution of service network breadth in 2011 in black (left vertical axis) and the average profit conditional on consumers who make claims for each service in red (right vertical axis). Panel B shows the distribution of residuals from a regression of service network breadth in 2011 on insurer-by-service fixed effects in black, market-by-service fixed effects in dark gray, and market-by-insurer fixed effect in light gray.

To more directly examine the direction in which market structure influences network breadth, Figure 4 presents a scatterplot of average service network breadth in a market (averaged across insurers and services) against the Herfindahl-Hirschman Index (HHI). The HHI is calculated based on insurer market shares in the total number of claims. In this figure I focus on markets with enough variation in service network breadth—the 13 metropolitan areas in the country.

Panel A illustrates that markets with higher insurer concentration generally exhibit lower average service network breadth, consistent with the predictions of the theoretical model. Panels B and C break down the correlation into specific services such as general medicine and cardiac care, respectively. Insurers may face different risk selection incentives across these two services because they have different probabilities of being claimed. There is a strong negative correlation between HHI and average network breadth in general medicine, while the correlation is null conditional on cardiac care.



(A) All Services (B) General Medicine (C) Cardiac Care

Figure 4: HHI and Average Service Network Breadth

Note: Scatter plot of average service network breadth in a market (across insurers and services) and the Herfindahl-Hirschman Index based on insurer market share in the total number of claims. One dot is a metropolitan area in the country. The solid line represents a linear fit. Panel A uses network breadth across all services, Panel B uses network breadth in general medicine, and Panel C uses network breadth in cardiac care. Each panel reports the coefficient and standard error in parenthesis of a linear regression of average network breadth on insurer HHI.

4 Empirical Model

Building on the descriptive evidence, this section introduces an equilibrium model of insurer competition on service network breadth. The model enables me to assess the impact of market power on provider networks, building on estimates from Serna (2024).

That paper offers a complete description of the model, identification strategy, estimates, and robustness checks. I summarize these modeling aspects in Appendix 4, and outline below the key empirical micro-foundations for the theoretical model presented in Section 2.

Insurers compete for new enrollees who make their first enrollment choice. Defining competition on new enrollees ensures there are no biases from consumer inertia. After consumers are "locked-in," insurers take into account the disease and age progression of their enrollees to choose the vector of service network breadth. Insurers make one-time simultaneous choices of service network breadth to maximize the present discounted value of their profits. Hence, insurers' network breadth decisions are static. Take one market m, insurer j's profit function in this market is:

$$\Pi_j = \sum_{\theta} \pi_{j\theta}(\mathbf{H_j}, \mathbf{H_{-j}})N_\theta + \sum_{s=t+1}^{T} \left[\zeta^s \sum_{\theta} (1-\rho_{\theta'})\mathcal{P}(\theta'|\theta)\pi_{j\theta'}(\mathbf{H_j}, \mathbf{H_{-j}})N_{\theta'} \right] - F_j(\mathbf{H_j}, \xi_\mathbf{j})$$

where θ is the consumer's sickness level. Higher θs denote sicker individuals. $\mathbf{H_j} = \{H_{jk}\}_{k=1}^{|K_m|}$ is insurer j's network breadth across all services k, ζ is a discount factor, ρ is the probability that the consumer drops out of the contributory system, $\mathcal{P}$ is the transition probability from type θ in period t to type θ' in period $t+1$, N_θ is the fixed market size of type-θ consumers, and F_j is the insurers' fixed cost, which mainly captures administrative expenses related to billing and auditing activities. I assume insurers pay this fixed cost once.

The profit per consumer type θ is:

$$\pi_{j\theta}(\mathbf{H_j}, \mathbf{H_{-j}}) = (R_\theta - (1-r_\theta)C_{j\theta}(\mathbf{H_j}))s_{j\theta}(\mathbf{H})$$

Here, R_θ is the risk-adjusted transfer from the government plus revenues from copayments, $C_{j\theta}$ is insurer j's cost for a type-θ consumer, r_θ is consumer θ's coinsurance rate, and $s_{j\theta}$ is insurer j's demand from type-θ consumers. Finally, $\mathbf{H} = \{\mathbf{H_j}\}_{j=1}^{|J|}$. Assume the demand and average cost functions are twice-continuously differentiable and that $\frac{\partial C_{j\theta}}{\partial \theta} > 0$, $\frac{\partial C_{j\theta}}{\partial H_{jk}} > 0$, $\frac{\partial F_j(\cdot)}{\partial H_{jk}} > 0$, $\frac{\partial^2 F_j(\cdot)}{\partial H_{jk}^2} > 0$, $\frac{\partial s_{j\theta}}{\partial H_{jk}} > 0$, and $\frac{\partial s_{j\theta}}{\partial H_{-jk}} < 0$.

Insurers compete in every market by choosing their service network breadth to maximize profits. The FOC of the insurer's problem is:

$$\frac{\partial \Pi_j}{\partial H_{jk}} = \underbrace{\sum_{\theta}\Big((R_\theta - (1-r_\theta)C_{j\theta})\frac{\partial s_{j\theta}}{\partial H_{jk}} - (1-r_\theta)s_{j\theta}\frac{\partial C_{j\theta}}{\partial H_{jk}}\Big)N_\theta}_{\text{Current profit derivative (CP)}} \tag{1}$$

$$+ \sum_{s=t+1}^{T}\zeta^s \sum_{\theta}\underbrace{(1-\rho_{\theta'})\mathcal{P}(\theta'|\theta)\Big((R_{\theta'} - (1-r_{\theta'})C_{j\theta'})\frac{\partial s_{j\theta'}}{\partial H_{jk}} - (1-r_{\theta'})s_{j\theta'}\frac{\partial C_{j\theta'}}{\partial H_{jk}}\Big)N_{\theta'}}_{\text{Future profit derivative (FP)}} - \frac{\partial F_j}{\partial H_{jk}} = 0$$

Consider the first line of equation (1). Adverse selection manifests as the covariance between the consumer's valuation for network breadth and the insurer's marginal cost, represented by $C_{j\theta}\frac{\partial s_{j\theta}}{\partial H_{jk}} > 0$ and $s_{j\theta}\frac{\partial C_{j\theta}}{\partial H_{jk}} > 0$, respectively. This covariance is positive and becomes more pronounced the broader is the network, because consumers of higher type have stronger preferences for network breadth. Therefore, adverse selection changes the composition of consumer types that enroll and incentivizes insurers to offer narrower networks.

The FOC also provides intuition on how market concentration—and perhaps market power—impacts service network breadth. Suppose for simplicity that insurers have the same marginal cost structure $C_{j\theta} = C_\theta$, and focus on the effects of a change in service network breadth weighted across insurers by their market share $s_{j\theta}$. We can rewrite equation (1) as:

$$\sum_{\theta}(R_\theta - (1-r_\theta)C_\theta)\Big(\sum_j \frac{\partial s_{j\theta}}{\partial H_{jk}} s_{j\theta}\Big)N_\theta - \sum_\theta (1-r_\theta)\frac{\partial C_\theta}{\partial H_{jk}}\overbrace{\Big(\sum_j s_{j\theta}^2\Big)}^{HHI_\theta}N_\theta \tag{2}$$

$$+ \sum_{s=t+1}^{T}\zeta^s \sum_{j\theta} s_{j\theta} FP - \sum_{j\theta} s_{j\theta}\frac{\partial F_j}{\partial H_{jk}} = 0$$

Equation (2) illustrates that market concentration exacerbates the adverse selection effect when firms exhibit homogeneous marginal cost structures. Specifically, the HHI has a multiplicative effect on the increase in insurers' costs from providing broader networks. This suggests that concentrated markets with adverse selection likely have narrower networks compared to less concentrated markets. However, in scenarios with heterogeneous costs and preferences, the effects of market concentration on network breadth become less clear. Furthermore, market concentration may not accurately reflect true market power.

Demand. In the profit function, insurer demand follows a random utility representation. A new enrollee i of type θ has the following utility from enrolling with insurer j in market m:

$$u_{ijm} = \underbrace{\beta_{im} \sum_{k} q_{\theta k} H_{jkm} - \alpha_i c_{\theta jm}(\mathbf{H_{jm}}) + \phi_j}_{v_{\theta jm}} + \varepsilon_{ijm} \tag{3}$$

where $q_{\theta k}$ is the probability that a type-θ consumer claims service k, $c_{\theta jm}$ is the expected out-of-pocket cost at insurer j, $\mathbf{H_{jm}} = \{H_{jkm}\}_{k=1}^{K_m}$ with K_m denoting the set of services available in market m, ϕ_j is an insurer fixed effect, and ε_{ijm} is a type-I extreme value shock. Consumer types are defined by combinations of sex, age group (19-24, 25-29, 30-34, 35-39, 40-44, 45-49, 50-54, 55-59, 60-64, 65-69, 70-74, 75 or more), and diagnosis (cancer, cardiovascular disease, diabetes, renal disease, pulmonary disease, other disease, no diseases).[10] The coefficients in the utility function are given by $\beta_i = (x_i \;\; x_m)\beta$, $\alpha_i = x_i'\alpha$; the vector x_i includes dummies for sex, age group, and diagnoses, and x_m are market dummies.

Given the distribution of the preference shock, insurer j's demand in market m among type-θ enrollees is

$$s_{j\theta m} = \frac{\exp(v_{\theta jm})}{\sum_{g=1}^{|J_m|} \exp(v_{\theta gm})}$$

where $|J_m|$ is the set of insurers participating in market m.

Marginal costs. Consumers' out-of-pocket costs are a function of service network breadth because they pay a fraction of the health service prices that their insurer negotiates with in-network providers: $c_{\theta jm} = r_\theta C_{\theta jm}(\mathbf{H_{jm}})$. In turn, insurers' marginal cost function

[10] In cases where a single individual has multiple health conditions, I assign the diagnosis that accounts for the highest share of their healthcare cost.

