# Appendices for Non-Price Competition and Risk Selection Through Hospital Networks

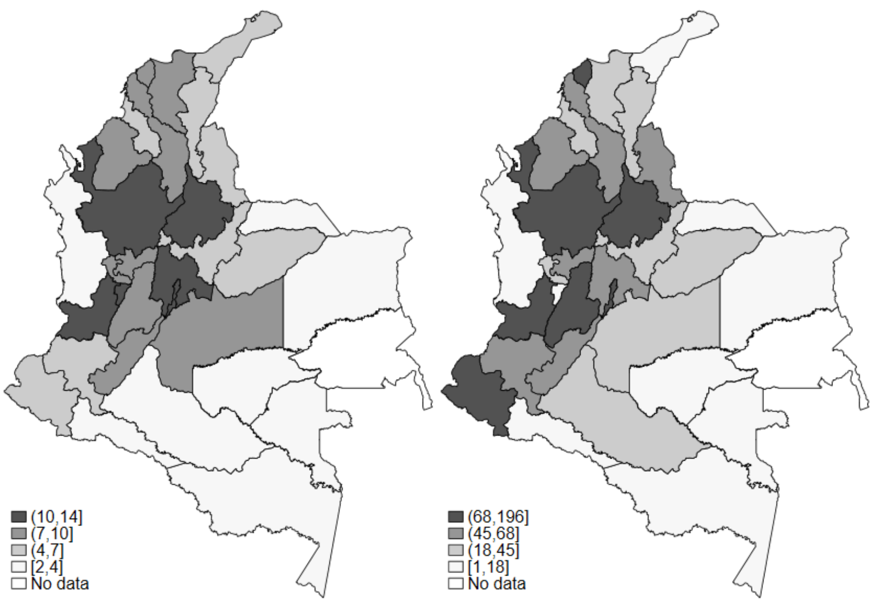
## Appendix 1 Service categories

| Service code | Description |
|---|---|
| 01 | Procedures in skull, brain, and cerebral meninges |
| 03 | Procedures in spinal cord and structures of spine |
| 04 | Procedures in peripheral and skull nerves |
| 05 | Procedures in nerves or sympathetic ganglia |
| 06 | Procedures in thyroid and parathyroid gland |
| 08 | Procedures in eyelids and lacrimal apparatus |
| 10 | Procedures in conjunctive, cornea, iris, retina, orbit |
| 18 | Procedures in ear |
| 21 | Procedures in nose and paranasal sinuses |
| 23 | Procedures in teeth, tongue, salivary glands |
| 27 | Procedures and interventions in mouth and face |
| 28 | Procedures in tonsils and adenoids |
| 29 | Procedures in pharynx, larynx, trachea |
| 32 | Procedures in lung and bronchus |
| 34 | Procedures in thoracic wall, pleura, mediastinum, diaphragm |
| 35 | Procedures in heart valves |
| 36 | Procedures in cardiac vessels |
| 37 | Procedures in heart and pericardium |
| 38 | Procedures in blood vessels |
| 40 | Procedures in lymphatic system |
| 41 | Procedures bone marrow and spleen |
| 42 | Procedures in esophagus |
| 43 | Procedures in stomach |
| 45 | Procedures in intestines |
| 47 | Procedures in appendix |
| 48 | Procedures in rectum, rectosigmoid, perirectal tissue |
| 50 | Procedures in liver |
| 51 | Procedures in gallbladder and biliary tract |
| 52 | Procedures in pancreas |
| 53 | Procedures in abdominal wall |
| 55 | Procedures in kidney |
| 56 | Procedures in ureter |
| 57 | Procedures in bladder |
| 58 | Procedures in urethra and urinary tract |
| 60 | Procedures in prostate, seminal vesicles, scrotum, testicles, penis |
| 65 | Procedures in ovaries, fallopian tubes, cervix, uterus |
| 70 | Procedures in vagina and cul-de-sac |
| 72 | Procedures and interventions in vaginal delivery |
| 76 | Procedures in bones and facial joints |
| 79 | Reduction of fracture and dislocation |
| 80 | Procedures in joint structures |
| 81 | Repair procedures and plasties in joint structures |
| 82 | Procedures in tendons, muscles, and hand fascia |
| 83 | Procedures in muscle, tendon, fascia, bursa except hand |
| 85 | Procedures in breast |
| 86 | Diagnostic procedures in skin and subcutaneous cellular tissue |
| 87 | Radiology and non-radiology imaging |
| 89 | Consultation, anatomic measures, physiology, manual tests, and pathology |
| 90 | Laboratory |
| 91 | Blood bank and transfusion medicine |
| 92 | Nuclear medicine and radiotherapy |
| 93 | Procedures and interventions in functional development and rehabilitation |
| 94 | Procedures related to mental health |
| 95 | Non-surgical procedures and interventions related to eye and ear |
| 97 | Substitution and extraction of therapeutic devices |
| 98 | Non-surgical extraction of kidney stones |
| 99 | Prophylactic and therapeutic procedures |
| S1 | Inpatient services |

## Appendix 2 Description of Colombian health care market

Appendix Table 1: National market shares in 2011

| Insurer | Market share |
|---|---|
| EPS013 | 21.4 |
| EPS016 | 15.2 |
| EPS037 | 11.1 |
| EPS002 | 9.3 |
| EPS017 | 7.2 |
| EPS010 | 7.1 |
| EPS005 | 4.5 |
| EPS018 | 4.4 |
| EPS003 | 4.0 |
| EPS008 | 3.7 |
| EPS023 | 3.1 |
| EPS009 | 1.8 |
| EPS001 | 1.6 |
| EPS012 | 1.6 |




