Centralized and Decentralized Equilibria in Provider Network Breadth

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Abstract

Health insurer competition in provider networks raises the question of how broad should networks be and whether regulation should promote this type of competition. In this paper, I use a structural model of insurer competition in service-level provider networks to derive the social planner's optimal solution and simulate the effects of competition among private insurers on provider network breadth. My findings indicate that the social planner, who maximizes consumer surplus subject to insurers' participation constraints, would choose complete networks. Collusion between private insurers generates an equilibrium that is farther away from the social planner's solution. Certain network adequacy rules can help approximate the first-best.

Keywords: Health insurance, Hospital networks, Adverse selection, Competition.

JEL codes: I11, I13, I18, L13.

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1 Introduction

Many countries around the globe, including Germany, Switzerland, Japan, Colombia, Chile, the Netherlands, and certain sectors of the U.S., rely on private companies to manage public health insurance programs. However, important questions about when private delivery of public services is desirable and how these companies operate remain largely unresolved, despite ongoing discussions since the early 2000s (e.g., Cutler and Reber, 1998; Cutler et al., 2000; Glied, 2000; Duggan et al., 2018; Layton et al., 2019). Private health insurers are increasingly differentiated by the financial characteristics of their contracts and often compete based on their networks of covered healthcare providers (Dafny et al., 2015b), posing significant challenges for health system regulation. Thus, to fully understand how these companies structure the delivery of public insurance, it is essential to examine the effects of competition within this sector.

In this paper, I examine how insurer competition influences the breadth of provider networks and propose a framework for optimal regulation. First, I both theoretically and empirically characterize a centralized equilibrium in which the regulator chooses the breadth of each insurer's provider network to maximize patient welfare, establishing the first-best solution. Next, I contrast this centralized outcome with various decentralized equilibria characterized by insurer competition, providing insights that inform regulatory design aimed at approximating the first-best scenario. While there has been considerable focus on premium and provider network competition (e.g., Dafny et al., 2015a; Cabral et al., 2018; Ho and Lee, 2017, 2019; Fleitas et al., 2024), less is known about optimal provider networks and policies that encourage insurer competition.

I present this analysis within the framework of the Colombian health care system, which serves as an ideal setting to study the impact of insurer competition for several reasons. Managed care competition was introduced in Colombia in 1993 with the enactment of Law 100. Under this system, private insurers offer a single national health insurance plan that provides equal benefits to all Colombians, ensuring near-universal coverage with mandatory enrollment. While private insurers can tailor their provider networks for each health service within the national plan, they do not charge premiums or set their own cost-sharing rules. Instead, premiums, cost-sharing, and benefits are uniformly regulated across all insurers and providers. This regulatory environment enables me to isolate the effects of insurer competition on provider network breadth and to evaluate the resulting benefits of competition.

To illustrate the effects of interest, I develop a straightforward theoretical model of insurer competition on provider network breadth. Incorporating elements of adverse selection and moral hazard in network breadth, the model reveals that a monopolistic insurer would opt for a narrow network, while a social planner would favor a broader one. With the option of uninsurance, fewer consumers choose to enroll under a monopoly compared to the scenario managed by a social planner, and those who do tend to be relatively sicker, leading to inadequate coverage for relatively unhealthy consumers. Additionally, the model suggests that in an insurance duopoly, the equilibrium is one where insurers maximally differentiate. Descriptive analyses support the patterns identified in this theoretical framework, showing that in Colombia, insurers' networks of covered providers are generally narrower in more concentrated markets, where insurers are likely to exert significant market power. To investigate the impact of competition on provider network breadth in a more systematic way, I transition to the empirical model.

My empirical framework builds upon the model and estimates presented in Serna (2024). The primary focus of this model is insurers' service network breadth, defined as the proportion of providers within a market that offer a specific health service and are covered by the insurer. On the demand side, new consumers select their insurer based on expected out-of-pocket expenses and the breadth of the service network. This demand function captures the trade-off between choosing broader networks for enhanced access to healthcare and bearing higher out-of-pocket costs to utilize these providers. On the supply side, insurers are differentiated by their marginal costs and fixed costs associated with network formation, competing by simultaneously selecting their service network breadth to maximize the net present value of their profits. Insurers consider discounted future profits when making decisions about network breadth because consumers exhibit significant inertia in their enrollment choices.

The model is estimated using enrollment and health claims data from all enrollees in the contributory system in Colombia from 2010 to 2011. Additionally, I have information on insurers' provider listing for every health service. The contributory system encompasses all individuals who pay payroll taxes and their dependents, nearly half of the country's population. Demand estimates show that there is substantial adverse selection on service network breadth. Sicker, relatively unprofitable individuals have higher willingness-to-pay for network breadth in services that they are more likely to claim compared to healthy, relatively profitable individuals. Cost estimates show that insurers enjoy substantial economies of scope across services and that some insurers have systematically lower network formation costs than others. Collectively, these findings suggest that insurers strategically respond to demand-driven selection incentives by offering narrower networks for less profitable services while simultaneously leveraging economies of scope and lower network formation costs to provide broader networks.

The observed equilibrium in service network breadth is asymmetric, with some insurers opting for broad networks and others choosing narrow networks for the same service within the same market. Given the zero premiums and stringent regulations on cost-sharing in Colombia, the empirical model rationalizes this asymmetry in several ways. First, the estimates reveal significant heterogeneity in preferences and costs among insurers. For instance, the demand model indicates that the trade-off between network breadth and out-of-pocket expenses varies notably based on consumers' health status, while the supply model suggests that some insurers are substantially more efficient in providing broad networks. Another factor contributing to this asymmetry is the level of competition among insurers for each health service. If all consumers tend to prefer broader networks independent of their health status, then insurers may have incentives to offer broader networks in markets where they face stronger competition. In the next part of the paper I measure this impact of insurer competition on provider network breadth offering the social planner's solution as comparative benchmark.

In line with the discussion of the theoretical framework, I use the model estimates to conduct a counterfactual analysis in which the social planner selects the vector of service network breadth for each insurer to maximize consumer surplus subject to insurers' participation constraints. I assume that the social planner enforces this equilibrium, ensuring that insurers' incentive compatibility constraints are non-binding. The participation constraints stipulate that insurers must achieve at least the median profit in the observed scenario. The results from this counterfactual analysis provide compelling empirical support for the first-best solution outlined in the theoretical model. In a system with mandatory enrollment, the social planner would opt for complete service networks, differing significantly from the observed scenario. For instance, the average network breadth for hospitalizations would more than double from a baseline of 0.32. While the first-best solution entails broader coverage and potentially improved access to care, it also comes with significantly higher administrative costs associated with managing these networks for enrollees. Consequently, the social planner faces a trade-off similar to that of consumers, balancing administrative costs and provider network coverage.

I then analyze whether a decentralized equilibrium, in which insurers compete based on service network breadth, can move market outcomes closer to those achieved by the social planner's solution. To explore this, I calculate equilibrium outcomes under a scenario where some insurers collude to maximize their joint profits. The heterogeneity in preferences and costs among insurers make it difficult to predict changes in network breadth resulting from collusion. For instance, if two insurers collude, one offering broad networks and the other providing narrow networks for a particular service, the equilibrium outcomes could differ significantly from a scenario in which both offer narrow networks at baseline for this service. Despite this ambiguity, my findings indicate that, irrespective of which insurers collude, the new equilibrium leads all insurers to opt for narrower service networks. Specifically, the results indicate a 5.3% reduction in average network breadth and a 1.8% decrease in consumer surplus when the three largest insurers collude. This suggests that network coverage improves with greater insurer competition, highlighting the importance of maintaining strong competitive pressures to enhance access to healthcare.

The existing regulation of the Colombian healthcare system permits insurers to differentiate their provider networks based on health services, effectively leading to discrimination based on consumers' health status. For instance, an insurer may choose to cover obstetric care while excluding renal care at a specific provider. Given the challenges of promoting insurer competition to enhance network coverage through policy reforms, my final analysis investigates the impact of policies that more directly address risk selection incentives. Specifically, I examine a network adequacy rule that prohibits discrimination of provider networks across different services; this rule mandates that insurers cover all services that an in-network provider is capable of delivering. My findings reveal that, under this rule, the average network breadth doubles for almost every service. Although the increased healthcare costs associated with broader networks are fully absorbed by insurers, consumer surplus rises by approximately 14% for both healthy and sick individuals. Overall, the results suggest that policies aimed at addressing risk selection can help align equilibrium network breadth more closely with the social planner's solution.

The findings of this paper make significant contributions to the literature on insurer competition and the formation of provider networks. In the first line of research, Ho and Lee (2017) examine the impact of insurer competition on premiums; my work complements theirs by investigating how competition influences provider network breadth. In a second line of research, Ho and Lee (2019); Liebman (2022); Ghili (2022) analyze how insurers utilize network exclusions to negotiate lower prices with hospitals. I expand on this body of work by quantifying the effects of varying levels of competition on network exclusions.

My paper offers insights into the crucial questions of whether broad networks are beneficial for society and whether insurance markets are competitive—issues that are particularly pertinent in an environment where narrow-network insurers have become prevalent across various health systems. Ho and Lee (2019) tackle similar questions within the context of a monopoly insurer. Additionally, several studies explore the trade-offs between broad and narrow provider networks (e.g., Dafny et al., 2015b; Atwood and Sasso, 2016). My research quantifies the balance between network breadth and healthcare costs, thereby both corroborating and complementing existing literature. Regarding the competitiveness of insurance markets, various studies have found that concentrated markets tend to experience higher premium growth (e.g., Dafny, 2010; Dafny et al., 2015a). Furthermore, it has been shown that policies designed to mitigate adverse selection in health insurance markets can lead to increased premiums when insurers have market power (Mahoney and Weyl, 2017). While these studies primarily focus on the relationship between competition and pricing, my analysis is set in an environment devoid of premium competition, allowing me to examine the interactions among competition, adverse selection, and non-price elements of insurance contracts.