$C_{\theta jm}$ is:

$$\log(C_{\theta jm}(\mathbf{H_{jm}})) = \tau_0\Big(\sum_{k}^{K_m} q_{\theta k}A_k\Big) + \tau_1\Big(\sum_{k}^{K_m} q_{\theta k}H_{jkm}\Big)$$
$$+ \frac{1}{2K_m}\tau_2 \sum_{k}^{K_m}\sum_{l\neq k}^{K_m} q_{\theta k}q_{\theta l}H_{jkm}H_{jlm} + \lambda_\theta + \eta_m + \delta_j + \epsilon_{\theta jm} \tag{4}$$

where A_k is the government's reference price for service k. This price is used to reimburse providers for events not covered by health insurance (such as car accidents, natural disasters, and terrorist attacks), and serves as the baseline in insurers' bilateral negotiations with providers. The second term to the right of equation (4) captures whether insurers with broad networks negotiate higher prices with in-network providers compared to those with narrower networks, thereby summarizing the bargaining environment. The third term introduces the potential for insurers to benefit from economies of scope across services, which helps explain why some insurers choose relatively broad networks across multiple services. Moreover, λ_θ is a consumer type fixed effect, η_m is a market fixed effect, and δ_j is an insurer fixed effect. Finally, I assume $\epsilon_{\theta jm}$ is a mean-zero shock independent of ε_{ijm}.

My specification of insurers' marginal cost is informed by patterns observed in the raw data illustrated in Appendix Figure 4. This figure shows a positive relationship between log average costs and service network breadth, along with a negative relationship with the interaction between network breadth across pairs of services.

Fixed costs. Finally, I parameterize insurers' fixed cost as:

$$F_{jm}(\mathbf{H_{jm}}, \boldsymbol{\xi_{jm}}) \equiv \sum_{k}\Big(\omega H_{jkm} + \xi_j + \xi_m + \xi_{jkm}\Big)H_{jkm}$$

where ξ_j and ξ_m are insurer- and market-specific cost components, $\boldsymbol{\xi_{jm}} = \{\xi_{jkm}\}_{k=1}^{K_m}$, and ξ_{jkm} is an unobserved (to the econometrician) cost component. The fixed cost allows me to rationalize insurers that choose broad networks despite selection incentives and imperfect competition by allowing for economies of scale in provider networks.

4.1 Identification and Estimation Results

The insurer demand model in equation (3) is a conditional logit model estimated on data from new enrollees with complete enrollment spells in 2011. Focusing on new enrollees avoids the confounding biases from inertia, which might make individuals appear as if they are not sensitive to out-of-pocket costs. The parameter on network breadth is identified from variation in consumer types across markets. The intuition is that markets with a higher prevalence of diseases will have greater preference for the services those diseases need for treatment. The parameter on out-of-pocket costs is identified from two sources of variation. First, the exogenous variation in coinsurance rates, which are indexed to the enrollee's income level but are unrelated to network coverage decisions. Second, from the variation in choice sets across markets.

One important simplification of the model is the conditional homogeneity of providers, requiring that providers that are able to deliver a specific service are similar to each other. Given the granularity of the choice variable (network breadth for each of 20 services), this assumption is not overly restrictive. The insurer fixed effects and market-specific preferences in the consumer's utility function also aid in identifying the preference parameters. For example, the insurer fixed effects help control for potential differences in unobserved insurer quality which may stem from their ability to efficiently process claims.

For the marginal cost function, coefficients are identified from variation in healthcare costs within insurer and across consumer types. Intuitively, identification requires observing two insurers that are identical (in terms of the characteristics of their enrollees) except for their network breadth. The rich set of fixed effects help account for potential unobserved cost variation within consumer types. Serna (2024) provides several robustness checks on this cost function and the demand function.

The fixed cost parameters are estimated from insurers' FOCs. Identification of these parameters relies on systematic variation in marginal variable profits across services within an insurer. For example, if two insurers have identical health risk, but one of them offers low service network breadth and the other offers high service network breadth across all services, then the model would rationalize these choices with high fixed costs for the former and low fixed costs for the latter. However, because insurers choose service network breadth with knowledge of their cost shocks ξ_{jkm}, to identify ω I use an instrumental variable. My instrument is the average claim probability among healthy consumers. Note that claim probabilities in the model affect marginal variable profits only through their interaction with service network breadth, satisfying the exclusion restriction.

Demand and marginal cost estimates are provided in Appendix 4.2. Appendix Table 2 presents demand results. I find that consumers prefer broad networks and dislike out-of-pocket costs. Since the marginal disutility for out-of-pocket costs is substantially lower among individuals with chronic health conditions, the parameter estimates imply these consumers have a higher willingness-to-pay for network breadth compared to individuals without diagnoses. For instance, patients with renal disease are willing to pay almost 7 times more for an additional provider in the network for renal care relative to a healthy patient, consistent with sorting on provider networks.

I estimate the marginal cost function using OLS. Estimation uses information from all continuously enrolled consumers in 2010 and 2011. Results are provided in Appendix Table 3. Marginal costs are increasing in service network breadth at a decreasing rate. Thus, broad-network insurers negotiate higher service prices with in-network providers and enjoy economies of scope across services. These scope economies might arise from price discounts at providers where insurers cover several services.

Appendix Tables 4 and 5 present estimates of dropout and transition probabilities, which are computed non-parametrically, outside of the model. For instance, the dropout probability is the fraction of consumers enrolled in 2010 but not in 2011, and the transition probability is the fraction of consumers with disease x in 2010 that develop disease y in 2011. These probabilities factor into the calculation of marginal variable profits in insurers' FOCs.

I estimate insurers' fixed costs using the FOCs with a 2SLS approach. This is possible given the static nature of my supply model and the assumption of continuity of service network breadth. Insurer profits and marginal variable profits in the left-hand side of the FOC are forward-simulated for 100 periods. Appendix Table 6 presents first-stage results regressing network breadth on the instrument (the average claim probabilities among healthy consumers). I find that the instrument has the expected sign and is highly relevant as seen by the F-statistic.

Appendix Table 7 presents second-stage results. Findings show that fixed costs vary significantly across insurers and importantly that some insurers enjoy substantial economies of scale. As mentioned before, the model rationalizes insurers with broad networks as also having large economies of scale captured by ξ_{jkm}. Appendix Figure 5 shows that the model predicts that insurers' marginal costs are positively related while fixed costs are negatively related to network breadth, in line with economies of scale.

5 Centralized Equilibrium

The first step to assess the impact of insurer competition on network breadth is to establish the optimal service network breadth a social planner would choose for each insurer. One limitation of my approach is that potential externalities across consumers in their use of provider networks are not captured in the model, but a social planner would likely observe and consider them. For example, broad-network insurers potentially have lower congestion, improving consumers' ability to schedule doctor appointments on time. While these types of externalities are not captured, the model is still useful to tractably solve the social planner's problem.

The social planner's objective is to maximize consumer surplus subject to insurers' participation constraints holding fixed total risk-adjusted transfers. My proxy for consumer surplus is the long-run expected utility obtained from the demand model:

$$CS_m(H_m) = \sum_{\theta} \Big(EU_i(H_m)\, N_{\theta m} + \sum_{s=t+1}^{T} \zeta^s \sum_{\theta'} (1 - \rho_{\theta' m}) \mathcal{P}(\theta'|\theta) EU_i'(H_m) N_{\theta' m} \Big)$$

where the short-run expected utility, following McFadden (1996), is

$$EU_i = \log \Big(\sum_j \exp(\beta_{im} \sum_k q_{\theta k} H_{jkm} - \alpha_i c_{\theta jm}(H_{jm}) + \phi_j) \Big)$$

The social planner solves the following optimization problem per market:

$$\max_{H_m} \; CS_m(H_m) \qquad (5)$$
$$\text{s.t} \;\; \overline{\Pi}_{jm}(H_m) = 0 \;\forall j$$

where $\overline{\Pi}_{jm}(H_m)$ is the average profit per enrollee. The participation constraints imply that insurers are in perfect competition.

The welfare maximization problem in equation (5) resembles the theoretical model of Section 2 in that the social planner maximizes the sum of consumer surplus and insurer profits, while holding risk-adjusted transfers fixed, which essentially makes these transfers irrelevant for the solution. In solving equation (5) I do not guarantee that the social planner's solution is an equilibrium of the game between insurers, rather, the planner takes insurers' technology as given. Finally, the maximization problem differs from the theoretical model in that the planner's solution is implemented through several insurers and must guarantee that these insurers are willing to participate.

To reduce the computational burden, I solve the social planner's problem only in the capital city of Bogotá. Additionally, because the optimization routine involves searching over 240 parameters (20 services for each of the 12 insurers in this market), I redefine the procedure over 24 parameters, which correspond to network breadth for general medicine and hospital admissions for each insurer, holding network breadth for the rest of services fixed at their values in the observed equilibrium. I focus on general medicine and hospital admissions because these are services commonly used by both healthy and sick individuals. Redefining the social planner's problem in this way means that the solution will reflect a partial equilibrium.

Results are presented in Table 2. Panel A shows the percentage change relative to the observed scenario in average network breadth (across insurers and services), marginal costs, total marginal costs, and long-run consumer surplus for individuals with and without diagnoses. Panel B presents the percentage change in average network breadth for specific services. I find that the social planner would choose networks for general medicine and hospital admissions that are almost twice as broad as in the observed

Table 2: Networks, Costs, and Welfare for Social Planner

Variable	Centralized equilibrium
Panel A. Overall	
Average network breadth	11.09
Marginal cost	8.02
Total marginal cost	7.93
Consumer surplus (with diagnoses)	18.74
Consumer surplus (without diagnoses)	19.09
Panel B. Service network breadth	
General medicine	84.96
Hospital admission	92.46
Other services	0.00

Note: Table presents the percentage change between the social planner's solution and the observed scenario in total marginal cost, total network formation costs, long-run consumer welfare for the healthy and sick, network breadth for general medicine, and network breadth for hospital admissions. The counterfactual is calculated with data from Bogotá only.

scenario. In the case of general medicine this is an average increase from 0.33 to 0.61 across insurers. Network breadth for hospital admissions similarly moves from 0.33 to 0.63. To put these results in context, health plans in the US Health Insurance Exchanges are considered to have broad hospital networks when they cover more than 70% of hospitals in a market (Bauman et al., 2014). Hence, the social planner in my setting would choose broad networks for hospital admissions and general medicine. Appendix Table 8 shows the value of the participation constraints, corroborating that for most insurers the average per-enrollee profit is near zero in my implementation.