(a) Insurers per market (b) Hospitals per market

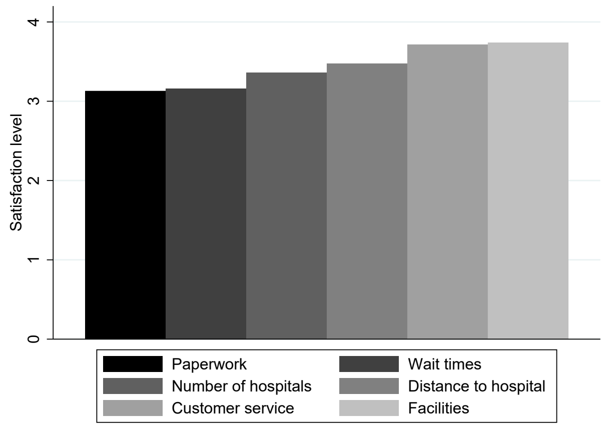
Appendix Figure 1: Number of players

Appendix Table 2: Distribution of percentage of covered services across departments in selected hospitals

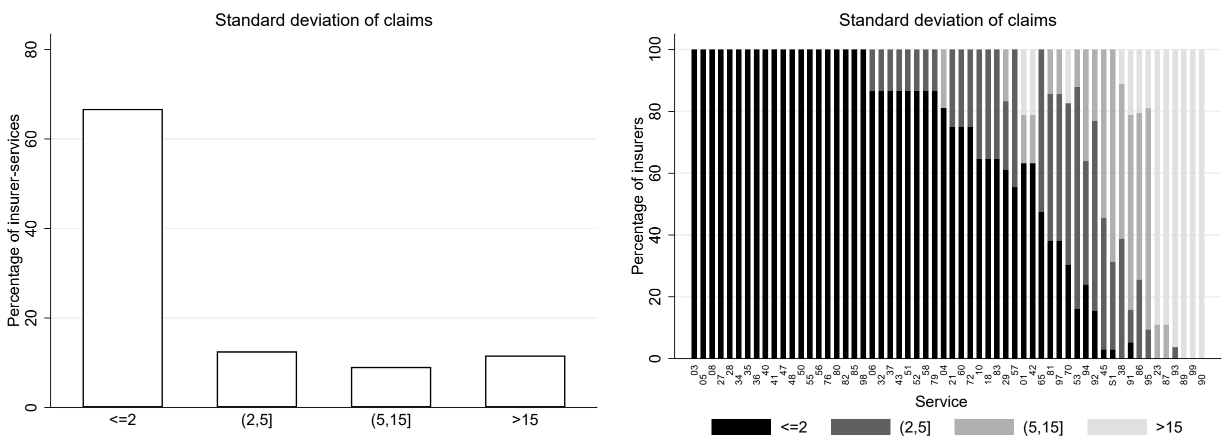
| | 2010 | | | | 2011 | | | |
|---|---|---|---|---|---|---|---|---|
| Insurer | Mean | SD | P25 | P75 | Mean | SD | P25 | P75 |
| EPS013 | 92.1 | 9.8 | 87.3 | 100.0 | 93.5 | 11.4 | 91.2 | 100.0 |
| EPS016 | 93.4 | 7.8 | 89.7 | 100.0 | 94.3 | 12.0 | 96.6 | 100.0 |
| EPS037 | 81.5 | 25.4 | 73.9 | 100.0 | 81.1 | 24.2 | 67.2 | 100.0 |
| EPS002 | 83.7 | 24.2 | 82.8 | 100.0 | 83.9 | 22.6 | 69.0 | 100.0 |
| EPS017 | 64.2 | 26.7 | 46.3 | 87.9 | 66.0 | 30.9 | 34.5 | 93.1 |
| EPS010 | 52.3 | 38.4 | 13.8 | 94.8 | 50.9 | 40.6 | 10.5 | 98.3 |
| EPS005 | 82.7 | 16.5 | 72.2 | 96.6 | 85.9 | 14.9 | 78.4 | 96.6 |
| EPS018 | 53.9 | 32.6 | 24.1 | 84.5 | 52.6 | 35.6 | 22.4 | 82.8 |
| EPS003 | 77.7 | 23.7 | 66.7 | 93.1 | 77.2 | 25.1 | 77.6 | 94.8 |
| EPS008 | 57.2 | 34.0 | 37.9 | 86.2 | 61.4 | 31.5 | 44.8 | 86.2 |
| EPS023 | 51.4 | 34.2 | 22.4 | 87.9 | 51.9 | 33.9 | 25.9 | 84.5 |
| EPS009 | 43.2 | 33.1 | 24.1 | 66.7 | 51.5 | 34.1 | 15.5 | 75.9 |
| EPS001 | 77.0 | 20.7 | 54.4 | 98.3 | 77.6 | 20.2 | 55.2 | 96.6 |
| EPS012 | 61.5 | 39.7 | 20.7 | 100.0 | 62.6 | 39.9 | 20.7 | 100.0 |

*Note*: Mean, standard deviation, and 25th and 75th percentiles of the percentage of services offered by each insurer across markets through the sample of providers in my data. A service is defined by its first 2 digits from the procedure codes covered in the national health insurance plan.

# Appendix 3 Variation in provider quality within service




Appendix Figure 2: Average satisfaction levels




(a) All services

(b) Per service

Appendix Figure 3: Standard deviation of claims across providers

# Appendix 4 Additional evidence of risk selection and inertia

In this appendix, I show additional regression results that are suggestive of the extent of risk selection through service-level networks. I estimate the correlation between consumer choice and network breadth using the following linear regression at the insurer-market level:

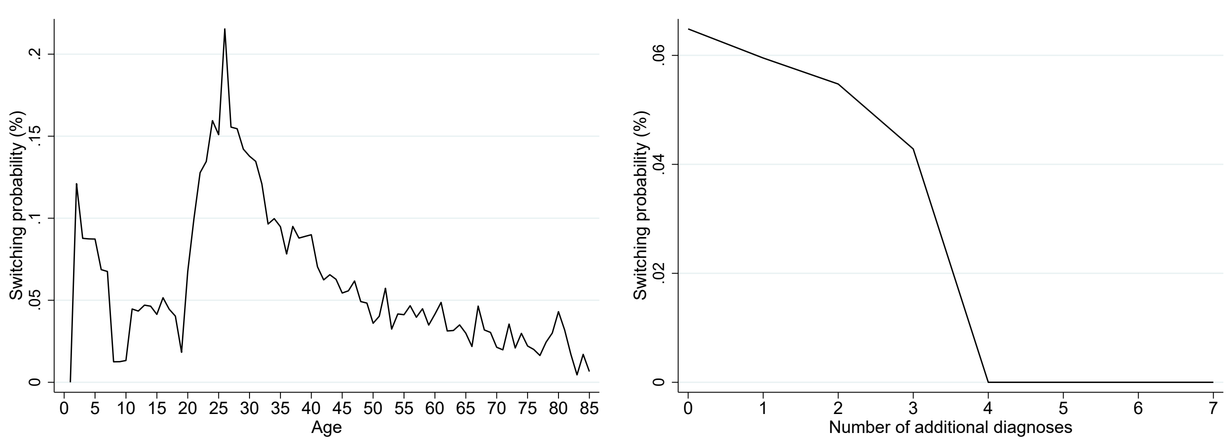
$$s_{jk}^{m} = \beta_0 + \beta_1 H_{jk}^{m} + \gamma_k + \varepsilon_{jk}^{m}$$

Here $s_{jk}^m$ is either the share of patients with renal disease, cancer, arthritis, or share of childbirths, and $H_{jk}^m$ is either network coverage for dialysis, chemotherapy and radiotherapy, procedures in bones and facial joints, and delivery, respectively. Results in table 3 show a positive correlation between network breadth and share of patients with certain health conditions for each service. This correlation is consistent with positive selection at the service level. Carriers that offer greater hospital coverage for services that sick patients demand the most, tend to have higher shares of such patients, who are also more expensive.

Appendix Table 3: Service-specific network breadth and share of chronic patients

| Share of patients with | Stayers | New |
|---|---|---|
| (1) *Renal disease* | | |
| $H_{jk}$ Dialysis | 0.005 | 0.001*** |
| | (0.004) | (0.0004) |
| (2) *Cancer* | | |
| $H_{jk}$ Therapy | 0.06*** | 0.007* |
| | (0.01) | (0.004) |
| (3) *Arthritis* | | |
| $H_{jk}$ Procedures in bones | 0.02*** | 0.002 |
| | (0.006) | (0.001) |
| (4) *Childbirth* | | |
| $H_{jk}$ Delivery | 0.01** | 0.006*** |
| | (0.005) | (0.001) |
| $N$ | 241 | 241 |

*Note*: OLS regressions of the share of patients with renal disease, cancer, arthritis, and childbirth, on the percentage of in-network providers of a particular service. All models include market fixed effects. Sample is constrained to insurers with at least 200 enrollees in each market. ***p<0.01, **p<0.05, *p<0.1.




(a) Switching by age

(b) Switching by diagnosis

Appendix Figure 4: Switching probability

Appendix Table 4: Insurer shares for current and new enrollees in 2011

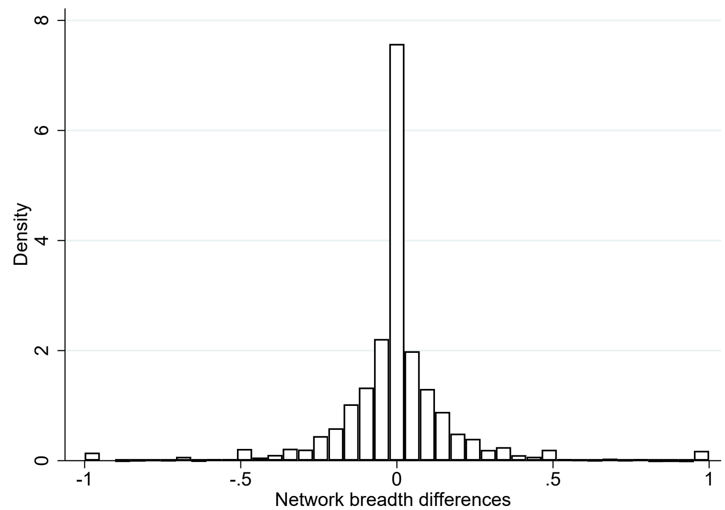
| Insurer | Current | New |
|---|---|---|
| EPS001 | 0.06 | 0.14 |
| EPS002 | 10.01 | 6.48 |
| EPS005 | 21.48 | 18.30 |
| EPS013 | 30.84 | 37.04 |
| EPS016 | 0.14 | 0.09 |
| EPS017 | 0.00 | 0.01 |
| EPS018 | 0.01 | 0.00 |
| EPS037 | 37.45 | 37.94 |

# Appendix 5 Steady state assumptions

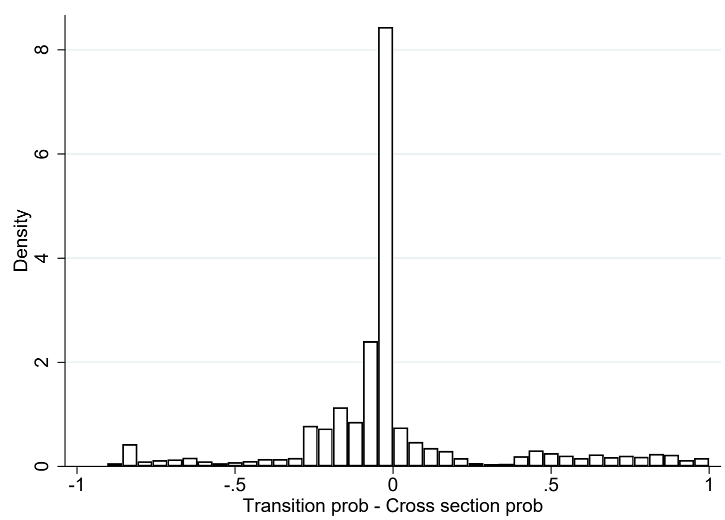
Steady state conditions require that choice variables are not changing over time. In my case, this means that service-level network breadth in 2010 should be equal to its value in 2011. In figure 5 I observe significant dispersion over time in my measure of coverage, which is inconsistent with a steady state argument.