The rest of this paper is organized as follows. Section 2 presents a simple theoretical model of insurer competition in provider networks. Section 3 summarizes the background and data. Section presents my empirical model and its 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 an alternative policy where insurers are prohibited from discriminating networks across health services. Section 8 concludes.

2 Theoretical Framework

To establish intuition on how insurer competition affects provider networks, I develop a simple model of competition in network breadth. Suppose a consumer is of type $\theta \sim U[\underline{\theta}, \overline{\theta}]$, with $\overline{\theta} > \underline{\theta} \geq 0$. 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 $H_j \in \{0, 1\}$, where 0 denotes a narrow network and 1 denotes a broad network.[1]

The expected medical cost of a type-θ consumer is $c(H_j, \theta)$, with $c_\theta(H_j, \theta) > 0$, $c(1, \theta) > c(0, \theta)$, $c_\theta(1, \theta) > c_\theta(0, \theta)$, and $c(1, \theta) < 2c(0, \theta)$. The consumer pays a fraction r of her expected medical cost. This cost structure captures adverse selection because different consumer types have different

[1]For simplicity in exposition, network breadth is a binary choice: narrow or broad. Choosing $H_j = 0$ means the insurer covers a small number of hospitals, but it does not mean the insurer has no coverage. For instance, in a case where there are two hospitals in the market, a narrow-network insurer will choose to cover one hospital, while a broad-network insurer would choose to cover both hospitals.

costs conditional on network breadth. The cost structure also captures moral hazard because the medical cost depends on network breadth conditional on the consumer type. Consumer θ's utility function for contract H_j is:

$$U(H_j, \theta) = \theta\beta_j(1 + H_j) - rc(H_j, \theta)$$

where $\beta_j > 0$ is a preference parameter that introduces heterogeneity across insurers and converts to monetary units. Suppose individuals can choose uninsurance, the utility of which equals zero. Consumers buy insurance if:

$$U(H, \theta) \geq 0 \iff \theta \geq \frac{rc(H, \theta)}{\beta(1 + H)}$$

For the problem to be non-trivial, assume also that $\overline{\theta} > \frac{rc(0,\theta)}{\beta}$. Insurers offer only one level of network breadth and make per-enrollee profits equal to $\pi(H_j, \theta) = R(\theta) - (1-r)c(H_j, \theta)$, where $R(\theta)$ is a risk-adjusted transfer from the government and $R_\theta(\theta) > 0$. Assume that the risk adjustment formula is imperfect so $R_\theta(\theta) < c_\theta(H_j, \theta)$. Moreover, assume that it is always profitable to serve the healthiest consumer under a broad network $R(\underline{\theta}) > (1 - r)c(1, \underline{\theta})$, but unprofitable to serve the sickest consumer under a narrow network $R(\overline{\theta}) < (1 - r)c(0, \overline{\theta})$.

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

$$\Pi(H) = \int_{\frac{rc(H,\theta)}{\beta(1+H)}}^{\overline{\theta}} (R(t) - (1 - r)c(H, t))dt$$

The choice of network breadth affects the monopolist's total demand, the composition of consumer types that buy insurance, and the cost of providing insurance.

Claim. The monopolist chooses a narrow network. This implies that

$$\int_{\frac{rc(1,\theta)}{2\beta}}^{\overline{\theta}} (R(t) - (1 - r)c(1, t))dt < \int_{\frac{rc(0,\theta)}{\beta}}^{\overline{\theta}} (R(t) - (1 - r)c(0, t))dt$$

We can rewrite the previous expression as

$$\int_{\frac{rc(1,\theta)}{2\beta}}^{\frac{rc(0,\theta)}{\beta}} (R(t) - (1 - r)c(1, t))dt < (1 - r) \int_{\frac{rc(0,\theta)}{\beta}}^{\overline{\theta}} (c(1, t) - c(0, t))dt$$

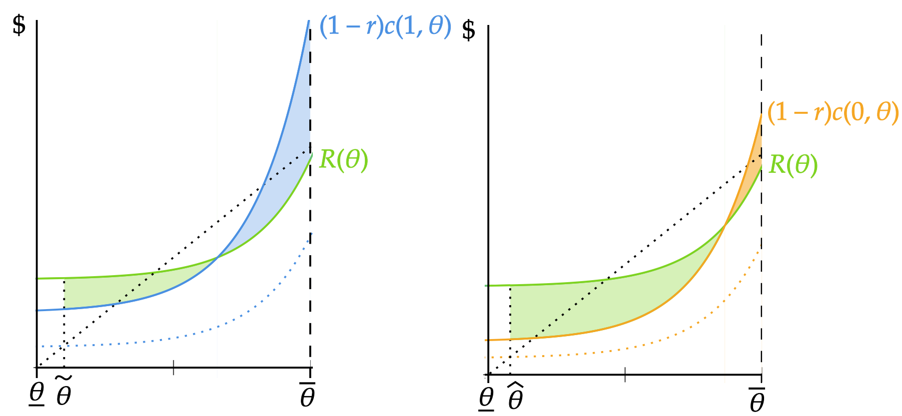
Using the fact that $c(1,\theta) < 2c(0,\theta)$ we obtain the following inequality

$$\int_{\frac{rc(1,\theta)}{2\beta}}^{\frac{rc(0,\theta)}{\beta}} (R(t) - (1-r)c(0,t))dt < (1-r)\int_{\frac{rc(1,\theta)}{2\beta}}^{\overline{\theta}} c(0,t)dt,$$

which holds under the assumptions that $\overline{\theta} > \frac{rc(0,\theta)}{\beta}$, $R(\underline{\theta}) > (1-r)c(1,\underline{\theta})$, and $R(\overline{\theta}) < (1-r)c(0,\overline{\theta})$. With a monopolist insurer, the lowest consumer type that participates in the market satisfies $\hat{\theta} = \frac{rc(0,\hat{\theta})}{\beta}$.

Figure 1 presents a graphical representation of the monopolist's problem. The left panel presents the monopolist's cost curve when choosing a broad network in blue and the risk-adjustment curve in green. The intersection between the 45 degree dotted black line and the function $\frac{rc(H,\theta)}{2\beta}$ in the dotted blue line, denotes the minimum consumer type that buys insurance when the monopolist chooses a broad network, $\tilde{\theta}$. The monopolists profit equals the green shaded area minus the blue shaded area. In the right panel, the orange curve denotes the monopolist's cost curve under a narrow network. In this case, the minimum consumer type that buys insurance is denoted by $\hat{\theta}$ and the monopolist's profits equal the green shaded area minus the orange shaded area.

Figure 1: Graphical Representation of the Monopolist's Problem



Note: The left panel presents a graphical depiction of the monopolist's problem when choosing a broad network. The monopolist's profits are the green shaded area minus the blue shaded area. The minimum consumer type that buys insurance under a broad network is denoted by $\tilde{\theta}$ where the 45 dotted black line intersects the dotted blue line. The right panel presents the monopolist's problem when choosing a narrow network. The monopolist's profits are the green shaded area minus the orange shaded area. The minimum consumer type that buys insurance under a broad network is denoted by $\hat{\theta}$ where the 45 dotted black line intersects the dotted orange line.

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

$$W(H) = \int_{\frac{rc(H,\theta)}{\beta(1+H)}}^{\overline{\theta}} (t\beta(1+H) - c(H,t))dt$$

Risk-adjusted payments in this function cancel out because they are transfers from the government to the insurer.

Claim. The social planner chooses a broad network, which implies that:

$$W(1) = \int_{\frac{rc(1,\theta)}{2\beta}}^{\overline{\theta}} (2t\beta - c(1,t))dt > \int_{\frac{rc(0,\theta)}{\beta}}^{\overline{\theta}} (t\beta - c(0,t))dt = W(0)$$

Under the assumption that $c(1,\theta) < 2c(0,\theta)$ we obtain the following:

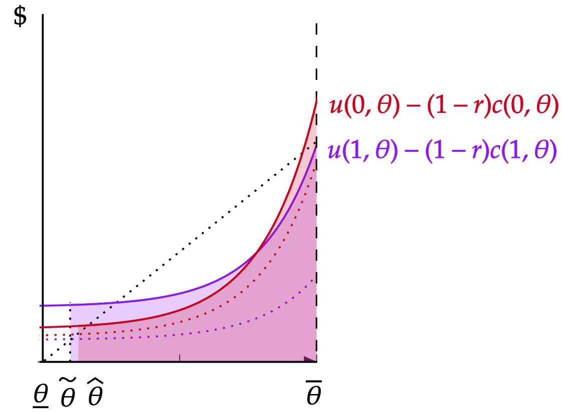
$$\begin{aligned} W(1) = \int_{\frac{rc(1,\theta)}{2\beta}}^{\overline{\theta}} (2t\beta - c(1,t))dt &> \int_{\frac{rc(0,\theta)}{\beta}}^{\overline{\theta}} (2t\beta - c(1,t))dt \\ &> \int_{\frac{rc(0,\theta)}{\beta}}^{\overline{\theta}} (2t\beta - 2c(0,t))dt > \int_{\frac{rc(0,\theta)}{\beta}}^{\overline{\theta}} (t\beta - c(0,t))dt = W(0) \end{aligned}$$

In this case the lowest type that participates in the market satisfies $\tilde{\theta} = \frac{rc(1,\tilde{\theta})}{2\beta}$. Figure 2 presents a graphical description of the social planner's problem. The per-enrollee social surplus under a broad network is depicted in purple and the corresponding function under a narrow network is depicted in red. The intersection between the 45 degree dotted black line and the each purple and red dotted curves represent the minimum consumer type that buys insurance under a broad and a narrow network respectively. A comparison between the purple shaded area and the red shaded area shows that total social surplus is higher under a broad network.