The increase in coverage for general medicine and hospital admissions raises insurers' total marginal cost by 8% and long-run consumer surplus by around 19%. This indicates that enhancing coverage for these widely utilized services more than offsets the welfare losses consumers experience from higher out-of-pocket expenses. Importantly, the resulting gain in consumer surplus is relatively uniform across individuals with different health statuses, since general medicine is more commonly used by those without diagnoses, while hospital admissions are more frequent among those with existing diseases, but both services see similar increases in coverage.

The trade-off between total costs and network breadth highlights one reason why the social planner's solution may not be attainable in practice for health systems with managed care competition. A policy that imposes complete network coverage in some services is costly and may generate incentives for insurers to drop coverage of other services altogether—however I am not able to quantify effects on other services given the dimensionality problem.

6 Collusive Equilibrium

I now turn to quantifying how changes in the level of insurer competition affect service network breadth relative to the social planner's benchmark ("first best"). If achieving the first-best solution is impractical due to administrative costs or other hassle costs, two key questions arise: First, can a decentralized equilibrium, in which insurers compete on service network breadth, achieve the first-best outcome? Second, if so, what level of competition is necessary to attain this first-best?

To address these questions, I use the empirical model to simulate a counterfactual scenario in which there is an insurance monopoly and in which insurers collude, approximating the solution outlined in the theoretical model. The impact of joint profit maximization on service network breadth is not immediately clear given the substantial heterogeneity in preferences and costs. On the one hand, we might predict that collusion would lead to narrower networks, as the colluding firms would internalize the negative externality they impose on their competitors' demand. On the other hand, economies of scope and scale could yield cost efficiencies that encourage colluding firms to expand their network breadth.

To derive intuition on the potential impact of imperfect competition from the econometric model, take one market with two firms j and g. When firms collude, they solve following optimization problem:

$$\max_{H_j, H_g} \Pi_j(\mathbf{H_j}, \mathbf{H_g}, \mathbf{H_{-jg}}) + \Pi_g(\mathbf{H_j}, \mathbf{H_g}, \mathbf{H_{-jg}})$$

where $\mathbf{H_j} = \{H_{jk}\}_{k=1}^{K}$ and $\mathbf{H_{-jg}}$ denotes the vector of network breadth for all other firms besides j and g. In the FOC for the merged firm, the derivative of per-enrollee profits with respect to H_{jk} is:

$$\frac{\partial \pi_\theta^*}{\partial H_{jk}} = (R_\theta - (1-r_\theta)C_{\theta j}^*)\frac{\partial s_{\theta j}^*}{\partial H_{jk}} - (1-r_\theta)s_{\theta j}^*\frac{\partial C_{\theta j}^*}{\partial H_{jk}} + (R_\theta - (1-r_\theta)C_{\theta g}^*)\frac{\partial s_{\theta g}^*}{\partial H_{jk}} \tag{6}$$

The upper-script (*) denotes objects that are evaluated in equilibrium. The first term to the right-hand side of equation (6) maps to the theoretical model's selection effect; it captures changes in the composition of marginal consumers weighted by their profitability. The second term describes how collusion may affect the colluding firm's cost structure. If $\frac{\partial C_{\theta j}}{\partial H_{jk}} > \frac{\partial C_{\theta j}^*}{\partial H_{jk}}$, then the new equilibrium may be characterized by broader networks because the colluding firm enjoys greater economies of scope. The third term captures the externality that firm j imposes on firm g's per-enrollee profits and maps to the theoretical model's competitive effect. Because $\frac{\partial s_{\theta g}}{\partial H_{jk}} < 0$, the merged firm internalizes the reduction in g's demand when j increases its network breadth. Therefore, collusion can lead the merged firm to choose narrower networks relative to the scenario where firms compete separately.

The ambiguous predictions of how imperfect competition impacts insurers' equilibrium choices also rest on my assumptions on how the merged firm's cost structure relates to firm j's and g's costs. In my empirical analysis, I approximate the merged firm's costs in several ways to test the importance of marginal and fixed cost heterogeneity as well as the stability of my results. In the first scenario labelled "Average," I assume the merged firm is an average of individual firms within the collusive agreement, so its marginal cost and its fixed cost have a firm fixed effect of $\delta_{\text{merger}} = N^{-1}\sum_{j\in\text{merger}}\delta_j$ and $\xi_{\text{merger}} = N^{-1}\sum_{j\in\text{merger}}\xi_j$, respectively, where N is the number of firms in the agreement. In the second scenario labelled "P25 FE," I assume the merged firm is as efficient as the firm in the 25th percentile of the distribution of firm fixed effects among those in the collusive agreement. Finally, I assume the merged firm does not accrue any cost efficiencies, so $\delta_{\text{merger}} = \max_{j\in\text{merger}}\{\delta_j\}$ and $\xi_{\text{merger}} = \max_{j\in\text{merger}}\{\xi_j\}$. I denote this last scenario as "Max FE."

For the sake of tractability, I conduct these counterfactual analyses in the city of Bogotá. Results are summarized in Table 3. Panel A shows the percentage change relative to the observed scenario in average network breadth, marginal costs, total marginal costs, and long-run consumer surplus for individuals with and without diagnoses. Panel B shows the percentage change relative to the observed scenario in network breadth for specific services. Columns (1) to (3) assume all 12 insurers maximize joint profits under the different assumptions regarding the merged firm's cost structure. Columns (4) to (6) show results assuming only the bottom 5 insurers collude (Insurers C, D, E, L, M).

In line with the intuition derived from equation (6) and from the theoretical model in Section 2, joint profit maximization leads to lower average network breadth in equilibrium because the merged firm internalizes the negative externality it imposes on its competitors. However, as the cost efficiencies achieved by the merged firm increase, the reduction in network breadth from imperfect competition decreases. Under an insurance monopoly, average network breadth across insurers and services falls by 69% relative to the observed scenario when the monopolist is as efficient as the firm in the 25th percentile of the distribution of firm fixed effects. As this efficiency decreases by imposing the average fixed effect and the maximum fixed effect, reductions in average network breadth are as large as 84%. In these cases, the market essentially unravels.

Although network breadth falls across the board, column (1) shows that reductions are larger among entry-level services with high baseline network breadth such as general medicine and laboratory testing relative to complex care such as renal and cardiac care. Given that individuals with diagnoses have higher claim probabilities across all services, their long-run surplus falls by a slightly greater magnitude than for individuals without diagnoses.

When the bottom 5 insurers engage in joint profit maximization, I find qualitatively similar results. In column (4) assuming the merged firm is as efficient as the firm in the 25th percentile of the distribution, average network breadth decreases 3.2%, with reductions being larger among services that mostly individuals with diagnoses tend to claim. The decrease in coverage reduces marginal costs because the direct effect of network breadth on marginal costs is greater than the impact of scope economies. In this case, long-run consumer surplus for individuals with and without diagnoses increases by a moderate amount because of the lower healthcare costs that are passed-through to consumers. As

Table 3: Networks, Costs, and Welfare under Decentralized Equilibria

Variable	Monopoly			Collusion		
	P25 FE (1)	Average FE (2)	Max FE (3)	P25 FE (4)	Average FE (5)	Max FE (6)
Panel A. Overall						
Average network breadth	-68.74	-84.17	-84.35	-3.24	-4.07	-16.02
Marginal cost	-24.81	-20.97	-0.07	-4.85	-0.84	7.38
Total marginal cost	-22.92	-19.57	2.24	-3.56	0.52	3.40
Consumer surplus (with diagnoses)	-35.75	-41.67	-42.26	1.58	1.28	-2.77
Consumer surplus (without diagnoses)	-34.40	-39.95	-40.36	1.48	1.24	-2.69
Panel B. Service network breadth						
Otorhinolaryngologic care	-83.94	-95.49	-95.59	-4.37	-5.17	-17.28
Cardiac care	-61.70	-79.42	-79.64	-4.35	-5.27	-17.62
Gastroenterologic care	-73.07	-88.78	-88.97	-4.32	-5.24	-17.12
Renal care	-62.85	-81.86	-82.09	-4.60	-5.57	-18.55
Gynecologic care	-71.92	-89.01	-89.17	-3.45	-4.39	-16.64
Orthopedic care	-64.35	-81.99	-82.24	-4.40	-5.32	-17.60
Imaging	-73.98	-83.90	-84.03	-1.77	-2.17	-10.89
General medicine	-77.98	-91.10	-91.19	-2.79	-2.95	-10.53
Laboratory	-74.28	-84.61	-84.74	-2.29	-2.60	-11.03
Hospital admission	-67.54	-82.79	-82.99	-2.77	-3.55	-13.89

Note: Panel A presents the percentage change relative to the observed scenario in average network breadth, marginal cost, total marginal cost, and long-run consumer surplus for sick and healthy individuals, in the scenario without risk adjustment in column (1), the scenario with improved risk adjustment in column (2), the scenario with homogeneous average costs in column (3), and the scenario with homogeneous network formation costs in column (4). Panel B presents the percentage change relative to the observed scenario in average network breadth for a few service categories. Simulations use data from Bogotá.

the merged firm becomes more inefficient in columns (5) and (6), network breadth falls by a greater magnitude and consumers experience declines in surplus. Importantly, while network breadth decreases when the bottom 5 insurers collude, in line with the theory, these reductions are economically small, suggesting the observed scenario is not far from imperfect competition with half the number of firms. Appendix Figure 6 presents the distribution of service network breadth in each scenario.