Another way to test for steady state is to compare the transition probability from 2010 to 2011 of each consumer type $\theta$ into each of the possible diagnoses $l$, to the cross-sectional probability in 2011 that the consumer type $\theta$ has diagnosis $l$. In steady state, these two probabilities should be equal. I define a consumer type $\theta$ as a sex and age combination, and focus on a list of 7 exhaustive and mutually exclusive list of diagnoses in $l$: cancer only, cardiovascular disease only, diabetes only, renal disease only, other disease only, several comorbidities, and no diseases. More explicitly, in steady state, the transition probability of a 40 year old healthy man into a 41 year old man with cardiovascular disease should equal the cross-sectional probability that a 40 year old man has cardiovascular disease.

Figure 6 shows the distribution of the difference between these two probabilities. Although there is a high density at zero, the distribution exhibits long tails. This means that even if I focus on a full commitment equilibrium in networks and on new enrollees' myopic decisions, to appropriately capture insurers' incentives to offer broad networks, I need to model their future profits as a function of networks and consumer type-specific transition probabilities to different health states.

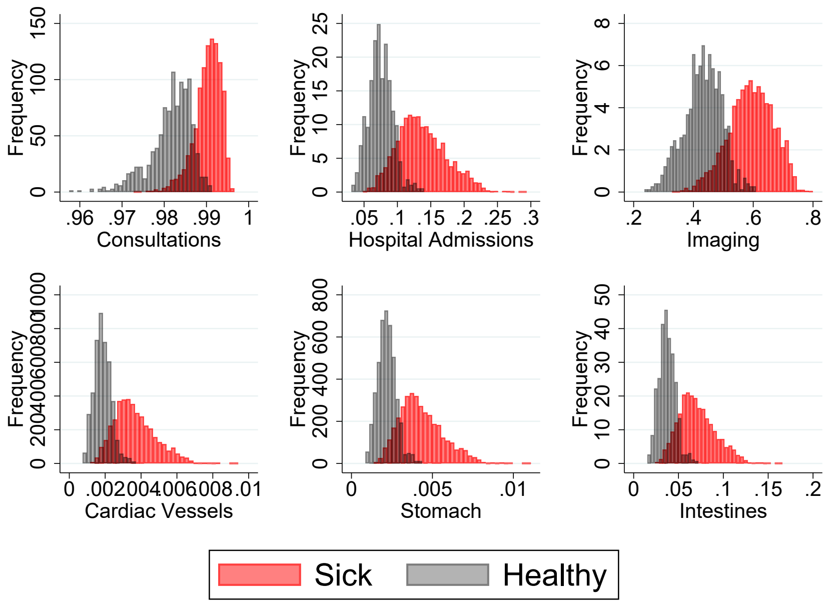



Appendix Figure 5: Differences in network breadth over time




Appendix Figure 6: Steady state diagnosis probability

# Appendix 6 Robustness checks on demand




Appendix Figure 7: Distribution of service claims probability

In this appendix, I estimate an alternative demand model where consumers take expectations over future diagnoses when choosing their carrier. The utility function is given below:

$$u_{ijt} = \beta_i^D \sum_{l \in L} \gamma_{\theta(i)l(i)} \sum_{m} \gamma_{\theta(i)l(i)mt} H_{jmt} - \alpha_i \sum_{l \in L} \gamma_{\theta(i)l(i)} c_{\theta(i)l(i)y(i)jt} + \delta_j + \varepsilon_{ijt}$$

where $\gamma_{\theta(i)l(i)}$ is the probability that consumer of sex and age $\theta$ has diagnosis $l$, calculated non-parametrically from the data.

Appendix Table 5: Insurer demand with expectation over diagnoses

| Variable | | Coefficient | Std. Error |
|---|---|---|---|
| Network | | 2.33*** | 0.01 |
| OOP spending | | -3.61*** | 0.19 |
| Interactions | | | |
| Network | Demographics | | |
| | Male | 0.34*** | 0.01 |
| | Age | -0.02*** | 0.00 |
| | Location | | |
| | Normal | 0.05*** | 0.01 |
| | Special | 0.72*** | 0.03 |
| | Urban | (ref) | (ref) |
| OOP spending | Demographics | | |
| | Male | -0.87*** | 0.09 |
| | Age | -0.01** | 0.00 |
| | Location | | |
| | Normal | 4.63*** | 0.10 |
| | Special | 2.12*** | 0.40 |
| | Urban | (ref) | (ref) |
| $N$ | | 5,800,610 | |
| $N$ enrollees | | 500,000 | |
| Pseudo-$R^2$ | | 0.17 | |

*Note*: This table presents results of an insurer choice model with uncertainty over diagnosis. Includes insurer fixed effects. Robust standard errors reported. ***p<0.01, **p<0.05, *p<0.1.

Appendix Table 6: Insurer demand in small markets

| Variable | | Coefficient | Std. Error |
|---|---|---|---|
| Network | | 1.14*** | 0.02 |
| OOP spending | | -1.65*** | 0.26 |
| Interactions | | | |
| Network | Demographics | | |
| | Male | 0.25*** | 0.01 |
| | Age | -0.01*** | 0.00 |
| | Diagnoses | | |
| | Cancer | -0.03* | 0.02 |
| | Cardiovascular | -0.13*** | 0.01 |
| | Diabetes | -0.23*** | 0.03 |
| | Renal | -0.41*** | 0.07 |
| | Other | -0.26*** | 0.02 |
| | >=2 diseases | -0.26*** | 0.01 |
| | Healthy | (ref) | (ref) |
| | Location | | |
| | Normal | 0.37*** | 0.02 |
| | Special | 0.79*** | 0.03 |
| | Urban | (ref) | (ref) |
| OOP spending | Demographics | | |
| | Male | 0.02 | 0.06 |
| | Age | 0.00*** | 0.00 |
| | Diagnoses | | |
| | Cancer | 1.76*** | 0.17 |
| | Cardiovascular | 2.23*** | 0.11 |
| | Diabetes | 1.55*** | 0.29 |
| | Renal | 2.38*** | 0.14 |
| | Other | 2.18*** | 0.12 |
| | >=2 diseases | 2.12*** | 0.11 |
| | Healthy | (ref) | (ref) |
| | Location | | |
| | Normal | -0.40* | 0.24 |
| | Special | -0.43 | 0.26 |
| | Urban | (ref) | (ref) |
| $N$ | | 4,391,032 | |
| $N$ enrollees | | 500,000 | |
| Pseudo-$R^2$ | | 0.19 | |

*Note*: This table presents results of the insurer choice model estimated on the subsample of markets that excludes the four main capital states: Antioquia, Atlántico, Bogotá, and Valle del Cauca. Includes insurer fixed effects. Robust standard errors reported. $^{***}$p<0.01, $^{**}$p<0.05, $^{*}$p<0.1.