Comparing the monopolist and the social planner solutions reveals that $\tilde{\theta} < \hat{\theta}$, that is, in a monopoly insurance market market fewer consumers buy insurance than is socially efficient, and these consumers are relatively sicker. With a monopolist insurer, network breadth is also under-provided relative to the social planner's solution in a market where consumers can choose uninsurance.

Insurance mandate. Now consider a scenario where there is an insurance mandate requiring that every consumer purchases insurance or that the market is covered. In this case the profit of a

Figure 2: Graphical Representation of the Social Planner's Problem



Note: Figure presents a graphical depiction of the social planner's problem. Total social surplus under a broad network is depicted in the purple shaded area and under a narrow network is depicted in the red shaded area. The minimum consumer type that participates under a broad and a narrow network is given by $\tilde{\theta}$ and $\hat{\theta}$, where the 45 degree dotted black line intersects the dotted purple and dotted red lines, respectively.

monopolist choosing network breadth is:

$$\Pi(H) = \int_{\underline{\theta}}^{\overline{\theta}} (R(\theta) - (1-r)c(H,\theta))d\theta$$

The monopolist chooses a narrow network because with fixed total revenues $\Pi(1) < \Pi(0)$, and this solution is independent of adverse selection.

The social planner's objective function is:

$$W(H) = \int_{\underline{\theta}}^{\overline{\theta}} (\theta\beta(1+H) - c(H,\theta))d\theta$$

The planner chooses a broad network because the assumption that $c(1,\theta) < 2c(0,\theta)$ implies the following

$$W(0) = \int_{\underline{\theta}}^{\overline{\theta}} (\theta\beta - c(0,\theta))d\theta < \int_{\underline{\theta}}^{\overline{\theta}} (2\theta\beta - 2c(0,\theta))d\theta < \int_{\underline{\theta}}^{\overline{\theta}} (2\theta\beta - c(1,\theta))d\theta = W(1)$$

Note that to the extent that consumer θ's valuation for a broad network is positively correlated with their cost (adverse selection), it is socially desirable to provide a broad network to all consumers under mandatory enrollment. Instead, with zero correlation, the cost function satisfies $c(H,\theta) =$

$c(H)$, and the social planner's objective function becomes:

$$W(H) = \int_{\underline{\theta}}^{\overline{\theta}} (\theta\beta(1+H) - c(H))d\theta = \frac{(\overline{\theta}^2 - \underline{\theta}^2)}{2}\beta(1+H) - (\overline{\theta} - \underline{\theta})c(H)$$

In this case it is optimal to provide a broad network if and only if the average consumer's valuation for a broad network is at least the average consumer's cost under a broad network: $(\overline{\theta} + \underline{\theta})\frac{\beta}{2} \geq c(1) - c(0)$. The fact that the social planner's solution with adverse selection coincides with the solution without adverse selection under certain conditions on the average consumer reflects the confounding effect of moral hazard.

This simple model highlights the tension between the social planner's solution and a decentralized equilibrium with a monopolist insurer in the presence of adverse selection. With mandatory enrollment, the monopolist is essentially a cost-minimizing firm, while the social planner chooses the most generous network conditional on every consumer participating. As a result, network breadth is under-provided in monopoly markets with insurance mandates. Competition between insurers may generate an equilibrium that is closer to the social planner's solution. To compare how different levels of competition impact network breadth, I proceed to the empirical application.

3 Data and Descriptive Evidence

3.1 Background

My empirical analysis focuses on the Colombian healthcare system, which is structured around 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 within a managed care competition framework that achieves near-universal coverage, with private insurers offering a single national health insurance plan. Premiums are set at zero, and both cost-sharing and benefits are 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.[2]

[2] 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 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

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. This government formula compensates insurers in advance (ex-ante) based on the sex, age, and geographic location of their enrollees, but it does not account for specific diagnoses. Additionally, while the government provides ex-post compensations for certain chronic diseases, both forms of risk-adjusted payments remain insufficient for effectively managing risk selection incentives.[3]

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 the prices of health services 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 the entirety of services covered in the national plan. Overall, health service coverage in Colombia is extensive, ranging from basic primary care consultations to complex organ transplants. As of 2011, the national health plan also included a comprehensive list of prescription medications, which consumers could access through moderate copays.

Consumers are free to choose any of the insurers that operate in their area of residence. 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 months. Insurers make available the list of covered providers to assist consumers in making their enrollment decisions. However, within the contributory system, only about 6% of individuals opt to switch insurers. In 2011, only 4 out of the 23 insurers in the contributory scheme also operated within the subsidized scheme.

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.

[3]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).

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 (in days). These data enable me to calculate the ex-ante risk-adjusted transfers that each insurer received for its enrollees.

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 (following the International Classification of Diseases), and the negotiated price for each health service. Using this information, I can assess consumers' health status by analyzing the diagnoses they received throughout the year, as well as compute the insurers' total healthcare cost incurred in each individual. Anonymized individual identifiers are the same across datasets data allowing me to merge enrollment information 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, physician practices, and independent doctors 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 more than 10 claims for a specific insurer-service (results are robust to this threshold in the number of claims).

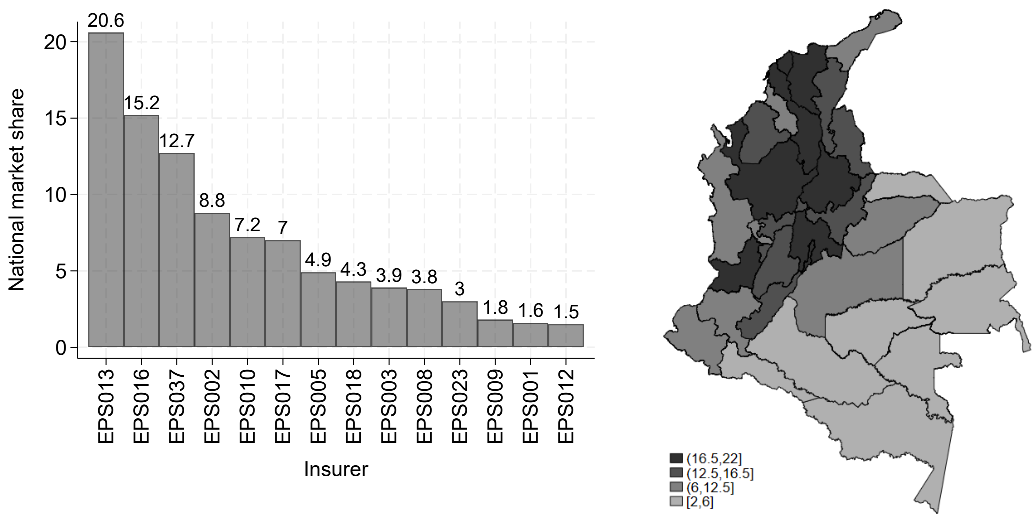
Using this final list of in-network provider-services, I calculate each insurer's service network breadth, defined as the proportion of providers in a market that offer a particular service and are covered by the insurer.[4] I define markets as Colombian states, recognizing that enrollees in

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

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 opt not to cover certain services in specific markets, potentially for profit-driven motives.

FIGURE 3: Description of Markets

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



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 that service network breadth is the primary choice variable for insurers in this health system, as both premiums and cost-sharing are subject to strict regulation. This assumption suggests that specific bilateral price negotiations between insurers and providers do not yield significantly different outcomes for a given service. Using service network breadth as a summary measure of insurer quality is appropriate in this context, given the relatively minimal variation in quality among providers for a specific service, as illustrated in Appendix Figure 1.[5]

During the sample period, 23 insurers participated in the contributory scheme, with 14 of these accounting for approximately 97% of enrollees. My analysis predominantly focuses on these 14 insurers. Figure 3 illustrates the structure of the contributory scheme in 2011; Panel A demonstrates significant concentration in the insurance market, with the three largest insurers covering 49% of enrollees. Notably, half of Colombian states had fewer than seven insurers, and around eight states

[5]If providers differed substantially in quality conditional on the service, as in the U.S., using service network breadth to characterize insurers' contracts would provide a lower bound on consumer surplus.

Table 1: Switch-in Rates

Insurer	All enrollees (1)	Continuously enrolled (2)
EPS001	0.032	0.030
EPS002	0.037	0.028
EPS003	0.026	0.016
EPS005	0.046	0.038
EPS008	0.045	0.031
EPS009	0.037	0.026
EPS010	0.056	0.039
EPS012	0.024	0.016
EPS013	0.024	0.014
EPS016	0.025	0.010
EPS017	0.029	0.008
EPS018	0.046	0.018
EPS023	0.028	0.008
EPS037	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.

exhibited an insurance duopoly, as shown in Panel B.

The considerable levels of market concentration in the contributory scheme raise important concerns about how competition affects insurers' network coverage decisions. The theoretical model presented earlier suggests that low competition—or high market power—can lead to provider networks that are narrower than socially desirable. In the Colombian context, insurers may wield market power by targeting the most profitable consumers and effectively "locking them in." Evidence of significant consumer inertia, indicative of this market power, is presented in Table 1. The table reveals that switching rates within the contributory scheme are relatively low; in the overall sample of enrollees (column 1), only 1% to 6% of consumers changed their insurer between 2010 and 2011. For enrollees with complete enrollment spells in both years (column 2), the switching rates are even lower, ranging from 0.4% to 3%.