Table 4 explores what happens with each firm in the collusive agreements. Panel A presents the percentage change relative to the observed scenario in average network breadth (across services) and total variable profits for the counterfactual in which there is an insurance monopoly with average efficiency.[11] Panel B presents these statistics when the bottom 5 insurers maximize joint profits and I impose the average firm fixed effect

[11] The change in total variable profits is calculated as the change in total revenues minus the change in total variable costs.

Table 4: Networks and Profits for Colluding Firms

Insurer	Network breadth (1)	Variable profits (2)
Panel A. Monopoly, Avg FE		
Insurer A	-85.02	39.93
Insurer B	-95.22	8.98
Insurer C	-74.90	17.14
Insurer D	-80.18	7.64
Insurer E	-83.07	50.39
Insurer G	-87.09	16.59
Insurer I	-97.04	11.69
Insurer J	-100.00	24.23
Insurer K	-66.47	7.70
Insurer L	-100.00	35.98
Insurer M	-61.27	7.65
Insurer N	-100.00	17.22
Panel B. Collusion, Avg FE		
Insurer C	2.55	-3.16
Insurer D	-8.52	-9.74
Insurer E	24.16	21.17
Insurer L	-96.64	5.26
Insurer M	16.09	-25.76

Note: Table presents the percentage change in average network breadth, total profits, and short-run average cost per enrollee for the insurers that collude.

in their cost structure. Each firm that makes up the insurance monopoly substantially reduces their network breadth relative to the observed scenario, and in some cases shuts down. These reductions range from 75% for Insurer C to 100% for insurer N. Consistent with joint profit maximization generating higher profits for each individual firm, Panel A, column (2) shows that variable profits increase between 7% and 50% across insurers. For insurers J, L, and N, for which network breadth completely collapses, the change in total variable profits essentially represents their scrap value.

In Panel B, I find that collusion among the bottom 5 insurers, results in one of these insurers shutting down (Insurer L), and the rest absorbing its demand and increasing network breadth. The reduction in coverage documented in Table 3 is therefore explained by the best response of insurers that are not in the collusive agreement. Column (2) shows that only 2 out of the 5 insurers that maximize joint profits see increases in total variable profits. However, the average change in variable profits weighted by demand is positive and equal to 1.32%.

The findings in this section show that collusion exacerbates risk selection incentives. Insurers in this market engage in risk selection by offering narrower networks for less profitable services. Thus, the significant decline in network breadth across services when firms maximize joint profits suggests lower levels of competition facilitate risk selection. Conversely, findings also suggest that a market equilibrium with strong competition between private health insurers, even if premiums and cost-sharing are regulated, can more closely approximate the social planner's solution. Table 2 showed that the social planner would choose around 60% coverage for general medicine and hospital admissions (holding other services fixed), while Table 3 indicates that network breadth for these two services when the bottom 5 insurers collude would be 28 percentage points farther away from the first-best.

7 Network Adequacy Rules

Encouraging competition among insurers to achieve broader provider networks can be challenging from a policy perspective. As an alternative, the social planner can develop regulations that directly target quality. In this section, I examine the impacts of an increasingly common policy tool known as network adequacy rules, which may go from guaranteeing minimum provider-to-enrollee ratios to forcing insurers to cover specific providers.

I implement a network adequacy rule that forces insurers to offer the same network breadth for hospital admissions and general medicine, which resembles the social planner's solution derived in Section 5. Given the model estimates, network adequacy rules that mandate coverage of specific providers will likely result in greater coverage after accounting for endogenous supply responses because insurers enjoy substantial economies of scale in the number of covered providers.

Formally, I impose that each insurer selects identical networks for general medicine and hospital care, i.e., $H_{\text{gen. med.}} = H_{\text{hosp}}$ without placing restrictions on the ultimate network breadth levels. Instead, the model determines insurers' optimal responses given this network adequacy constraint. However, the solution depends on assumptions regarding the fixed costs insurers face for these two services. If insurers choose to cover both hospital admissions and general medicine through the same provider, it is reasonable to assume they incur one average fixed cost across these services rather than separate ones. Alternatively, if insurers contract with additional providers for only one of the services, they would face distinct fixed costs for general medicine and hospital care. In my implementation, I adopt the former assumption.

TABLE 5: Networks, Costs, and Welfare Under Network Adequacy

Variable	Network adequacy
Panel A. Overall	
Average network breadth (all)	0.72
Average network breadth (rest)	-0.22
Marginal cost	-0.04
Total marginal cost	0.15
Consumer surplus (with diagnoses)	0.26
Consumer surplus (without diagnoses)	0.19
Panel B. Service network breadth	
Otorhinolaryngologic care	-0.22
Cardiac care	-0.21
Gastroenterologic care	-0.21
Renal care	-0.22
Gynecologic care	-0.22
Orthopedic care	-0.21
Imaging	-0.16
General medicine	-1.11
Laboratory	-0.15
Hospital admission	17.07

Note: Panel A presents the percentage change in average network breadth, marginal costs, total marginal costs, and long-run consumer welfare for individuals with and without diagnoses, in the scenario with a network adequacy prohibiting discrimination of networks across hospital admissions and general medicine. Panel B presents the percentage change in average network breadth by service category. Simulations use data from Bogotá.

Table 5 presents the results. Panel A shows that average network breadth would increase across insurers, because network breadth for hospital admissions increases 17% while network breadth for general medicine decreases 1% as seen in Panel B. Insurers also respond to the policy by decreasing network breadth for other services, although the reduction is economically small. The increase in coverage for hospital admissions coupled with the slight decrease among other services results in slightly higher total average costs for insurers. Despite reductions in coverage for other services, long-run consumer surplus rises for both types of consumers, with increases being larger among those with chronic diseases. This suggests that guaranteeing broad networks across *all* services is not needed to improve welfare but perhaps only across a few key services.

The network adequacy rule generates an equilibrium that is closer to the social planner's solution from Table 2 but does not fully implement it. Consumer surplus increases under the network adequacy rule but not by a similar magnitude as in the social planner's solution. One concern with fully implementing the centralized outcome is that the health system may incur substantial administrative costs. For example, the network adequacy rule considered in this section raises insurers' fixed costs by 10% on average. The lesson from this exercise is that designing network adequacy regulations should consider its impacts on health system administrative costs.

8 Conclusion

This paper analyzes how insurer competition on quality—proxied by insurers' provider network breadth—affects welfare in health insurance markets with regulated premiums. I show that in these markets, stronger competition raises welfare by mitigating the underprovision of provider network coverage associated with adverse selection. Using a structural model of the Colombian health insurance system, I provide the first empirical characterization of equilibrium quality under the social planner. Results indicate that the planner would choose substantially broader provider networks—roughly twice as broad as in the observed equilibrium—but not full coverage.

Counterfactual simulations show that any degree of imperfect competition reduces welfare: collusion or monopoly leads to significantly narrower networks and to equilibria that are farther from the social planner's benchmark. Direct quality regulations such as network adequacy rules can help expand coverage and improve welfare but they fall short of replicating the planner's solution. My findings suggest that in markets where premiums are heavily regulated, competition on quality is unambiguously welfare-enhancing. However, policies designed to approximate the first-best must weigh the gains from broader coverage against the administrative costs of enforcing it.

References

AZEVEDO, E. M. AND D. GOTTLIEB (2017): "Perfect Competition in Markets with Adverse Selection," *Econometrica*, 85, 67–105.

BAUMAN, N., E. COE, J. OGDEN, AND A. PARIKH (2014): "Hospital Networks: Updated National View of Configurations on the Exchanges," *McKinsey Report*, accessed through https://www.mckinsey.com/industries/healthcare/our-insights/hospital-networks-updated-national-view-of-configurations-on-the-exchanges/.

BREKKE, K. R., L. SICILIANI, AND O. R. STRAUME (2011): "Hospital Competition and Quality with Regulated Prices," *Scandinavian Journal of Economics*, 113, 444–469.

BUNDORF, M. K., J. LEVIN, AND N. MAHONEY (2012): "Pricing and Welfare in Health Plan Choice," *American Economic Review*, 102, 3214–3248.

COOPER, Z., S. GIBBONS, S. JONES, AND A. MCGUIRE (2011): "Does hospital competition save lives? Evidence from the English NHS patient choice reforms," *The Economic Journal*, 121, F228–F260.

CUESTA, J. I. AND A. SEPÚLVEDA (2021): "Price Regulation in Credit Markets: A Trade-off Between Consumer Protection and Credit Access," *Available at SSRN 3282910*.

CUESTA, J. I. AND P. TEBALDI (2025): "Public Procurement vs. Regulated Competition in Selection Markets," National Bureau of Economic Research, Working Paper 34141.

CUTLER, D. M., M. MCCLELLAN, AND J. P. NEWHOUSE (2000): "How does managed care do it?" *The Rand journal of economics*, 526–548.

CUTLER, D. M. AND S. J. REBER (1998): "Paying for Health Insurance: The Trade-Off between Competition and Adverse Selection," *The Quarterly Journal of Economics*, 113, 433–466.

DAFNY, L. (2010): "Are Health Insurance Markets Competitive?" *American Economic Review*, 100, 1399–1431.

Dafny, L., J. Gruber, and C. Ody (2015): "More Insurers Lower Premiums: Evidence from Initial Pricing in the Health Insurance Marketplaces," *American Journal of Health Economics*, 1, 53–81.

Fang, H. and Z. Wu (2018): "Multidimensional Private Information, Market Structure, and Insurance Markets," *The RAND Journal of Economics*, 49, 751–787.

Gaynor, M., R. Moreno-Serra, and C. Propper (2013): "Death by Market Power: Reform, Competition, and Patient Outcomes in the National Health Service," *American Economic Journal: Economic Policy*, 5, 134–166.

Glied, S. (2000): *Managed care*, vol. 1, Elsevier.