Appendix Table 7: Insurer demand with additional quality measures

| Variable | | Coefficient | Std. Error |
| --- | --- | --- | --- |
| Network | | 2.32*** | 0.01 |
| OOP spending | | -5.84*** | 0.22 |
| Avg. quality | | 0.003*** | 0.00 |
| Avg. wait time | | -0.01*** | 0.00 |
| Interactions | | | |
| Network | Demographics | | |
| | Male | 0.29*** | 0.01 |
| | Age | -0.01*** | 0.00 |
| | Diagnoses | | |
| | Cancer | -0.33*** | 0.02 |
| | Cardiovascular | -0.33*** | 0.01 |
| | Diabetes | -0.46*** | 0.04 |
| | Renal | -0.60*** | 0.08 |
| | Other | -0.52*** | 0.02 |
| | >=2 diseases | -0.65*** | 0.02 |
| | Healthy | (ref) | (ref) |
| | Location | | |
| | Normal | 0.19*** | 0.01 |
| | Special | 0.66*** | 0.03 |
| | Urban | (ref) | (ref) |
| OOP spending | Demographics | | |
| | Male | 0.11 | 0.10 |
| | Age | -0.01*** | 0.00 |
| | Diagnoses | | |
| | Cancer | 4.57*** | 0.24 |
| | Cardiovascular | 5.26*** | 0.19 |
| | Diabetes | 5.34*** | 0.32 |
| | Renal | 5.71*** | 0.21 |
| | Other | 4.80*** | 0.22 |
| | >=2 diseases | 5.24*** | 0.19 |
| | Healthy | (ref) | (ref) |
| | Location | | |
| | Normal | 1.08*** | 0.11 |
| | Special | 0.67 | 0.45 |
| | Urban | (ref) | (ref) |
| $N$ | | 5,358,649 | |
| $N$ enrollees | | 489,442 | |
| Pseudo-$R^2$ | | 0.17 | |

*Note*: This table presents results of the insurer choice model including additional insurer quality measures: the average quality from a likert scale and average wait time for an appointment with the primary care doctor or specialist. Both variables are measured at the insurer-market level and obtained from enrollee-level survey data conducted by the Colombian Ministry of Health during 2013 to 2016. Includes insurer fixed effects. Robust standard errors reported. ***p<0.01, **p<0.05, *p<0.1.

Appendix Table 8: Insurer demand with alternative network measures

| | | (1) Only large hospitals | | (2) All providers | |
|---|---|---|---|---|---|
| Variable | | Coef. | SE | Coef. | SE |
| Network | | 2.37*** | 0.01 | 2.54*** | 0.01 |
| OOP spending | | -6.64*** | 0.21 | -4.90*** | 0.16 |
| Interactions | | | | | |
| Network | Demographics | | | | |
| | Male | 0.30*** | 0.01 | 0.14*** | 0.01 |
| | Age | -0.01*** | 0.00 | 0.00*** | 0.00 |
| | Diagnoses | | | | |
| | Cancer | -0.34*** | 0.02 | -0.71*** | 0.02 |
| | Cardiovascular | -0.33*** | 0.01 | -0.50*** | 0.02 |
| | Diabetes | -0.44*** | 0.04 | -0.65*** | 0.06 |
| | Renal | -0.61*** | 0.08 | -0.64*** | 0.10 |
| | Other | -0.53*** | 0.02 | -0.69*** | 0.03 |
| | >=2 diseases | -0.64*** | 0.02 | -0.93*** | 0.02 |
| | Healthy | (ref) | (ref) | (ref) | (ref) |
| | Location | | | | |
| | Normal | 0.05*** | 0.01 | -0.25*** | 0.01 |
| | Special | 0.73*** | 0.04 | -0.59*** | 0.02 |
| | Urban | (ref) | (ref) | (ref) | (ref) |
| OOP spending | Demographics | | | | |
| | Male | 0.05 | 0.09 | -0.02 | 0.06 |
| | Age | -0.01*** | 0.00 | -0.01*** | 0.00 |
| | Diagnoses | | | | |
| | Cancer | 5.36*** | 0.22 | 4.41 | 0.15 |
| | Cardiovascular | 5.89*** | 0.18 | 4.57*** | 0.15 |
| | Diabetes | 5.77*** | 0.31 | 4.81*** | 0.25 |
| | Renal | 6.27*** | 0.22 | 4.82*** | 0.17 |
| | Other | 5.56*** | 0.20 | 4.32*** | 0.15 |
| | >=2 diseases | 5.89*** | 0.18 | 4.61*** | 0.15 |
| | Healthy | (ref) | (ref) | (ref) | (ref) |
| | Location | | | | |
| | Normal | 1.15*** | 0.11 | 0.74*** | 0.08 |
| | Special | 0.67 | 0.43 | 0.92*** | 0.16 |
| | Urban | (ref) | (ref) | (ref) | (ref) |
| $N$ | | 5,800,610 | | 5,800,610 | |
| $N$ enrollees | | 500,000 | | 500,000 | |
| Pseudo-$R^2$ | | 0.17 | | 0.12 | |

*Note*: This table presents results of the insurer choice model under alternative specifications of the network breadth variable. Column (1) reports coefficients and standard errors of a model where network breadth is constructed based on a sample of the largest hospitals in each market. Large hospitals are defined as having number of beds above the 70th percentile of the distribution of beds in the market. Column (2) presents coefficients and standard errors of a model where network breadth is constructed using all institutional provider and stand-alone doctors. Includes insurer fixed effects. Robust standard errors reported. $^{***}$p<0.01, $^{**}$p<0.05, $^{*}$p<0.1.