3.3 Service-Level Provider Networks

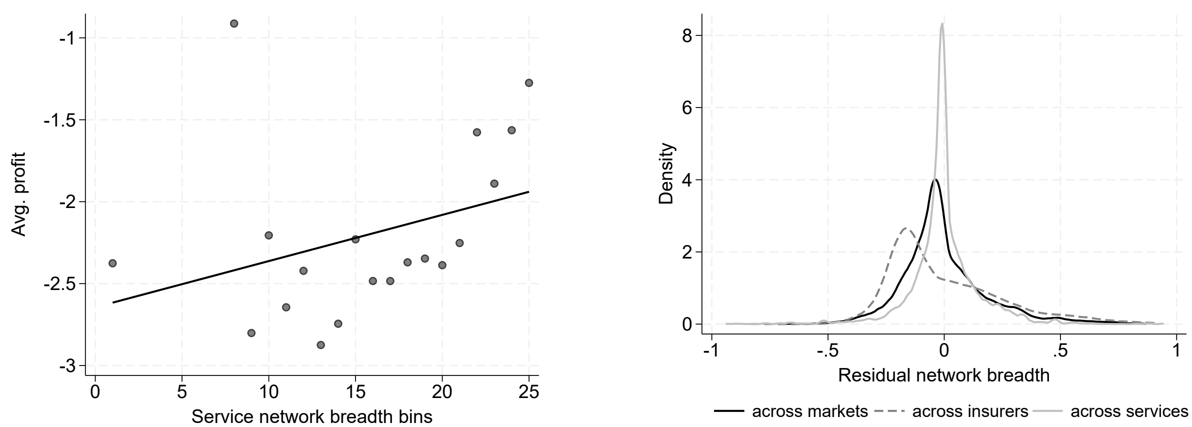
Figure 4 describes my measure of service network breadth. Panel A indicates that insurers' network coverage decisions seem to be influenced by profit motives. This panel presents the average profit per enrollee—calculated as the risk-adjusted transfer minus total healthcare costs—across different bins of service network breadth conditional on individuals who file claims. Highly profitable individuals who do not file claims are excluded from this analysis. The data reveal that making any claim is associated with lower profits; however, services for which insurers provide extensive network coverage tend to yield relatively higher profits compared to those with narrower networks.

Panel B further illustrates that variations in service network breadth primarily occur among insurers and markets, rather than across different services. This panel displays the distribution of residuals from a regression analysis of service network breadth, incorporating insurer-by-service (across markets), market-by-service (across insurers), and market-by-insurer (across services) fixed effects. The observed variation in service network breadth among insurers, given the stringent regulation of premiums and cost-sharing, may stem from differences in consumer preferences or insurer cost structures, as discussed by Serna (2024). Additionally, variations across markets may arise from differences in market structure.

FIGURE 4: Distribution of (Residual) Network Breadth

(A) Network breadth

(B) Residual network breadth

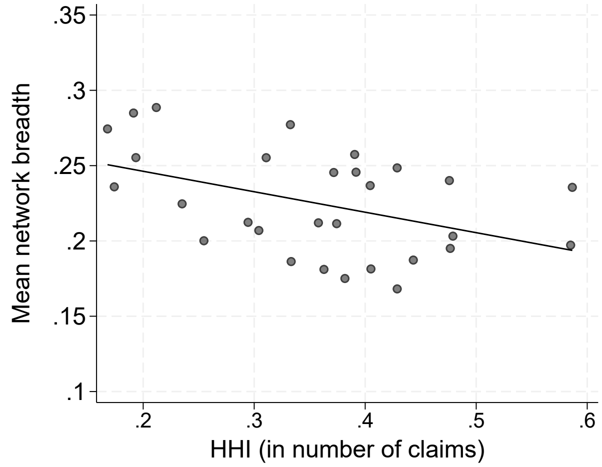


Note: Panel A shows the distribution of service network breadth in 2011 in black (left vertical axis) and the average profit conditional on consumers who make claims for each service in red (right vertical axis). Panel B shows the distribution of residuals from a regression of service network breadth 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.

3.4 Market Structure and Network Breadth

To examine variations in market structure, Figure 5 displays a scatterplot comparing average service network breadth (across insurers and services) with the Herfindahl-Hirschman Index (HHI) for each market. The HHI is computed based on insurer market shares derived from the total number of claims. The figure illustrates that markets with higher insurer concentration generally exhibit lower average service network breadth, consistent with the predictions of the theoretical model.

Figure 5: HHI and Mean 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 per market. Every dot is a market. The solid line represents a linear fit. I exclude four markets with HHI above 0.6, which cover less than 0.3% of all enrollees in the country.

However, the market-level correlation masks an underlying adverse selection effect. Figure 6 breaks down the same scatter plot into two panels, with Panel A focusing on general medicine and Panel B on cardiac care. General medicine tends to have a higher claim probability among both healthy and sick individuals, while cardiac care services are predominantly utilized by patients with chronic conditions. Consequently, insurers face different risk selection incentives across these two types of services. The plot illustrates a negative correlation between the HHI, based on the number of claims for each service, and the average service network breadth. The correlation is much stronger for general medicine compared to cardiac care, suggesting that insurer competition can have different impacts across services depending on the degree of adverse selection.

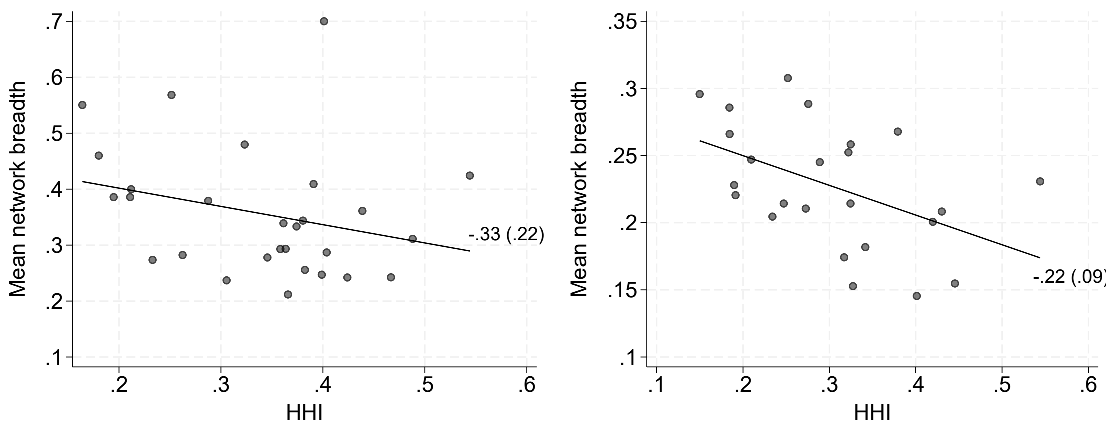
4 Empirical Model

Building on the descriptive evidence, this section introduces an equilibrium model of insurer competition on service network breadth. This model enables me to assess the impact of market power on provider networks, building on estimates from Serna (2024). This prior work offers a comprehensive overview of the model, the identification strategy, and the estimates that inform my analysis. I summarize these modeling aspects in Appendix 2, and outline the key empirical micro-foundations for the theoretical model presented in section 2 below.

Because the Colombian insurance market is characterized by substantial consumer inertia, in-

Figure 6: HHI and Mean Network Breadth for General Medicine and Cardiac Care

(A) General medicine (B) Cardiac care



Note: Scatter plot of average service network breadth in a market (across insurers) and the Herfindahl-Hirschman Index based on insurer market share in the total number of claims per market and service, for general medicine in Panel A and for cardiac care in Panel B. Every dot is a market. The solid line represents a linear fit. Each panel reports the coefficient and standard error in parenthesis of a linear regression of service network breadth on the HHI. In both panels I exclude four markets with HHI above 0.6, which cover less than 0.3% of all enrollees in the country.

surers compete for new enrollees who are make their first enrollment choice. 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 simultaneous choices of service network breadth to maximize the present discounted value of their profits. Take one market m, insurer j's profit function in this market is:

$$\Pi_j = \sum_{\theta} \pi_{j\theta}(H_{jk}, H_{-jk}) N_\theta + \sum_{s=t+1}^{T} \zeta^s \sum_{\theta} (1-\rho_{\theta'}) \mathcal{P}(\theta'|\theta) \pi_{j\theta'}(H_{jk}, H_{-jk}) N_{\theta'} - C_j(H_j, \xi_j)$$

where θ is a consumer's—unobserved to insurers—sickness level, with higher θs denoting sicker individuals, H_{jk} is insurer j's network breadth for service 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 C_j is the network formation cost, which captures administrative costs associated with including additional providers and maintaining the network.[6] Moreover, $H_j = \{H_{jk}\}_{k=1}^{|K_m|}$ and $H = \{H_j\}_{j=1}^{|J|}$.

The profit per consumer type θ is:

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

[6] Network formation costs comprise wages to agents and lawyers that contract with providers and rents and public utilities fees for providers that are vertically integrated with the insurer. These costs vary with the breadth of the network but not with the types of consumers that insurers enroll.

Here, R_θ is the risk-adjusted transfer from the government plus revenues from copayments, $AC_{j\theta}$ is insurer j's average 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. Assume that $\frac{\partial AC_{j\theta}}{\partial\theta} > 0$, $\frac{\partial AC_{j\theta}}{\partial H_{jk}} > 0$, $\frac{\partial C_j(\cdot)}{\partial H_{jk}} > 0$, $\frac{\partial^2 C_j(\cdot)}{\partial H_{jk}^2} > 0$, $\frac{\partial s_{j\theta}}{\partial H_{jk}} > 0$, and $\frac{\partial s_{j\theta}}{\partial H_{-jk}} < 0$.

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

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

Consider the first line of equation (1). Adverse selection manifests as a positive correlation between the insurer's average costs and demand fluctuations from specific consumer types, represented by $4AC_{j\theta}\frac{\partial s_{j\theta}}{\partial H_{jk}} > 0$. This correlation becomes more pronounced with greater network breadth, subsequently driving up the insurer's marginal costs. Therefore, adverse selection may incentivize insurers to opt for narrower networks, as adjusting network breadth adversely impacts the composition of consumer types that the insurer attracts.