Guth, M., M. Ammula, and E. Hinton (2021): "Understanding the Impact of Medicaid Premiums & Cost-Sharing: Updated Evidence from the Literature and Section 1115 Waivers," *Kaiser Family Foundation Report*.

Ho, K. and R. Lee (2017): "Insurer Competition in Health Care Markets," *Econometrica*, 85, 379–417.

Kong, E., T. Layton, and M. Shepard (2024): "Adverse Selection and (Un) Natural Monopoly in Insurance Markets," Working Paper.

MacLeod, W. B. (2021): "A Welfare Analysis of Competitive Insurance Markets with Vertical Differentiation and Adverse Selection," National Bureau of Economic Research.

Mahoney, N. and G. Weyl (2017): "Imperfect Competition in Selection Markets," *The Review of Economics and Statistics*, 99, 637–651.

McFadden, D. (1996): "Computing Willingness-to-Pay in Random Utility Models," *University of California at Berkeley, Econometrics Laboratory Software Archive, Working Papers*.

Propper, C., S. Burgess, and K. Green (2004): "Does Competition Between Hospitals Improve the Quality of Care?: Hospital Death Rates and the NHS Internal Market," *Journal of Public Economics*, 88, 1247–1272.

ROTHSCHILD, M. AND J. STIGLITZ (1976): "Equilibrium in Competitive Insurance Markets: An Essay on the Economics of Imperfect Information*," *The Quarterly Journal of Economics*, 90, 629–649.

SALTZMAN, E., A. SWANSON, AND D. POLSKY (2021): "Inertia, Market Power, and Adverse Selection in Health Insurance: Evidence from the ACA Exchanges," National Bureau of Economic Research.

SERNA, N. (2024): "Determinants of Healthcare Provider Networks: Risk Selection vs. Administrative Costs," .

SHAKED, A. AND J. SUTTON (1982): "Relaxing Price Competition Through Product Differentiation," *The Review of Economic Studies*, 49, 3–13.

STIGLITZ, J. AND J. YUN (2013): "Optimality and Equilibrium in a Competitive Insurance Market under Adverse Selection and Moral Hazard," National Bureau of Economic Research.

TRISH, E. E. AND B. J. HERRING (2015): "How do health insurer market concentration and bargaining power with hospitals affect health insurance premiums?" *Journal of Health Economics*, 42, 104–114.

VATTER, B. (2025): "Quality Disclosure and Regulation: Scoring Design in Medicare Advantage," *Econometrica*, 93, 959–1001.

VEIGA, A. AND E. G. WEYL (2016): "Product Design in Selection Markets," *The Quarterly Journal of Economics*, 131, 1007–1056.

Supplemental Appendix

Appendix 1 Proofs

1.1 Proposition 1

Given the conditions on the utility and cost functions, $H^*_{planner} > H^*_{mon}$.

Proof. The monopolist's profit is:

$$\Pi(H) = \int_{\theta^*(H)}^{1} \Big[R(\theta) - (1-r)c(H,\theta)\Big] f(\theta)\, d\theta.$$

and the planner's welfare function is:

$$W(H) = \int_{\theta^*(H)}^{1} \Big[u(H,\theta) - c(H,\theta)\Big] f(\theta)\, d\theta.$$

where I have assumed no externalities ($w = u$).

Define

$$\Delta(H) \equiv W(H) - \Pi(H) = \int_{\theta^*(H)}^{1} \Big[u(H,\theta) - R(\theta) - rc(H,\theta)\Big] f(\theta)\, d\theta.$$

Differentiating yields:

$$\frac{d\Delta}{dH} = \int_{\theta^*(H)}^{1} (u_H(H,\theta) - rc_H(H,\theta)) f(\theta)\, d\theta \;-\; \big[u(H,\theta^*) - R(\theta^*) - rc(H,\theta^*)\big] \frac{d\theta^*}{dH}.$$

The marginal consumer satisfies $u(H,\theta^*) = rc(H,\theta^*)$, so the expression above simplifies to

$$\frac{d\Delta}{dH} = \int_{\theta^*(H)}^{1} (u_H(H,\theta) - rc_H(H,\theta)) f(\theta)\, d\theta - R(\theta^*) \left(\frac{d\theta^*}{dH}\right).$$

This expression is strictly positive since $u_H(H,\theta) > rc_H(H,\theta)$ by assumption and since $R(\theta^*) > 0$ and $d\theta^*/dH < 0$.

Therefore,

$$\frac{d\Delta}{dH} > 0 \quad \text{for all } H.$$

At the monopolist's optimum H^*_{mon},

$$\frac{d\Pi}{dH}(H^*_{\text{mon}}) = 0.$$

Then

$$\frac{dW}{dH}(H^*_{\text{mon}}) = \frac{d\Pi}{dH}(H^*_{\text{mon}}) + \frac{d\Delta}{dH}(H^*_{\text{mon}}) = 0 + \frac{d\Delta}{dH}(H^*_{\text{mon}}) > 0.$$

So welfare is still increasing at H^*_{mon}, implying that the planner's maximizer satisfies

$$H^*_{\text{planner}} > H^*_{\text{mon}}.$$

Finally, since $\theta^*(H)$ decreases in H, it follows that

$$\theta^*(H^*_{\text{planner}}) < \theta^*(H^*_{\text{mon}}).$$

□

1.2 Proposition 2

The insurance duopoly has a Nash equilibrium in which $H^*_b > H^*_a$.

Proof. I first proof that a Nash equilibrium exists. Let firm $j \in \{a, b\}$ choose network breadth $H_j \in [0, 1]$ to maximize:

$$\Pi_j(H_j, H_{-j}) = \int_{B_j} \Big[R(\theta) - (1 - r)c(H_j, \theta)\Big] f(\theta)\, d\theta,$$

where B_j is the set of consumer types who choose firm j, and is determined by utility indifference conditions as in the main text.

Given the (i) assumptions of continuity, concavity, and continuous differentiability of $u(H, \theta)$ and $c(H, \theta)$ and (ii) compact and convex strategy space, each firm's objective function is continuous in its own strategy and in its rival's. Moreover, the profit function is concave in H_j. Therefore, by the Weierstrass Theorem, a maximum exists for each firm's best response:

$$H_j^* = \arg\max_{H_j \in [0,1]} \Pi_j(H_j, H_{-j}).$$

Define the best response correspondence as:

$$\mathcal{B}_j(H_{-j}) = \arg\max_{H_j \in [0,1]} \Pi_j(H_j, H_{-j}).$$

This mapping is nonempty (by compactness), convex-valued (due to concavity), and upper hemicontinuous. Thus, the best response correspondence $\mathcal{B} : [0,1]^2 \rightrightarrows [0,1]^2$ satisfies the conditions of Kakutani's fixed-point theorem. Therefore, there exists a fixed point $(H_a^*, H_b^*) \in \mathcal{B}(H_a^*, H_b^*)$.

Now I show that the Nash equilibrium is asymmetric, with one firm choosing higher network breadth than the other. Suppose as in the main text that insurer b serves consumer types $\theta \in [\theta', 1]$ and insurer a serves types $\theta \in [\theta_{duo}, \theta']$.

At type θ', the consumer that is indifferent between enrolling with each firm satisfies:

$$u(H_a, \theta') - rc(H_a, \theta') = u(H_b, \theta') - rc(H_b, \theta').$$

Define $\Delta(H, \theta) = u(H, \theta) - rc(H, \theta)$. By differentiating with respect to θ, we get:

$$\frac{\partial \Delta}{\partial \theta} = u_\theta(H, \theta) - rc_\theta(H, \theta) > 0,$$

by assumption. Suppose, by contradiction, that $H_b < H_a$. Then:

$$\Delta(H_b, \theta') < \Delta(H_a, \theta'),$$

so type θ' would strictly prefer insurer a, hence $H_b < H_a$ is not an equilibrium.

Thus, the only consistent sorting equilibrium under the model's primitives is:

$$H_b \geq H_a$$

□

1.3 Proposition 3

Let H^*_{mon} denote the monopolist's optimal network, and let (H^*_a, H^*_b) denote the equilibrium network choices in an asymmetric duopoly. Then $H^*_{mon} < \frac{1}{2}(H^*_a + H^*_b) < H^*_{planner}$.

Proof. To show that the average optimal network breadth in the duopoly is greater than the monopolist's optimal network breadth, I first show that the minimum optimal network breadth in the duopoly is at least the monopolist's network breadth, $\min\{H^*_a, H^*_b\} \geq H^*_{mon}$.

The monopolist maximizes:

$$\Pi(H) = \int_{\theta^*_{mon}(H)}^{1} [R(\theta) - (1-r)c(H,\theta)]\, f(\theta)\, d\theta,$$

where $\theta^*_{mon}(H)$ solves $u(H, \theta^*_{mon}) = rc(H, \theta^*_{mon})$.

Differentiating yields:

$$\frac{d\Pi}{dH} = -(1-r)\mathbb{E}[c_H(H,\theta) \mid \theta \geq \theta^*_{mon}(H)] - [R(\theta^*_{mon}) - (1-r)c(H, \theta^*_{mon})](\text{selection effect}),$$

where the selection effect is negative, making the second part of the expression positive.

Now consider insurer a who serves types $\theta \in B_a = [\theta^*_{duo}, \theta']$. Its profit is:

$$\Pi_a(H_a, H_b) = \int_{B_a} [R(\theta) - (1-r)c(H_a,\theta)]\, f(\theta)\, d\theta.$$

Differentiating yields:

$$\begin{aligned} \frac{d\Pi_a}{dH_a} = &-(1-r)\mathbb{E}[c_H(H_a,\theta)|B_a] - \left[R(\theta^*_{duo}) - (1-r)c(H_a, \theta^*_{duo})\right] (\text{selection effect}) \\ &+ \left[R(\theta') - (1-r)c(H_a, \theta')\right] (\text{competitive effect}) \end{aligned}$$

Comparing the FOCs, we first have that the average marginal cost for insurer a is lower than for the monopolist given that a serves consumers of lower type. Second, because $R_\theta(\theta) < (1-r)c_\theta(H,\theta)$ by assumption and $\theta^*_{duo} < \theta^*_{mon}$, then $R(\theta^*_{duo}) - (1-r)c(H_a, \theta^*_{duo}) >$

$R(\theta^*_{mon}) - (1-r)c(H_a, \theta^*_{mon})$. Third, the competitive effect is positive for insurer a and missing for the monopolist.