Appendix Table 9: Insurer demand on adults aged 19 or older

| Variable | | Coef. | SE |
|---|---|---|---|
| Network | | 2.28*** | 0.01 |
| OOP spending | | -5.41*** | 0.19 |
| Interactions | | | |
| Network | Demographics | | |
| | Male | 0.30*** | 0.01 |
| | Age | -0.01*** | 0.00 |
| | Diagnoses | | |
| | Cancer | -0.31*** | 0.02 |
| | Cardiovascular | -0.34*** | 0.01 |
| | Diabetes | -0.36*** | 0.03 |
| | Renal | -0.63*** | 0.07 |
| | Other | -0.48*** | 0.02 |
| | >=2 diseases | -0.62*** | 0.01 |
| | Healthy | (ref) | (ref) |
| | Location | | |
| | Normal | 0.01 | 0.01 |
| | Special | 0.54*** | 0.03 |
| | Urban | (ref) | (ref) |
| OOP spending | Demographics | | |
| | Male | -0.08 | 0.07 |
| | Age | -0.01*** | 0.00 |
| | Diagnoses | | |
| | Cancer | 3.44*** | 0.22 |
| | Cardiovascular | 4.46*** | 0.17 |
| | Diabetes | 4.47*** | 0.29 |
| | Renal | 5.03*** | 0.18 |
| | Other | 4.30*** | 0.16 |
| | >=2 diseases | 4.43*** | 0.14 |
| | Healthy | (ref) | (ref) |
| | Location | | |
| | Normal | 1.36*** | 0.11 |
| | Special | 1.40*** | 0.16 |
| | Urban | (ref) | (ref) |
| N | | 5,849,583 | |
| N enrollees | | 500,000 | |
| Pseudo-$R^2$ | | 0.17 | |

*Note*: This table presents results of the insurer choice model estimated on a sample of adults aged > 18. Includes insurer fixed effects. Robust standard errors reported. $^{***}$p<0.01, $^{**}$p<0.05, $^{*}$p<0.1.

# Appendix 7 Note on primitives of average cost function

Suppose there is a second stage in the demand model where consumers choose a hospital to receive service $m$. The cost of consumer $i$ enrolled to insurer $j$ can be written as:

$$c_{ij}(H_j) = \sum_m \gamma_{\theta(i)l(i)m} \sum_{h \in H_{jm}} p_{jhm} s_{ihm}(H_{jm})$$

where $p_{jhm}$ is the negotiated price for service $m$ between insurer $j$ and hospital $h$, $s_{ihm}$ is the probability that consumer $i$ chooses hospital $h$ for service $m$, and $\gamma$ is the probability that consumer $i$ of type $(\theta, l)$ makes a claim for service $m$.

With this specification of individual costs, the insurer profit function is:

$$\pi_j = \sum_i (R_{ij} - c_{ij}(H_j)) s_{ij}(H_j)$$

where $s_{ij}$ is the probability that consumer $i$ enrolls insurer $j$. We can rewrite the previous equation as:

$$\pi_j = (R_j - AC_j(H_j)) D_j$$

where $R_j = \sum_i R_{ij}$, $D_j = \sum_i s_{ij}$, and

$$AC_j(H_j) = \frac{1}{D_j} \sum_i c_{ij}(H_j) s_{ij}(H_j)$$

Suppose $s_{ihm}$ and $s_{ij}$ are obtained from a discrete choice model with preference shocks that are distributed T1EV. Also, for simplicity, assume there are two hospitals and two insurers. Then, the average cost is:

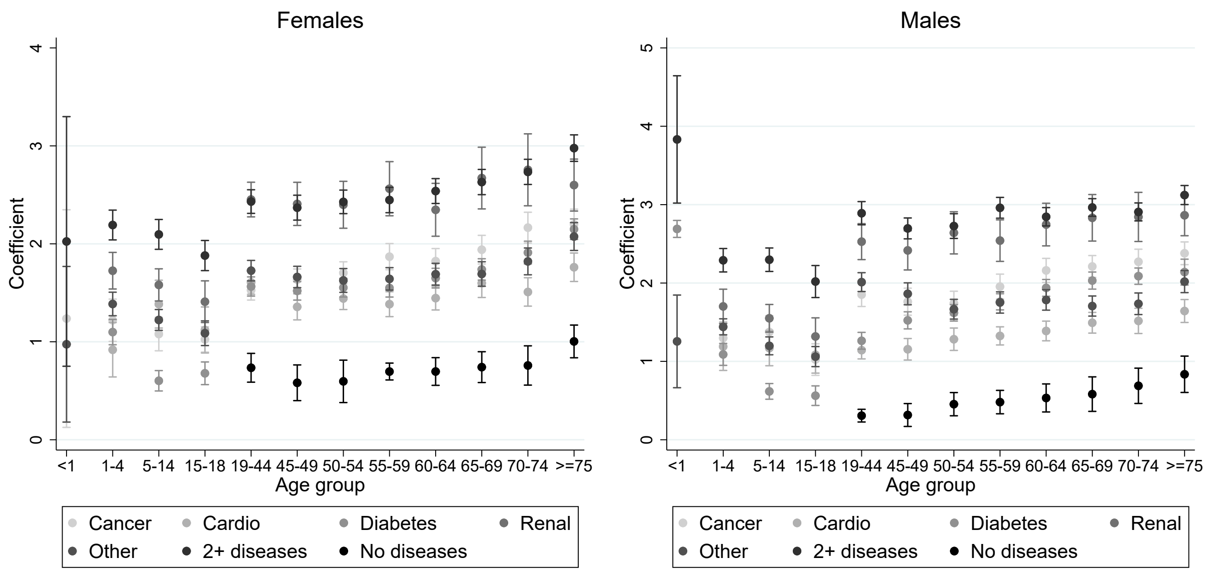
$$AC_j(H_j) = \sum_i \left( \sum_m \gamma_{\theta(i)l(i)m} \underbrace{\sum_{h \in H_{jm}} p_{jhm} \frac{exp(\delta_{ihm})}{1 + exp(\delta_{ihm})} \left( \frac{1 + exp(\eta(H_j))}{exp(\eta(H_j))} \right)}_{A_m} \right) \frac{exp(\eta_i(H_j))}{1 + exp(\eta_i(H_j))}$$

where $\eta(H_j)$ is the average utility of choosing insurer $j$ and $\delta_{ihm}$ is the average utility of choosing hospital $h$ for service $m$. For one consumer, taking logs of the equation above yields:

$$\log(AC_{ij}(H_j)) = \log\Big(\sum_m \gamma_{\theta(i)l(i)m} A_m\Big) + \underbrace{\eta_i(H_j)}_{\sum_m \gamma_{\theta(i)l(i)m} H_{jm}} - \log(1 + exp(\eta_i(H_j)))$$

which shows that my average cost function can be obtained from a more involved model of hospital choice under certain conditions.