The FOC also provides intuition on how market concentration—and perhaps market power—may impact service network breadth. Suppose for simplicity that insurers have the same average cost structure $AC_{j\theta} = AC_\theta$, 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:

$$\sum_\theta (R_\theta - (1-r_\theta)AC_\theta)\Big(\sum_j \frac{\partial s_{j\theta}}{\partial H_{jk}} s_{j\theta}\Big) - \sum_\theta (1-r_\theta)\frac{\partial AC_\theta}{\partial H_{jk}} \overbrace{\Big(\sum_j s_{j\theta}^2\Big)}^{HHI_\theta}$$
$$+ \sum_{s=t+1}^{T}\zeta^s \sum_{j\theta} s_{j\theta} FP - \sum_{j\theta} s_{j\theta}\frac{\partial C_j}{\partial H_{jk}} = 0 \tag{2}$$

Equation (2) illustrates that market concentration exacerbates the adverse selection effect when firms exhibit homogeneous cost structures and average costs rise with network breadth. Specifically, the HHI has a multiplicative impact on the increase in insurers' average costs associated with broader networks, indicating that concentrated markets facing adverse selection are likely to 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, since market concentration may not accurately reflect true market power, it is essential to conduct counterfactual analyses directly targeting market power—such as examining potential collusion among insurers—to effectively assess its impact on provider networks.

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

$$u_{ijm} = \underbrace{\beta_i \sum_k q_{\theta k} H_{jkm} - \alpha_i c_{\theta jm}(H_{jm}) + \phi_{jm}}_{\delta_{\theta jm}} + \varepsilon_{ijm}$$

where $q_{\theta k}$ is the weight that a type-θ consumer places on service k such that $\sum_k q_{\theta k} = 1$, $c_{\theta jm}$ is the expected out-of-pocket cost at insurer j (aggregated across services), ϕ_{jm} is an insurer-by-market 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, arthritis, asthma, other disease, healthy).[7] The coefficients in the utility function are given by $\beta_i = x_i'\beta$, $\alpha_i = x_i'\alpha$. The vector x_i includes dummies for sex, age group, diagnoses, residing in a rural area, having low income, and having (anecdotally) high-quality insurers in the choice set (these are insurers EPS010, EPS016, and EPS013).

The dependence of the average out-of-pocket cost to network breadth is captured by the pass-through of insurers' average cost to consumers' out-of-pocket cost via coinsurance rates: $c_{\theta jm} = r_\theta AC_{\theta jm}(H_{jm})$. In turn, insurers' average cost function $AC_{\theta jm}$ is:

$$\begin{aligned}\log(AC_{\theta jm}(H_{jm})) = \tau_0\Big(\sum_k^{K_m} q_{\theta k} A_k\Big) + \tau_1\Big(\sum_k^{K_m} q_{\theta k} H_{jkm}\Big) \\ + \frac{1}{2K_m}\tau_2 \sum_k^{K_m}\sum_{l\neq k}^{K_m} q_{\theta k} q_{\theta l} H_{jkm} H_{jlm} + \lambda_\theta + \eta_m + \delta_j + \epsilon_{\theta jm}\end{aligned} \tag{3}$$

In the first term on the right side of equation (3), A_k represents the government's reference price

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

for service k. This price is utilized to reimburse providers for events not covered by health insurance (such as car accidents, natural disasters, and terrorist attacks), and it serves as the baseline in insurers' bilateral negotiations with providers. The second term captures whether insurers with broad networks negotiate higher prices with in-network providers compared to those with narrower networks. The third term introduces the potential for insurers to benefit from economies of scope across services, which helps explain why some insurers opt for broader networks in services that mostly sick individuals tend to claim. Moreover, K_m is the set of services available in market m, λ_θ is a consumer type fixed effect, η_m is a market fixed effect, and δ_j is an insurer fixed effect.

I also assume that $\epsilon_{\theta jm}$ is mean-zero, white noise and independent of ε_{ijm}. My specification for insurers' average cost per enrollee is guided by trends observed in the raw data illustrated in Appendix Figure 2, which reveals a positive relationship between log average costs and service network breadth, along with a negative relationship with network breadth when interacting across pairs of services.

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

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

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

Finally, I parameterize the network formation cost as:

$$C_{jm}(H_{jm}, \xi_{jm}) \equiv \sum_k \Big(\omega H_{jkm} + \xi_j + \xi_m + \xi_{jkm}\Big) H_{jkm}$$

where ξ_j and ξ_m are insurer- and market-specific cost components and ξ_{jkm} is an unobserved (to the econometrician) cost component. The network formation cost allows me rationalize insurers that choose systematically broader or narrower networks across *all* services. Using data from insurers' 2011 public income statements reported to the National Health Superintendency, I provide evidence of the existence of these network formation costs as administrative costs that vary with network breadth in Appendix Figure 3.

4.1 Estimation Results

I estimate the model on data from new enrollees with complete enrollment spells in 2011. Demand and cost estimates are provided in Appendix 2.5. Appendix Table 2 shows that consumers prefer broad networks overall and dislike out-of-pocket expenses. The preference for network breadth is lower among individuals without diseases, and the disutility for out-of-pocket costs is lower among individuals with chronic diseases. These parameter estimates imply substantial heterogeneity in willingness-to-pay for service network breadth across consumers. For instance, patients with renal disease are willing to pay almost 27 times more for an additional provider in the network for renal care relative to a healthy patient, consistent with adverse selection on provider networks.

Estimation results for the average cost function are provided in Appendix Table 3. Results show that average costs per enrollee are increasing in service network breadth at a decreasing rate. Thus, broad-network insurers negotiate higher service prices with in-network providers and enjoy substantial scope economies across services. These scope economies might come from price discounts at providers where insurers cover several services. Findings also show substantial heterogeneity in these average costs across insurers as seen by the insurer fixed effects.

Appendix Tables 4 and 5 present estimates of dropout and transition probabilities, which are computed non-parametrically, outside of the model. These probabilities factor into the estimation of network formation costs in Appendix Table 6 using the FOC. Findings show that network formation costs are strictly convex in service network breadth and vary significantly across insurers. In particular, the insurers' cost structure explains half of the variation in total profits when an insurer unilaterally increases network breadth for a particular service, while heterogeneity in willingness-to-pay coming from the demand function explains the other half. This suggests that adverse selection—sicker, less profitable individuals choosing insurers with greater coverage in certain services—and cost incentives are the main determinants of insurers' network breadth choices.

To gauge the importance of market structure in driving network coverage decisions, a typical counterfactual exercise would predict market outcomes after an insurer is removed from the market (as in e.g., Ho and Lee, 2017). However, in my case preference and cost heterogeneity across services make it challenging to predict the direction of the effect. For example, if the insurer that is removed has market power in renal care but not in cardiac care, then network breadth might increase in the former service but not in the latter.

5 Centralized Equilibrium

To assess the impact of insurer competition, the first step is to establish a benchmark for service network breadth. This benchmark represents the optimal service network breadth that a social planner would choose for each insurer. Although deriving a social welfare function and interpreting its implications are inherently complex tasks, I approximate the social planner's problem using the empirical model described in section 4.

The social planner's objective is to maximize consumer surplus subject to insurers' participation constraints. In the participation constraints, insurers need to make at least the median total profit in the market, denoted by $\overline{\Pi}_m$. 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

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

The social planner solves the following optimization problem per market:

$$\max_{H_m}\ CS_m(H_m)$$
$$\text{s.t}\ \ \Pi_{jm}(H_m) \geq \overline{\Pi}_m\ \forall j$$

To reduce the computational burden, I solve the social planner's problem only in the capital city of Bogotá. Moreover, because this problem involves searching over 240 parameters (20 services for each of 12 insurers), I redefine the optimization routine over 20 parameters, which correspond to network breadth for general medicine and hospitalizations 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 hospitalizations because they are services commonly used by both healthy and sick individuals. By redefining the social planner's problem in this way, the solution will reflect a partial equilibrium.

Results are presented in Table 2. The table shows the percentage change in several outcomes between the social planner's solution and the observed scenario such as insurer long-run total average costs, total network formation cost, long-run consumer surplus for sick and healthy individuals, and average network breadth for general medicine and hospital admissions. I find that the social planner chooses nearly complete networks for each insurer in these two services. Average network breadth for general medicine increases to 0.92 from 0.45, while average network breadth for hospital admissions increases to 0.85 from 0.38, both corresponding to a 47% increase. In the social planner's solution insurers' participation constraints are binding for those with above-median profits in the observed scenario, but slack for those with below-median profits.

Although complete coverage of general medicine and hospital admissions reduce total average costs by 13% due to greater scope economics, they also increase network formation costs by 37% per year. This substantial increase in network formation cost is due to the fact that insurers now need to maintain and negotiate with a broader network. Complete coverage in these two services increases consumer surplus around 14% for both sick and healthy individuals.

TABLE 2: Networks, costs, and welfare for social planner

Variable	Centralized equilibrium
Total average cost	-13.04
Network formation cost per year	37.20
Consumer surplus (sick)	14.07
Consumer surplus (healthy)	14.33
Nework breadth general medicine	47.27
Network breadth hospital admissions	46.77

Note: Table presents the percentage change between the social planner's solution and the observed scenario in total average 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.

The trade-off between total costs and network breadth highlights one reason for why the social planner's solution is not attainable in practice for health systems with managfe. 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. Although my counterfactual results in Table 2 can not speak to these latter incentives, adverse selection suggests that this is one way in which insurers may respond to network adequacy rules requiring complete networks in highly claimed services.

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 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 solution?

To address these questions, I employ the empirical model to simulate a counterfactual scenario in which insurers collude. For simplicity, I calculate the new market equilibrium under the assumption that only three insurers are maximizing joint profits. This counterfactual scenario would approximate the monopolistic solution outlined in the theoretical model of section 2. The impact of joint profit maximization on service network breadth is not immediately clear. On 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, considerations such as economies of scope and network formation costs could yield cost efficiencies that encourage colluding firms to expand their network breadth.