Therefore:

$$\left.\frac{d\Pi_a}{dH_a}\right|_{H_a^*} > \left.\frac{d\Pi}{dH}\right|_{H^*_{\text{mon}}}$$

for any given H.

Since both problems are strictly concave, this implies:

$$H_a^* > H^*_{\text{mon}}.$$

Now I show that the maximum network breadth in the duopoly is less than the social planner's optimum, $\max\{H_a^*, H_b^*\} \leq H^*_{\text{planner}}$. The planner chooses H to maximize:

$$W(H) = \int_{\theta^*(H)}^{1} [w(H,\theta) - c(H,\theta)]\, f(\theta)\, d\theta.$$

Assuming no externalities ($w = u$), the FOC of the welfare maximization problem is:

$$\frac{dW}{dH} = \mathbb{E}\left[u_H(H,\theta) - c_H(H,\theta) | \theta > \theta^*\right] - (u(H,\theta^*) - c(H,\theta^*))\left(\frac{d\theta^*}{dH}\right)$$

In the duopoly, the firm serving the sickest consumer types chooses H_j to maximize:

$$\Pi_b(H_a, H_b) = \int_{B_b} [R(\theta) - (1-r)c(H_b,\theta)]\, f(\theta)\, d\theta,$$

where $B_b = [\theta'(H_a, H_b), 1]$ is the subset of consumers enrolling with insurer b. The FOC for this firm is:

$$\frac{d\Pi_b}{dH_b} = -\mathbb{E}\left[(1-r)c_H(H_b,\theta)|B_b\right] - \left[R(\theta') - (1-r)c(H_b,\theta')\right]\left(\frac{d\theta'}{dH_b}\right)$$

where $d\theta'/dH_b < 0$.

Comparing the FOCs we have that insurer b has higher average marginal cost than the social planner because it serves sicker consumer types. From Proposition 1 we also know that the profitability of the marginal consumer is higher for the social planner than the private firm. Hence, $dW/dH > d\Pi_b/dH_b$. Given that the problems are concave, we can conclude that $H^*_{\text{planner}} > H^*_b$.

□

Appendix 2 Relation to Rothschild-Stiglitz Model

This Appendix describes the equilibrium in the Rothschild and Stiglitz (1976) model when firms cannot charge prices. Suppose there is a unit mass of risk-averse consumers with utility $u : \mathbb{R}_+ \to \mathbb{R}$, where $u' > 0$ and $u'' < 0$. Each consumer has exogenous wealth $W > 0$ and faces a potential monetary loss $L \in (0, W)$ if they become sick (denoted by S). Consumers differ in their loss probability $p \in \{p_L, p_H\}$ with $0 < p_L < p_H < 1$. Let the population shares be $\lambda \in (0, 1)$ for p_L and $1 - \lambda$ for p_H. A type-p consumer's expected utility from state-contingent consumption for the healthy and sick states (c_H, c_S) is

$$U(c_H, c_S \mid p) = (1 - p)\, u(c_H) + p\, u(c_S).$$

An insurance contract is a pair $(\alpha, P) \in [0, L] \times \mathbb{R}_+$, where α is the amount paid by the insurer if the loss occurs and P is the premium paid by the consumer in both states. I assume this premium is fixed. Given (α, P), a consumer's consumption is

$$c_H = W - P, \qquad c_S = W - L + \alpha - P \tag{7}$$

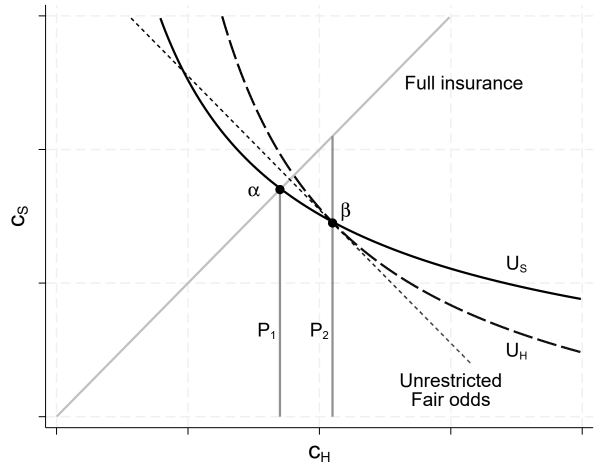
There is free entry of competitive, risk-neutral, expected-profit maximizer insurers. If a type-p consumer buys (α, P), the insurer's expected cost is $p\alpha$. Hence the (type-p) zero-profit condition is

$$\alpha = \frac{P}{p} \tag{8}$$

In (c_H, c_S) space, equations (7) and (8) imply the type-p zero-profit line is

$$c_S = W - L + \left(\frac{1 - p}{p}\right) P$$

which is independent of c_H because of fixed premiums.



Appendix Figure 1: Rothschild-Stiglitz Model with Quality-Only Competition

Note: Figure shows the Rothschild-Stiglitz model under the assumption that premiums are fixed and insurers choose only how much to pay in the event of sickness. The unrestricted fair odds line depicts the zero-profit condition without premium regulation.

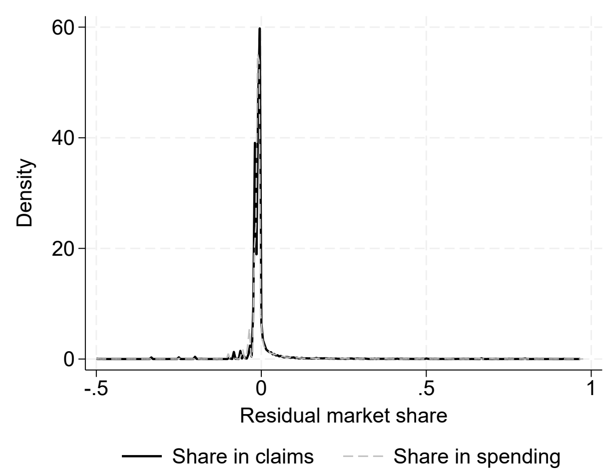
Appendix Figure 1 depicts the model. In this case, the zero-profit condition is depicted by the vertical lines. These lines move horizontally depending on the value of P, which is set exogenously.

First, I examine whether a pooling equilibrium exists. Suppose the premium is P_1. In this case, a pooling contract (α, P_1) cannot be an equilibrium because healthy types would choose uninsurance and insurers' profit would be $\pi < 0$, violating the zero-profit condition. This shows that when P is set too low, the market can unravel. Now suppose the premium is P_2. In this case, a pooling contract (β, P_2) is an equilibrium. If the insurer deviates and offers $\beta + \epsilon$, both consumer types would prefer this contract over β and the insurer would make a loss. A similar argument shows that a separating equilibrium exists in which the contracts are (α, P_1) and (β, P_2).

Appendix 3 Additional Descriptive Evidence

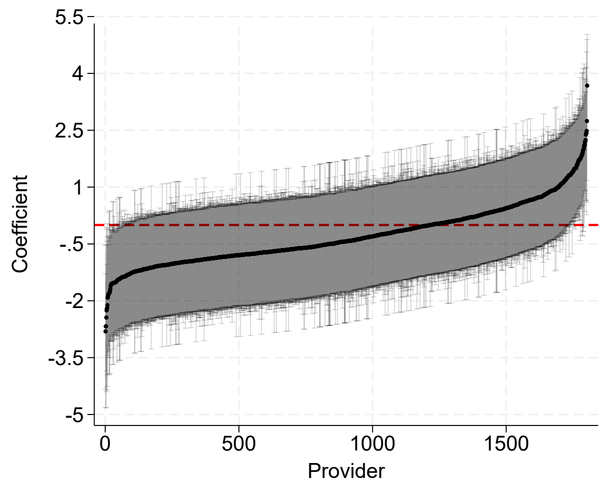
Appendix Table 1: List of services

Service code	Description
01	**Neurosurgery:** Procedures in skull, brain, and spine
02	**Other neurologic care:** Procedures in nerves and glands
03	**Otorhinolaryngologic care:** Procedures in face and trachea
04	**Pneumologic care:** Procedures in lungs and thorax
05	**Cardiac care:** Procedures in cardiac system
06	**Angiologic care:** Procedures in lymphatic system and bone marrow
07	**Gastroenterologic care:** Procedures in digestive system
08	**Hepatologic care:** Procedures in liver, pancreas, and abdominal wall
09	**Renal care:** Procedures in urinary system
10	**Gynecologic care:** Procedures in reproductive system
11	**Orthopedic care:** Procedures in bones and joints
12	**Other orthopedic care:** Procedures in tendons, muscles, and breast
13	**Diagnostic aid:** Diagnostic procedures in skin and subcutaneous cellular tissue
14	**Imaging:** Radiology and non-radiology imaging
15	**Internal and general medicine:** Consultations
16	**Laboratory:** Laboratory and blood bank
17	**Nuclear medicine:** Nuclear medicine and radiotherapy
18	**Rehab and mental health:** Rehabilitation, mental health care, therapy
19	**Therapy (chemo and dialysis):** Prophylactic and therapeutic procedures
20	**Hospital admissions:** Inpatient services



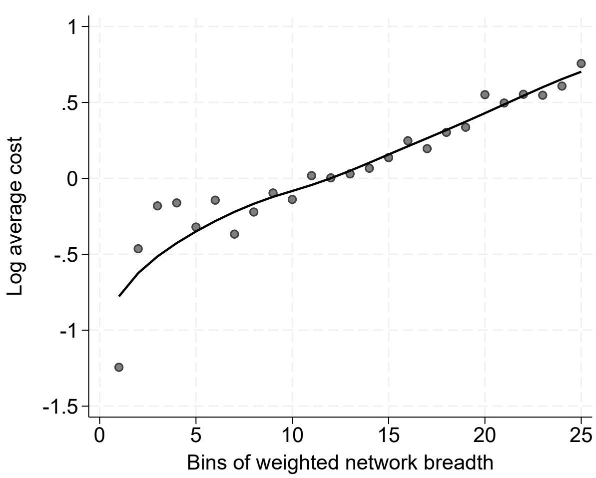
Appendix Figure 2: Residual Provider Market Share

Note: Figure presents the distribution of residuals from a regression of provider market shares in the number of claims (in black) and of provider market share in total health care spending (in gray) on market-by-service fixed effects.