# Appendix 8 Additional average cost results




Appendix Figure 8: Consumer type fixed effects

Appendix Table 10: Predicted change in females' average cost by type of carrier and diagnosis

| | F, 19-44, Healthy | | F, 19-44, Cancer | |
|---|---|---|---|---|
| Service | Narrow | Broad | Narrow | Broad |
| Cardiac vessels | 455 | 1,588 | 787 | 6,784 |
| Stomach | 457 | 1,592 | 799 | 6,802 |
| Intestines | 659 | 1,784 | 1,638 | 7,559 |
| Imaging | 3,399 | 4,071 | 9,841 | 14,105 |
| Consultations | 8,236 | 6,893 | 17,764 | 18,175 |
| Laboratory | 5,413 | 5,847 | 14,711 | 17,086 |
| Nuclear medicine | 1,296 | 2,724 | 3,189 | 8,816 |
| Hospital admissions | 1,755 | 3,035 | 4,949 | 9,967 |

*Note*: This table shows the average change in the average cost of a healthy female aged 19-44 and a female aged 19-44 with cancer following a 10% increase in network breadth for the service in the row, separately for broad and narrow network carriers. Broad network carriers are defined as insurers with average network breadth across all other services above 70% and narrow network carriers as the complement. Units are in Colombian pesos.

Appendix Table 11: Predicted change in males' average cost by type of carrier and diagnosis

| | M, 19-44, Healthy | | M, 19-44, Diabetes | |
|---|---|---|---|---|
| Service | Narrow | Broad | Narrow | Broad |
| Cardiac vessels | 210 | 757 | 772 | 3,365 |
| Stomach | 211 | 759 | 779 | 3,374 |
| Intestines | 317 | 860 | 1,180 | 3,782 |
| Imaging | 1,902 | 2,213 | 6,302 | 8,209 |
| Consultations | 5,305 | 4,252 | 13,752 | 12,302 |
| Laboratory | 3,248 | 3,639 | 9,951 | 11,182 |
| Nuclear medicine | 804 | 1,733 | 2,331 | 5,312 |
| Hospital admissions | 1,047 | 1,904 | 3,277 | 5,969 |

*Note*: This table shows the average change in the average cost of a healthy male aged 19-44 and a male aged 19-44 with diabetes following a 10% increase in network breadth for the service in the row, separately for broad and narrow network carriers. Broad network carriers are defined as insurers with average network breadth across all other services above 70% and narrow network carriers as the complement. Units are in Colombian pesos.

## Appendix 9 Dropout and transition probabilities

To estimate the marginal cost of network formation in the third step of my model, I first need to compute the probability that consumer type $(\theta, l)$ drops out of the contributory system and the probability that consumer type $(\theta, l)$ in period $t$ transitions into diagnosis $l'$ in period $t+1$. Both of these probabilities weight future per-enrollee profits in the insurer's total profit function.

I use the data from *all* enrollees to the contributory system in 2010 and 2011, regardless of their enrollment spell length, to compute dropout probabilities. For each consumer type $(\theta, l)$, I calculate the probability that she drops out of the system non-parametrically as the number of individuals of type $(\theta, l)$ observed only in 2010 but not 2011, divided by the total number of type $(\theta, l)$ individuals in 2010. Table 12 presents the mean and standard deviation of the dropout probability overall, and conditional on health status, sex, and age. Healthy individuals are on average 10 percentage points more likely to dropout of the system compared to sick patients, and consumers aged less than 44 are on average 3.8 percentage points more likely to dropout compared to individuals aged 45 or older. The table also shows that males are more likely to dropout of the contributory system relative to females, with the difference in means equal to 3.6 percentage points.

I use a non-parametric approach to compute transition probabilities as well, using data from continuously enrolled new *and* current enrollees in 2010 and 2011. Given that the transition from $\theta$ to $\theta'$ is deterministic, I only need to compute transition probabilities across diagnoses. The probability that type $(\theta, l)$ transitions into $(theta', l')$ equals the number of type $(\theta, l)$ in 2010 that end up with diagnosis $l'$ in 2011, divided by the number of type $(\theta, l)$ individuals in 2010. Table 13 presents the mean and standard deviation in parenthesis of transition probabilities from having cancer, cardiovascular disease, diabetes, renal disease, other diseases, 2 or more diseases, and no diseases in period $t$ to having each of these 7 diagnoses in period $t+1$. Because my list of diagnoses is mutually exclusive, the table shows that the probability of transitioning from a particular diagnosis in $t$ to a single different diagnosis in $t+1$ is zero, but the probability for the transition into the same diagnosis or to an added diagnosis ($\geq 2$ diseases) in $t+1$ is non-zero. For patients without diseases in period $t$, remaining healthy in period $t+1$ has the higher likelihood, followed by receiving a diagnosis for cardiovascular disease and other diseases like long-term pulmonary disease. The fact that the diagnosis list is mutually exclusive simplifies the computation of future profits and future marginal variable profits per enrollee that are needed to recover the marginal cost of network formation. I move to the estimation of this marginal cost next.