Take one market with two firms j and g. In this counterfactual scenario the firms solve the following optimization problem:

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

In the FOC for the merged firm, the derivative of per-enrollee profits with respect to H_{jk} is:

$$\frac{\partial \pi^*_\theta}{\partial H_{jk}} = (R_\theta - (1-r_\theta)AC^*_{\theta j})\frac{\partial s^*_{\theta j}}{\partial H_{jk}} - (1-r_\theta)s^*_{\theta j}\frac{\partial AC^*_{\theta j}}{\partial H_{jk}} + (R_\theta - (1-r_\theta)AC^*_{\theta g})\frac{\partial s^*_{\theta g}}{\partial H_{jk}} \tag{4}$$

where the upper-script (*) denotes objects that are evaluated at the new equilibrium with collusion. Relative to the baseline scenario, the second term in equation (4) captures how collusion may affect the colluding firm's cost structure. If $\frac{\partial AC_{\theta j}}{\partial H_{jk}} > \frac{\partial AC^*_{\theta j}}{\partial H_{jk}}$, then the new equilibrium may be characterized by broader networks because the colluding firm has greater economies of scope.

The third term in equation (4) captures the externality that firm j imposes on firm g's per-enrollee profits. 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. Collusion can therefore lead the merged firm to choose narrower networks relative to the scenario where firms compete separately. These ambiguous predictions suggest that the effect of market power on network coverage will depend on relative magnitudes of preference and cost heterogeneity across insurers and services.

For the sake of tractability, I conduct this counterfactual analysis in the city of Bogotá. The results are summarized in Table 3. Columns (1) and (2) present findings based on different sets of insurers that engage in collusion. In column (1), the three largest insurers in the market maximize joint profits, while column (2) focuses on collusion among smaller insurers. The results indicate that, regardless of which insurers engage in joint profit maximization, the effect on service network breadth remains consistent: lower levels of competition among insurers result in narrower service networks, aligning with the theoretical model. However, the magnitude of this effect varies depending on which insurers collude, due to differences in preferences and costs. Specifically, the impact on service network breadth is more pronounced when larger insurers form a collusive agreement, as they capture a greater share of the market (and a higher proportion of healthier individuals).

Table 3: Networks, costs, and welfare under collusion

	Colluding insurers	
	(1)	(2)
	EPS017	EPS013
	EPS008	EPS002
Variable	EPS005	EPS037
A. Overall		
Average network breadth	-5.26	-1.10
Consumer surplus (sick)	-1.83	-0.64
Consumer surplus (healthy)	-1.83	-0.60
B. Service network breadth		
Otorhinolaryngologic care	-5.11	-1.17
Cardiac care	-5.56	-0.97
Gastroenterologic care	-5.97	-1.02
Renal care	-6.56	-1.03
Gynecologic care	-4.68	-1.05
Orthopedic care	-6.15	-0.99
Imaging	-4.24	-1.07
General medicine	-4.55	-1.23
Laboratory	-2.80	-1.16
Hospital admission	-4.71	-0.91

Note: Panel A presents the percentage change in mean network breadth and long-run consumer surplus for sick and healthy individuals in the collusive scenario. Column (1) presents results when EPS017, EPS008, and EPS005 collude. column (2) when EPS013, EPS002, and EPS037 collude. Panel B presents the percentage change of mean network breadth by service category.

Focusing on column (1), I find that average network breadth falls by 5.3%. The reduction in coverage generates a 1.8% reduction in surplus for consumers with and without chronic diseases. Consumer surplus falls by a similar magnitude across individuals with different health statuses because the reduction in network breadth is similar across services. For example, Panel B shows that network breadth falls 5.6% for cardiac care services and 4.6% for general medicine. These findings imply that collusion exacerbates risk selection incentives. As noted by Serna (2024), insurers engage in risk selection by offering narrower networks for less profitable services. Consequently, the significant decrease in network breadth across services when firms maximize joint profits suggests that lower levels of competition enable risk selection.

The 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 complete networks for general medicine and hospitalizations (holding other services fixed), while table 3 indicates that network breadth for these two services would be 53% farther away from the first-best if firms collude.

In each counterfactual scenario, colluding insurers experience an increase in profits and a decrease in average network breadth compared to the observed scenario where they operate as independent firms. When EPS017, EPS008, and EPS005 maximize joint profits, Table 4 reveals that total profits rise by approximately 8.4% for EPS017, 3.7% for EPS008, and 11% for EPS005. The fact that all firms involved in the collusion agreement see an uptick in profits relative to the observed scenario, alongside a decrease in network breadth, suggests that collusion enhances risk selection. Therefore, the exercise of market power within insurance markets is inherently linked to the establishment of narrow provider networks.

Table 4: Networks and profits for colluding firms

Variable	EPS017	EPS008	EPS005	EPS013	EPS002	EPS037
Average network breadth	-2.02	-99.01	-6.43	-11.23	-5.50	-7.19
Total profits	8.39	3.67	10.96	2.73	6.25	4.64
Avg. cost per enrollee	2.26	3.28	3.88	6.25	3.24	3.15

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

7 Network Adequacy Rules

Implementing the first-best solution or fostering competition among insurers can be challenging from a policy perspective. As an alternative, a social planner can develop strategies that directly address risk selection within the existing market structure. In Colombia, where insurers can differentiate networks based on health services, restricting their leverage across services may help mitigate risk selection incentives. In this context, I examine the potential impact of a network adequacy rule that requires insurers to cover all services rendered by in-network providers, thereby ensuring uniform network breadth across services. While insurers still have the discretion to determine whether to include a provider in their network, this policy effectively targets their primary mechanism for risk selection: offering narrow networks for services utilized by less profitable patients.

Table 5: Networks, costs, and welfare under network adequacy

Variable	Network adequacy outcomes
A. Overall	
Average network breadth	78.32
Consumer surplus (sick)	13.72
Consumer surplus (healthy)	13.84
B. Service network breadth	
Otorhinolaryngologic care	92.53
Cardiac care	59.43
Gastroenterologic care	84.42
Renal care	78.17
Gynecologic care	72.70
Orthopedic care	80.72
Imaging	59.52
General medicine	58.16
Laboratory	41.25
Hospital admission	60.46

Note: Panel A presents the percentage change in average network breadth and long-run consumer welfare for sick and healthy individuals, in the scenario with a network adequacy prohibiting discrimination of networks across services. Panel B presents the percentage change in mean network breadth by service category.

Formally, insurer j chooses $H_k = H \ \forall k$ in each market. The FOC of the profit maximization problem in a given market is:

$$\frac{1}{K}\sum_{k}\sum_{\theta}\left(\frac{\partial \pi_{\theta j}}{\partial H_{jk}}N_{\theta} + \sum_{s=t+1}^{T}\zeta^{s}\sum_{\theta'}(1-\rho_{\theta'})\mathcal{P}(\theta'|\theta)\frac{\partial \pi'_{\theta j}}{\partial H_{jk}}N_{\theta'}\right) - \frac{1}{K}\sum_{k}\frac{\partial C_j}{\partial H_{jk}} = 0$$

Table 5, Panel A shows that forcing insurers to cover all services at a provider increases average network breadth by 78% from a baseline of 0.24. This change in coverage translates into a 14% increase in consumer surplus for both sick and healthy individuals despite having to make higher out-of-pocket payments. Panel B shows that network breadth increases substantially across all services, and percentage changes in network breadth are larger for services that were underprovided in the observed scenario due to risk selection incentives. For instance, average network breadth for renal care increases 78%, while average network breadth for general medicine increases 58%. Prohibiting discrimination of networks across services thus reduces the impact of adverse selection.

Eliminating variation in network breadth across services generates an equilibrium that closely resembles the social planner's solution from Table 2. Consumer surplus for both healthy and sick individuals increase by a similar magnitude across the two scenarios as well. The fact that offering comprehensive networks in general medicine and hospital admissions leads to welfare effects comparable to an equilibrium where network breadth is doubled across all services suggests that only a few key services significantly impact access to care. This finding opens up opportunities for designing healthcare policies that focus on provider networks, such as network adequacy rules. By ensuring sufficient access to care in these critical services, such policies can enhance patient well-being.

8 Conclusion

Private health insurers in different managed care health systems typically compete on the breadth of their provider networks. These systems have seen a proliferation of narrow-network insurers, which raises the question of whether narrow networks are desirable for society. To answer this question and to appropriately design policies that target provider networks, we need to understand the trade-offs associated with network breadth, as well as how these trade-offs relate to insurer competition.

In this paper, I study the effect of insurer competition on provider network breadth. I develop and estimate a model of insurer competition in service-level network breadth using data from the Colombian health care system. I find that a social planner who maximizes consumer surplus subject to insurers' participation constraints, would choose complete networks in services such as general medicine and hospital admissions. The social planner's solution increases consumer surplus by 14%, but also substantially increase the system's administrative costs.

Simulations of the model allowing insurers to collude show that network breadth is lower when insurers have market power. Thus, network breadth is an increasing function of the degree of insurer competition. While policies that promote competition may be difficult to implement, I find that a simple network adequacy rule that prohibits the discrimination of networks across services can closely implement the social planner's solution. More broadly, findings suggest that competition between insurers is necessary to maintain proper access to care for patients, and that policies that target provider network design should carefully consider their impact on administrative costs.