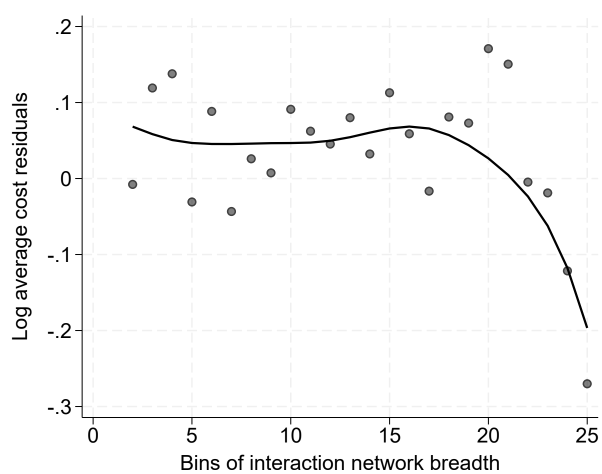


Appendix Figure 3: Differences in Unobserved Provider Quality

Note: Figure shows the coefficients and 95% confidence intervals of provider fixed effects in a regression of average provider prices per service on provider and service fixed effects. An observation in this regression is a provider-service combination. Average prices are calculated over the insurers that cover each provider.



(a) Network breadth



(b) Network breadth interactions

Appendix Figure 4: Empirical Relation of Log Average Cost per Enrollee

Note: Panel A presents a scatter plot of log average cost per enrollee averaged within 20 bins of weighted service network breadth, $\sum_k q_{\theta k} H_{jkm}$. Panel B presents a scatter plot of log average cost per enrollee averaged within 20 bins of weighted interactions of network breadth across pairs of services, $\sum_k \sum_l q_{\theta k} q_{\theta l} H_{jkm} H_{jlm}$. The solid line represents a linear fit.

Appendix 4 Model Summary

In this Appendix I describe additional details of the empirical model of insurer competition in service-level network breadth presented in Serna (2024).

4.1 Service Claim Probabilities

I estimate the claim probability, $q_{\theta k}$, outside of the model. I use data from all enrollees in 2010 and 2011 to estimate the following logistic regression:

$$\text{logit(any claims)}_{ik} = \psi_k + \psi_\theta + \epsilon_{ik}$$

The dependent variable is an indicator for whether patient i makes a claim for service k, and ψ_k and ψ_θ are service and consumer type fixed effects, respectively.

4.2 Model Estimates

The following tables summarize the model estimates from Serna (2024). Appendix Table 2 shows estimation results for the insurer demand model. I find that consumers have preferences for broad networks and dislike out-of-pocket costs. The estimates imply that willingness-to-pay for service network breadth—defined as $\frac{1}{-\alpha_i}\frac{\partial s_{ijm}}{\partial H_{jkm}}\frac{H_{jkm}}{s_{ijm}}$—is higher for individuals with chronic conditions than for individual without diagnoses, consistent with adverse selection. As shown in Serna (2024), demand estimates are robust to alternative calculations of network breadth weighting each provider by their number of beds, to considering only diagnoses that individuals receive in January 2011 to determine their health status, and to including a separate variable denoting network breadth among the roughly 40 top-tier academic medical centers.

Appendix Table 3 shows results of insurers' marginal costs. These costs are increasing in service network breadth in line with broad-network insurers negotiating higher prices with providers, but at a decreasing rate, in line with insurers enjoying economies of scope across services. My estimates are robust to more granular definitions of consumer type, to constructing network breadth weighting each provider by their number of beds, and to accounting for any remaining quality variation across providers using network breadth among academic medical centers.

Appendix Tables 4 and 5 present summary statistics of dropout and transition probabilities which enter the computation of future profits. These probabilities are estimated outside of the model as follows. To compute both probabilities, I use enrollment data for all continuously enrolled individuals between 2010 and 2011. The probability that a consumer type θ drops out of the contributory system is the fraction of consumers type θ enrolled in 2010 but not enrolled in 2011. The transition probability is the fraction of consumers type θ in 2010 that turn into θ' in 2011.

Appendix Table 2: Insurer Demand

Variable	Network breadth		OOP spending (million)	
	coef	se	coef	se
Mean	3.429	(0.021)	-1.602	(0.117)
Interactions				
Male	0.543	(0.010)	0.121	(0.066)
Cancer	-0.601	(0.013)	0.003	(0.092)
Cardiovascular	-0.901	(0.011)	-0.205	(0.075)
Diabetes	-0.464	(0.023)	0.008	(0.105)
Other disease	-0.783	(0.015)	0.465	(0.068)
Pulmonary	-0.610	(0.031)	0.841	(0.095)
Renal	0.039	(0.037)	0.873	(0.069)
Age 19-24	0.055	(0.020)	0.566	(0.158)
Age 25-29	-0.575	(0.019)	0.326	(0.120)
Age 30-34	-0.560	(0.019)	0.338	(0.130)
Age 35-39	-0.456	(0.020)	-0.312	(0.215)
Age 40-44	-0.356	(0.020)	0.442	(0.161)
Age 45-49	-0.384	(0.019)	0.237	(0.141)
Age 50-54	-0.324	(0.020)	0.314	(0.133)
Age 55-59	-0.246	(0.021)	0.477	(0.122)
Age 60-64	-0.147	(0.023)	0.160	(0.121)
N	5200890			
Pseudo-R^2	0.112			

Note: Table presents a conditional logit model of insurer choice estimated by maximum likelihood on a random sample of 500,000 new enrollees. An observation is a combination of individual and insurer. Specification includes insurer fixed effects. Robust standard errors in parenthesis.

Appendix Table 3: Insurer Average Costs Per Enrollee

Variable	Log average cost per enrollee coef	se
Service network breadth	0.274	(0.047)
Scope economies	-1.100	(0.580)
Reference price	3.372	(0.544)
Insurer FE		
Insurer A	0.156	(0.038)
Insurer B	-0.084	(0.022)
Insurer C	0.020	(0.025)
Insurer D	-0.137	(0.027)
Insurer E	0.279	(0.047)
Insurer F	-0.012	(0.062)
Insurer G	0.062	(0.033)
Insurer H	0.043	(0.040)
Insurer I	-0.002	(0.017)
Insurer J	0.099	(0.020)
Insurer K	-0.135	(0.033)
Insurer L	0.116	(0.035)
Insurer M	-0.059	(0.032)
Constant	-1.368	(0.097)
Consumer type FE	Yes	
Market FE	Yes	
N	18369	
R^2	0.611	

Note: Table presents OLS regressions of the log of average costs per consumer type on service network breadth, the measure economies of scope, and the service reference price. An observation is a combination of insurer, consumer type, market and year. Estimation uses data from all continuously enrolled individuals in 2010 and 2011. Specification includes consumer type fixed effects, market fixed effects, and insurer fixed effects. Robust standard errors in parenthesis.

Appendix Table 4: Dropout Probabilities

	mean	sd
Female	0.084	(0.131)
Male	0.106	(0.165)
Age 19-24	0.120	(0.177)
Age 25-29	0.087	(0.134)
Age 30-34	0.081	(0.135)
Age 35-39	0.085	(0.141)
Age 40-44	0.085	(0.146)
Age 45-49	0.085	(0.149)
Age 50-54	0.089	(0.153)
Age 55-59	0.091	(0.158)
Age 60-64	0.092	(0.158)
Age 65-69	0.096	(0.159)
Age 70-74	0.104	(0.160)
Age 75+	0.124	(0.164)
Cancer	0.048	(0.024)
Diabetes	0.027	(0.008)
Cardiovascular	0.028	(0.009)
Pulmonary	0.040	(0.015)
Renal	0.044	(0.018)
Other disease	0.026	(0.011)
Healthy	0.450	(0.073)

Note: Mean and standard deviation in parenthesis of dropout probabilities conditional on diagnosis in the first panel, age group in the second panel, and sex in the third panel.

Appendix Table 5: Transition Probabilities

Diagnosis	Stat	Cancer	Cardio	Diabetes	Renal	Pulmonary	Other	Healthy
Cancer	mean	0.316	0.017	0.139	0.014	0.007	0.047	0.460
	sd	0.067	0.014	0.090	0.013	0.006	0.019	0.176
Diabetes	mean	0.030	0.557	0.170	0.009	0.013	0.021	0.200
	sd	0.026	0.078	0.100	0.010	0.011	0.010	0.140
Cardio	mean	0.043	0.028	0.554	0.014	0.011	0.034	0.316
	sd	0.036	0.018	0.205	0.012	0.010	0.009	0.224
Pulmonary	mean	0.055	0.019	0.191	0.234	0.007	0.078	0.416
	sd	0.046	0.014	0.089	0.152	0.006	0.034	0.231
Renal	mean	0.044	0.036	0.214	0.012	0.371	0.058	0.265
	sd	0.035	0.030	0.132	0.013	0.062	0.031	0.154
Other	mean	0.056	0.016	0.156	0.023	0.008	0.343	0.398
	sd	0.040	0.013	0.106	0.020	0.004	0.058	0.095
Healthy	mean	0.055	0.012	0.108	0.014	0.004	0.045	0.762
	sd	0.042	0.008	0.068	0.014	0.003	0.021	0.109

Note: Table presents mean and standard deviation in parenthesis of transition probabilities across diagnoses. Summary statistics are calculated across sex-age combinations in each cell.