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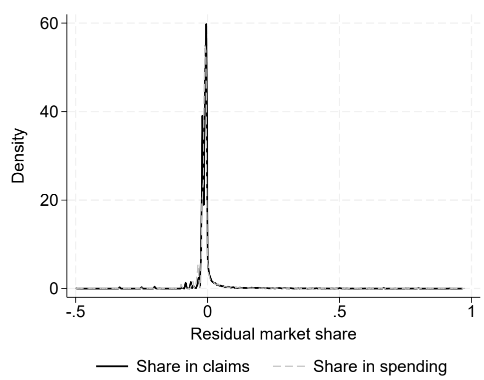
Appendix 1 Additional Descriptives

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

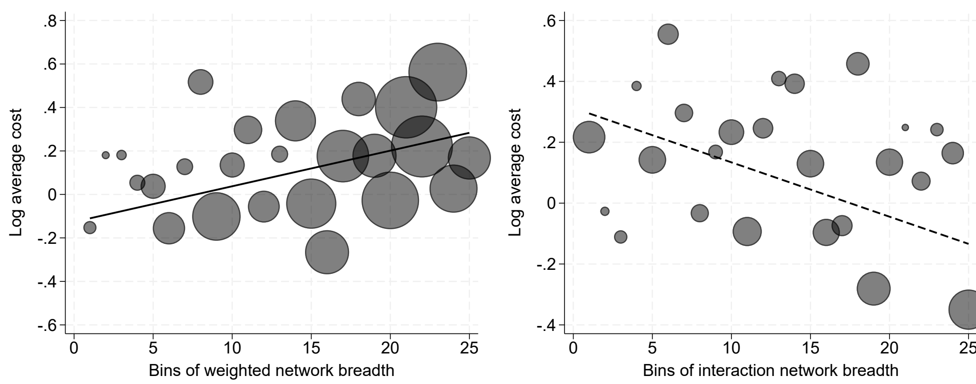
Appendix Figure 1: Residual Provider Market Share



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.

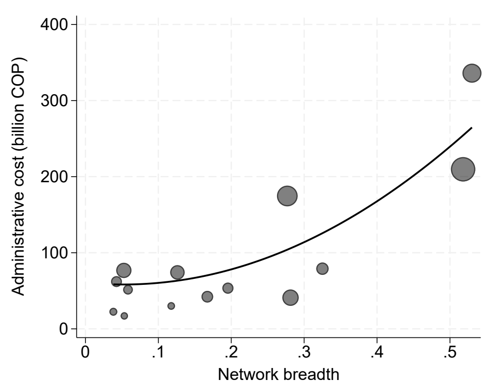
Appendix Figure 2: Empirical Relation of Log Average Cost per Enrollee

(A) Network breadth (B) Network breadth interactions



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 Figure 3: Empirical Relation of Administrative Costs



Note: Figure presents a scatter plot of insurers' total administrative cost in 2011 against average network breadth across services and markets. The solid line represents a quadratic fit. Administrative costs are obtained from insurers' public income statements reported to the National Health Superintendency, accessed through https://docs.supersalud.gov.co/PortalWeb/SupervisionRiesgos/EstadisticasEPSRegimenContributivo/RC%20Estados%20financieros%20Dic%202011-CT2011.pdf.

Appendix 2 Model Summary

In this Appendix I describe the empirical model of insurer competition in service-level network breadth presented in Serna (2024). Insurers compete in every market by simultaneously choosing their vector of service network breadths; then observing networks and expected out-of-pocket costs, consumers make enrollment decisions. I estimate the model on the sample of new enrollees with full enrollment spells (continuously enrolled), that is, individuals who I observe in the enrollment data for all of 2011 but not in 2010. New enrollees potentially do not experience inertia when making their first enrollment choice. However, after this first choice, consumers become fully inertial, since the data report switching rates of less than 2% on the sample of the continuously enrolled.

2.1 Insurer Demand

The utility of a myopic new consumer i of type θ for insurer j in market m is:

$$u_{ijm} = \beta_i \sum_k q_{\theta k} H_{jkm} - \alpha_i c_{\theta jm}(H_{jm}) + \phi_{jm} + \varepsilon_{ijm} \tag{5}$$

A consumer's type is given by the combination of sex, age category (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, arthritis, asthma, other disease, healthy). H_{jkm} insurer j's network breadth for service k in market m, $q_{\theta k}$ is the weight that a consumer of type θ places on service k such that $\sum_k q_{\theta k} = 1$, $c_{\theta jm}$ is the expected out-of-pocket cost at insurer j (aggregated across services), ϕ_{jm} is an insurer-by-market fixed effect, and ε_{ijm} is a type-I extreme value shock. The coefficients in the utility function are given by $\beta_i = x_i'\beta$ and $\alpha_i = x_i'\alpha$, where x_i includes dummies for sex, age group, diagnoses, living in a rural area, being low income, and having access to high-quality insurers.

The first term to the right-hand side of equation (5) is a reduced-form representation of the consumer's valuation for the network of covered providers. Service network breadth is weighted by the claim probability to account for the fact that consumers with certain diagnoses will prefer broader networks in services that are related to the treatment of their health condition. For example, patients with renal disease will care more about network breadth for dialysis than network breadth for procedures in the stomach.

The expected out-of-pocket cost in the second term of equation (5) is a function of network breadth across all services, $H_{jm} = \{H_{jkm}\}_{k=1}^{K}$, and is aggregated across services with weights equal to $q_{\theta k}$. The dependence of out-of-pocket costs to service network breadth reflects a cost-coverage trade-off for consumers: broad-network insurers negotiate higher prices with providers in their network, which translates into higher out-of-pocket costs for enrollees. The positive relation between service network breadth and negotiated prices is explained by the insurer's inability to use replacement threats during negotiations with providers when the insurer already has a broad network (Ho and Lee, 2019).

The utility function, which is defined over new consumers, assumes that individuals know their diagnoses beforehand. This suggests either that individuals have a medical family history or that they have had healthcare encounters before choosing their insurer. Since new consumers to may move from the subsidized system, knowledge of their health status prior to enrollment decisions in the contributory system is highly likely.

The assumption of consumer myopia also suggests that consumers make enrollment choices with knowledge of their current health status only, but that they do not take into account the progression of their diseases. For healthy consumers, this implies that the choice of a narrow-network insurer is potentially utility maximizing. While for an individual with chronic diseases, the utility maximizing choice is potentially that of a broad-network insurer.

2.2 Insurer Competition

Unlike consumers who are myopic, I assume insurers are forward looking. Insurers internalize the future profits associated with each new consumer that enrolls with it, since consumers do not switch after making their first enrollment decision. Insurers compete in every market by simultaneously choosing their vector of service network breadths to maximize the net present discounted value of their profits. Profits are given by:

$$\Pi_{jm}(H_m) = \sum_{\theta} \Big(\underbrace{\pi_{ijm}(H_m, \theta) N_{\theta m}}_{\text{current profit}} + \underbrace{\sum_{s=t+1}^{T} \zeta^s \sum_{\theta'} (1 - \rho_{\theta' m}) \mathcal{P}(\theta' | \theta) \pi_{ijm}(H_m, \theta') N_{\theta' m} \Big)}_{\text{future profit}} \\ - \underbrace{\sum_{k} \Big(\omega H_{jkm} + \xi_{jkm} \Big) H_{jkm}}_{\text{network formation cost}} \tag{6}$$

where $N_{\theta m}$ is the market size of consumers type θ in market m, ζ is a discount factor (set to 0.95 in estimation), $\rho_{\theta' m}$ is the probability that a consumer type θ drops out of the contributory system in period $t+1$, and $\mathcal{P}$ is the transition probability from state θ in period t to state θ' in period $t+1$.

I assume that both $\rho_{\theta' m}$ and $\mathcal{P}$ are exogenous for several reasons. On the one hand, dropping out of the contributory system depends mostly on unemployment or mortality, both of which are likely independent of service network breadth choices. On the other hand, transition probabilities across states reflect only the transition across diagnoses, since age and sex are deterministic. Transitions across the diagnoses considered in the model depend mostly on the natural progression of the disease. Serna (2024) also shows that these transition probabilities are uncorrelated with service network breadth.

In the profit function, π_{ijm} is the per-enrollee profit given by:

$$\pi_{ijm}(H_m, \theta) = (R_{\theta m} - (1 - r_i) AC_{\theta jm}(H_{jm})) s_{ijm}(H_m)$$

Here $R_{\theta m}$ is the risk-adjusted transfer from the government plus revenues from copayments, r_i is consumer i's coinsurance rate, s_{ijm} is consumer i's choice probability for insurer j in market m (which comes from the demand model), and $AC_{\theta jm}$ is the average cost of consumer type θ at insurer j in market m. The average cost is a flexible function of service network breadth as seen below

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

This average cost structure is a reduced-form approximation to an equilibrium where insurers and hospitals negotiate service prices and consumers make claims for those services. In the average cost function, A_k is the government's reference price for service k, which insurers use as starting point in their bilateral negotiations with providers.[8] K_m is the set of services available in market m, λ_θ is a consumer type fixed effect, η_m is a market fixed effect, and δ_j is an insurer fixed effect.

[8]The service reference prices were created by the government with a group of medical experts in 2005. These prices reflect the cost of providing each service and are updated every year based on inflation. The reference prices are paid to hospitals only in the event of car accidents, natural disasters, or terrorist attacks. That is, in any of these events, healthcare claims are reimbursed directly by the government to the hospitals and do not go through insurance.

The dependence of the insurer's average cost per enrollee to its choice of service network breadth captures whether broad-network insurers bargain higher prices with providers in their network compared to narrow-network insurers. The model would rationalize this bargaining argument with a positive estimate of τ_1. Moreover, the data shows that insurers that offer a broad network in one service, tend to offer broad networks in other services. If offering greater network breadth across services is always costlier, the model would have a difficult time explaining the existence of broad-network insurers in equilibrium. The average cost function thus includes interactions of network breadth between pairs of services to capture whether insurers enjoy scope economies. A negative estimate of τ_2 would imply that it is cheaper for the insurer to offer a broad network in service k if service l also has a broad network.

In addition to cost differences in average costs, insurers differ in the third component of the profit function, namely, the network formation cost. Network formation costs are administrative costs associated with setting up and maintaining these service-level networks; they encompass for instance wages to agents in charge of contracting with providers and rents and utilities fees for providers that are vertically integrated with the insurer. The network formation cost is non-linear in service network breadth and heterogeneous across insurers and markets. The parameter ω in equation (6) captures whether network formation costs are convex in service network breadth. Moreover, $\xi_{jkm} = \xi_j + \xi_m + \vartheta_{jkm}$ is a cost shock with an insurer- and market-specific components as well as an unobserved (to the econometrician) cost shock.