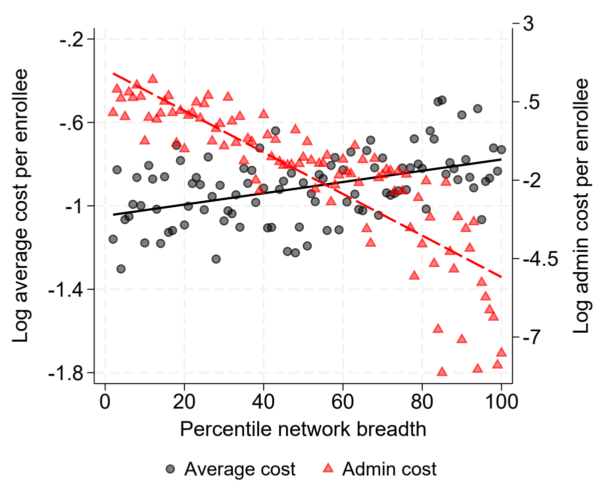
Using the demand, merginal costs, and dropout and transition probability estimates, I forward simulate the insurers' profit function and marginal variable profits for 100 periods. I estimate the remaining parameters associated with the fixed cost from insurers' FOC, re-written below:

$$\text{MVP}_{jkm} = \omega H_{jkm} + \xi_j + \xi_m + \xi_{jkm}$$

where

$$\text{MVP}_{jkm} \equiv \sum_i \left(\frac{\partial \pi_{ijm}}{\partial H_{jkm}} N_{\theta m} + \sum_{s=t+1}^{T} \zeta^s \sum_{\theta'} (1 - \rho_{\theta' m}) \mathcal{P}(\theta' | \theta) \frac{\partial \pi'_{ijm}}{\partial H_{jkm}} N_{\theta' m} \right)$$

To accommodate the fact that marginal variable profits vary substantially across insurers and some values are relatively large (in the order of billions of COP), I estimate the parameters on the log of MVP_{jkm}. Appendix Table 6 presents first-stage results of network breadth on the instrument (the average claim probabilities among healthy consumers) and 7 presents second-stage results. As before these estimates are also robust to constructing network breadth weighting providers by their number of beds.



Appendix Figure 5: Model-predicted relation between average costs, administrative costs, and networks

Note: Figure presents a scatter plot of the log of model-predicted average cost per enrollee (for every insurer and market) within each percentile of average network breadth (averaged across services) in black. Log average costs are depicted on the left vertical axis. The solid black line corresponds to a linear fit. On the right vertical axis and in the red markers, the figure presents a scatter plot of the log of model-predicted network administrative cost per enrollee within each percentile of average network breadth (averaged across services). The dashed red line corresponds to a linear fit.

Appendix Table 6: First-Stage Regression for Fixed Cost Estimation

	Service network breadth	
	coef	se
Claim probability, healthy	0.310	(0.019)
Insurer FE		
Insurer A	-0.322	(0.013)
Insurer B	-0.103	(0.016)
Insurer C	-0.255	(0.014)
Insurer D	-0.199	(0.014)
Insurer E	-0.249	(0.020)
Insurer F	-0.301	(0.026)
Insurer G	-0.330	(0.014)
Insurer H	-0.031	(0.029)
Insurer I	-0.074	(0.016)
Insurer J	-0.178	(0.015)
Insurer K	-0.198	(0.020)
Insurer L	-0.034	(0.026)
Insurer M	-0.303	(0.018)
Constant	0.524	(0.015)
Market FE	Yes	
F-statistic	249.47	
N	2280	

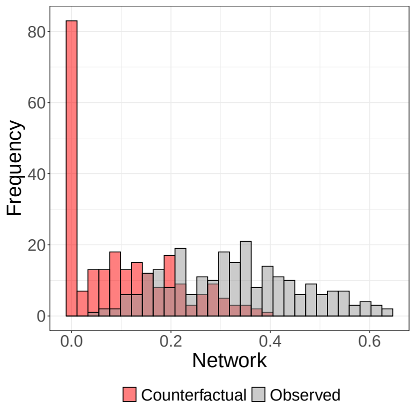
Note: Table presents first stage regression for my preferred specification of the network administrative cost. The outcome variable is service network breadth and the covariates are insurer fixed effects, market fixed effects, and the instrument which is the average service claim probability among healthy consumers. The table reports the F-statistic associated with the instrument. Robust standard errors in parenthesis.

Appendix Table 7: Model of Insurer Fixed Costs

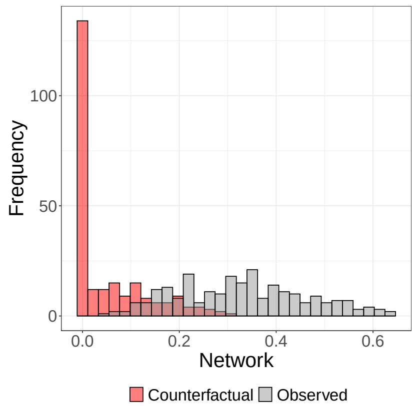
	Log marginal variable profit	
Variable	coef	se
Service network breadth	29.19	(1.903)
Insurer FE		
Insurer A	7.762	(0.744)
Insurer B	3.067	(0.464)
Insurer C	6.419	(0.643)
Insurer D	5.391	(0.551)
Insurer E	6.955	(0.932)
Insurer F	8.307	(0.989)
Insurer G	9.376	(0.772)
Insurer H	1.441	(1.105)
Insurer I	2.107	(0.423)
Insurer J	4.741	(0.523)
Insurer K	5.479	(0.616)
Insurer L	-1.694	(0.604)
Insurer M	8.122	(0.833)
Constant	-8.799	(1.130)
Market FE	Yes	
First-stage F-stat	249.47	
N	2280	
Unadjusted R^2	0.670	

Note: Table presents 2SLS regression of the log of marginal variable profit on service network breadth. An observation is a combination of insurer, service, and market. The instrument for service network breadth is the average claim probability for each service among healthy consumers. Table reports the F-statistic for the first stage regression. Specification includes market fixed effects and insurer fixed effects. Robust standard errors in parenthesis.

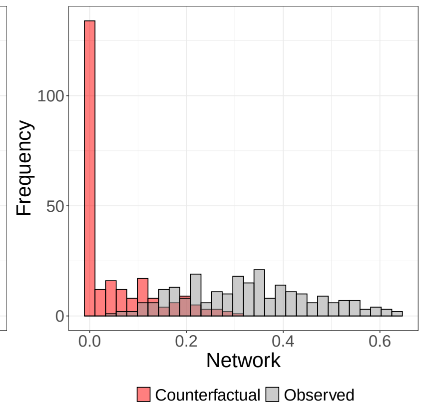
Appendix 5 Additional Counterfactual Results



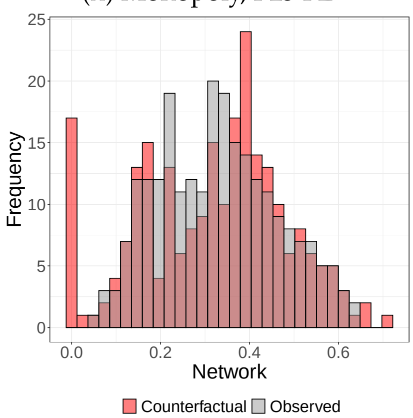
(A) Monopoly, P25 FE



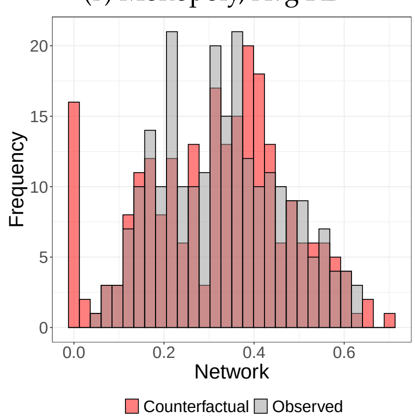
(B) Monopoly, Avg FE



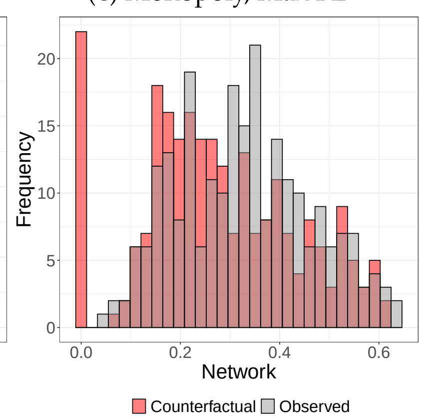
(C) Monopoly, Max FE



(D) Collusion, P25 FE



(E) Collusion, Avg FE



(F) Collusion, Max FE

Appendix Figure 6: Distribution of Service Network Breadth in Collusive Agreements

Note: Figure presents the distribution of service network breadth in the insurance monopoly in the first row and the scenario where the bottom 5 insurers collude in the second row. The first column imposes that the merged firm's fixed effects equals that of the firm in the 25h percentile of the distribution, the second column imposes the average firm fixed effect among those in the collusive agreement, and the third column imposes the maximum firm fixed effects. Histograms in gray represent the observed scenario and in red the counterfactual scenario.

Appendix Table 8: Insurer Participation Constraints in Centralized Equilibrium

Insurer	Profit per enrollee
Insurer A	-0.009
Insurer B	0.105
Insurer C	0.085
Insurer D	-0.007
Insurer E	-0.009
Insurer G	-0.008
Insurer I	0.261
Insurer J	-0.006
Insurer K	0.230
Insurer L	0.002
Insurer M	-0.001
Insurer N	-0.002

Note: Table shows insurers' total profit divided by their total demand in the social planner's scenario.