2.3 Service Weights

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:

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

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. Let $\hat{p}_{\theta k}$ be the prediction from this logistic regression, then $q_{\theta k} = \hat{p}_{\theta k} / \sum_k \hat{p}_{\theta k}$.

2.4 Identification

The main source of variation that identifies the preference for service network breadth in the demand model is the variation in claim probabilities $q_{\theta k}$ across consumer types and markets. These claim probabilities are plausibly exogenous to the extent that the diseases considered in the model require explicit treatment guidelines and therefore do not vary with service network breadth. Insurer-by-market fixed effects also absorb the endogenous variation in service network breadth that stems from insurer competition in every market.

The main concern associated with identification of the coefficient on out-of-pocket costs in the demand model is variation in provider quality. For example, if an insurer covers a high-quality provider, then we would likely see high demand for that insurer (because consumers value having access to high-quality provider) as well as high out-of-pocket costs (because the provider has a relatively high bargaining power), which would bias α_i towards zero. Variation in provider quality introduces endogenous variation in service network breadth across insurers and markets. Thus, the inclusion of insurer-by-market fixed effects help control for this source of endogenous variation. The coefficient α_i is then identified from exogenous variation in income across consumers within a market, which generates variation in the coinsurance rates.

For the average cost function, coefficients are identified from variation in average costs within insurer and across consumer types. The rich set of fixed effects included in this function account for potential unobserved cost variation within consumer types. Intuitively, identification of the average cost parameters requires observing two insurers that are identical (in terms of the characteristics of their enrollees) except for their network breadth.

Identification of the network formation cost relies on systematic variation in marginal variable profits across services within an insurer that is independent of consumer types. For example, if there are two insurers that have identical health risk, but one insurer offers low service network breadth and another offers high service network breadth across all services, then the model would rationalize these choices with high network formation costs for the former and low network formation costs for the latter. To identify ω, I rely on instrumental variables because insurers choose service network breadth with knowledge of their cost shocks ξ_{jkm}. My instrument follows Gowrisankaran et al. (2015) and is given by the predicted demand for each insurer assuming that insurers offer service network breadth equal to the market average.

2.5 Model Estimates

The following tables summarize the model estimates from Serna (2024). Appendix Table 2 shows estimation results of the insurer demand model. I find that consumers have preferences for broad networks and dislike the 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.

Appendix Table 3 shows results of insurers' average cost per consumer type. Average 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. Average costs are also heterogeneous across insurers.

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. For computing both probabilities, I use the enrollment data for all enrollees between 2010 and 2011. The probability that a consumer type θ drops out 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)
Mean		2.34 (0.42)	-2.41 (0.11)
Interactions			
Demographics	Male	0.15 (0.02)	0.06 (0.07)
	Age 19-24	-0.60 (0.05)	1.51 (0.12)
	Age 25-29	-1.19 (0.05)	0.70 (0.12)
	Age 30-34	-1.46 (0.05)	0.56 (0.15)
	Age 35-39	-1.50 (0.05)	0.30 (0.18)
	Age 40-44	-1.31 (0.05)	0.49 (0.17)
	Age 45-49	-1.17 (0.05)	0.51 (0.14)
	Age 50-54	-0.95 (0.05)	0.69 (0.12)
	Age 55-59	-0.88 (0.06)	0.39 (0.14)
	Age 60-64	-0.43 (0.06)	0.16 (0.14)
	Age 65 or more	(ref)	(ref)
Diagnoses	Cancer	0.55 (0.05)	0.46 (0.09)
	Diabetes	-0.11 (0.08)	0.41 (0.12)
	Cardio	-0.50 (0.04)	0.19 (0.08)
	Pulmonary	-0.60 (0.11)	1.11 (0.14)
	Renal	1.87 (0.14)	1.52 (0.08)
	Other	-0.43 (0.06)	0.88 (0.09)
	Healthy	(ref)	(ref)
Insurer	High-quality	1.07 (0.31)	—
Location	Rural	4.08 (0.04)	-0.21 (0.09)
	Urban	(ref)	(ref)
Income	Low	0.28 (0.03)	-1.72 (0.14)
	High	(ref)	(ref)
N		5,544,805	
N enrollees		500,000	
Pseudo-R^2		0.15	

Note: Table presents 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. Includes insurer-by-market fixed effects. Robust standard errors in parenthesis.

Appendix Table 3: Insurer average costs per enrollee

Variable	Coefficient	Std. Error
Network breadth	0.44	(0.08)
Scope economies	-93.0	(45.0)
Reference price	40.9	(6.63)
Insurer		
EPS001	-0.02	(0.05)
EPS002	-0.16	(0.04)
EPS003	-0.14	(0.04)
EPS005	-0.24	(0.04)
EPS008	0.17	(0.05)
EPS009	0.20	(0.04)
EPS010	-0.06	(0.06)
EPS012	-0.02	(0.04)
EPS013	-0.13	(0.03)
EPS016	-0.01	(0.03)
EPS017	-0.11	(0.04)
EPS018	0.06	(0.06)
EPS023	-0.18	(0.04)
EPS037	(ref)	(ref)
N	8,662	
R^2	0.66	

Note: Table presents OLS regression of logarithm of average costs per consumer type on network breadth, economies of scope, and service reference prices. Includes insurer, market, and consumer type fixed effects. Robust standard errors in parenthesis.

Appendix Table 4: Dropout probabilities

	mean	sd
Diagnosis		
Cancer	4.79	(2.40)
Diabetes	2.75	(0.83)
Cardio	2.79	(0.90)
Pulmonary	4.04	(1.51)
Renal	4.42	(1.79)
Other	2.62	(1.11)
Healthy	45.00	(7.29)
Age group		
19-24	12.00	(17.73)
25-29	8.72	(13.36)
30-34	8.13	(13.47)
35-39	8.47	(14.07)
40-44	8.47	(14.59)
45-49	8.51	(14.93)
50-54	8.88	(15.32)
55-59	9.09	(15.77)
60-64	9.20	(15.84)
65-69	9.63	(15.93)
70-74	10.37	(15.95)
75 or more	12.38	(16.43)
Sex		
Female	8.42	(13.07)
Male	10.55	(16.50)

Note: Table reports average and standard deviation in parenthesis of dropout probabilities. I use the data from *all* enrollees to the contributory system in 2010 and 2011, regardless of enrollment spell length, to compute these probabilities. For each consumer type θ, the dropout probability is the number of individuals of type θ observed only in 2010 but not 2011, divided by the total number of type θ individuals in 2010.

Appendix Table 5: Transition probabilities

Diagnosis	Cancer	Cardio	Diabetes	Renal	Pulmonary	Other	Healthy
Cancer	31.6	1.7	13.9	1.4	0.7	4.7	46.0
	(6.7)	(1.4)	(9.0)	(1.3)	(0.6)	(1.9)	(17.6)
Diabetes	3.0	55.7	17.0	0.9	1.3	2.1	20.0
	(2.6)	(7.8)	(10.0)	(1.0)	(1.1)	(1.0)	(14.0)
Cardio	4.3	2.8	55.4	1.4	1.1	3.4	31.6
	(3.6)	(1.8)	(20.5)	(1.2)	(1.0)	(0.9)	(22.4)
Pulmonary	5.5	1.9	19.1	23.4	0.7	7.8	41.6
	(4.6)	(1.4)	(8.9)	(15.2)	(0.6)	(3.4)	(23.1)
Renal	4.4	3.6	21.4	1.2	37.1	5.8	26.5
	(3.5)	(3.0)	(13.2)	(1.3)	(6.2)	(3.1)	(15.4)
Other	5.6	1.6	15.6	2.3	0.8	34.3	39.8
	(4.0)	(1.3)	(10.6)	(2.0)	(0.4)	(5.8)	(9.5)
Healthy	5.5	1.2	10.8	1.4	0.4	4.5	76.2
	(4.2)	(0.8)	(6.8)	(1.4)	(0.3)	(2.1)	(10.9)

Note: Table reports average and standard deviation in parenthesis of transition probabilities. Using data from continuously enrolled new *and* current enrollees in 2010 and 2011, the probability that type θ transitions into θ' equals the number of type θ in 2010 that end up with diagnosis l' in 2011, divided by the number of type θ individuals in 2010.

Using the demand, average 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 network formation cost from insurers' first-order condition below:

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

where

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

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 the results. I find that network formation costs are increasing and convex with respect to service network breadth. Network formation costs also vary substantially across insurers.

Appendix Table 6: Model of insurer network formation costs

$\log(MVP_{jmk})$	coef	se
Service network breadth	16.05	(1.75)
Insurer FE		
EPS001	(ref)	(ref)
EPS002	-0.83	(0.45)
EPS003	-0.11	(0.34)
EPS005	-0.82	(0.40)
EPS008	0.41	(0.46)
EPS009	-0.06	(0.64)
EPS010	1.85	(0.32)
EPS012	-1.81	(0.76)
EPS013	-0.44	(0.49)
EPS016	0.23	(0.44)
EPS017	-1.61	(0.58)
EPS018	-3.31	(0.61)
EPS023	0.73	(0.35)
EPS037	-1.94	(0.64)
Market FE		
5	(ref)	(ref)
11	1.08	(0.24)
13	-0.44	(0.26)
25	-0.92	(0.25)
76	0.88	(0.27)
Constant	3.97	(0.47)
N	1,060	
F-statistic	76.4	

Note: Table presents 2SLS regression of the log of marginal variable profit on network breadth, insurer fixed effects, and market fixed effects. An observation is a combination of insurer, service, and market. The instrument for service network breadth is predicted insurer demand assuming that all insurers have service network breadth equal to the market average. Robust standard errors in parenthesis. Table reports F-statistic for the first stage regression.