Appendix Table 12: Summary statistics of dropout probability

| | Mean | SD |
|---|---|---|
| Overall | 0.111 | 0.114 |
| Sick | 0.094 | 0.110 |
| Healthy | 0.201 | 0.092 |
| Age>44 | 0.094 | 0.100 |
| Age<=44 | 0.135 | 0.129 |
| Male | 0.129 | 0.124 |
| Female | 0.093 | 0.101 |

Appendix Table 13: Summary statistics of transition probabilities across diagnoses

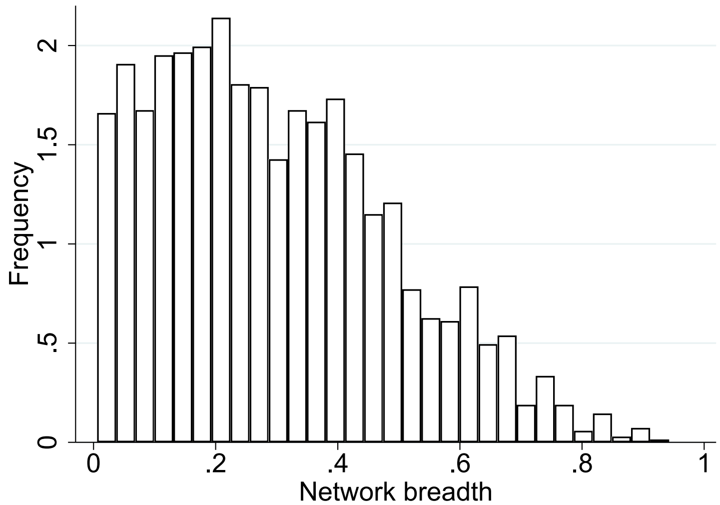
| Diagnosis t/t+1 | Cancer | Cardio | Diabetes | Renal | Other | ≥2 disea. | No disea. |
|---|---|---|---|---|---|---|---|
| Cancer | 0.789 | 0.000 | 0.000 | 0.000 | 0.000 | 0.211 | 0.000 |
| | (0.136) | (0.000) | (0.000) | (0.000) | (0.000) | (0.136) | (0.000) |
| Cardio | 0.000 | 0.774 | 0.000 | 0.000 | 0.000 | 0.226 | 0.000 |
| | (0.000) | (0.148) | (0.000) | (0.000) | (0.000) | (0.148) | (0.000) |
| Diabetes | 0.000 | 0.000 | 0.654 | 0.000 | 0.000 | 0.346 | 0.000 |
| | (0.000) | (0.000) | (0.209) | (0.000) | (0.000) | (0.209) | (0.000) |
| Renal | 0.000 | 0.000 | 0.000 | 0.643 | 0.000 | 0.357 | 0.000 |
| | (0.000) | (0.000) | (0.000) | (0.167) | (0.000) | (0.167) | (0.000) |
| Other | 0.000 | 0.000 | 0.000 | 0.000 | 0.711 | 0.289 | 0.000 |
| | (0.000) | (0.000) | (0.000) | (0.000) | (0.171) | (0.171) | (0.000) |
| >=2 diseases | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 1.000 | 0.000 |
| | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) |
| No diseases | 0.034 | 0.087 | 0.007 | 0.004 | 0.044 | 0.054 | 0.770 |
| | (0.038) | (0.086) | (0.015) | (0.016) | (0.028) | (0.084) | (0.148) |

*Note*: This table shows the mean and standard deviation in parenthesis of transition probabilities from cancer, cardiovascular disease, diabetes, renal disease, other diseases, 2 or more diseases, and no diseases in period $t$ to each of these 7 diagnoses in period $t+1$. Summary statistics are calculated across sex-age combinations in each cell.

Appendix Table 14: Summary statistics of marginal variable profits per insurer

| Insurer | MVP |
|---|---|
| EPS001 | 287 (1,202) |
| EPS002 | 859 (3,231) |
| EPS003 | 419 (1,636) |
| EPS005 | 248 (981) |
| EPS010 | 930 (3,203) |
| EPS013 | 757 (2,472) |
| EPS016 | 1,302 (4,258) |
| EPS017 | 663 (3,591) |
| EPS018 | 597 (2,312) |
| EPS037 | 1,138 (3,675) |

*Note*: Mean and standard deviation in parenthesis of marginal marginal variable profits in the left-hand side of equation (4). Measured in millions of Colombian pesos per service per market.




Appendix Figure 9: Distribution of network breadth for FOC

Appendix Table 15: First stage regression of network breadth

| $H_{jmk}$ | Coefficient | Std. Error |
|---|---|---|
| $H_{jmk}^{t-1}$ | 0.76*** | 0.01 |
| $\overline{\gamma}_{female,m,k}$ | 33.94*** | 8.45 |
| $\overline{\gamma}_{healthy,m,k}$ | 14.31*** | 4.20 |
| $\overline{\gamma}_{age\ 19-44,m,k}$ | -55.33*** | 13.63 |
| $H_{jmk}^{t-1} \times \overline{\gamma}_{age\ 19-44,m,k}$ | 0.16*** | 0.05 |
| Insurer FEs | | |
| EPS001 | -0.02*** | 0.01 |
| EPS002 | 0.01* | 0.01 |
| EPS003 | -0.04*** | 0.01 |
| EPS005 | 0.02** | 0.01 |
| EPS010 | -0.01 | 0.01 |
| EPS013 | 0.00 | 0.01 |
| EPS016 | 0.14*** | 0.01 |
| EPS017 | 0.00 | 0.01 |
| EPS018 | -0.01 | 0.01 |
| EPS037 | (ref) | (ref) |
| Market FEs | | |
| Market 05 | (ref) | (ref) |
| Market 08 | 0.00 | 0.01 |
| Market 11 | 0.00 | 0.00 |
| Market 76 | -0.02*** | 0.01 |
| N | 2,262 | |
| F-stat | 929.67 | |

*Note*: This table presents the first stage of the GMM estimation of equation (5). $H_{jmk}^{t-1}$ is the network breadth in 2010. $\overline{\gamma}_{i,m,k}$ is the average probability that a consumer with characteristic $i$ makes a claim for service $m$ in market $k$. The specification includes insurer, market, and service fixed effects. Robust standard errors and first-stage F-statistic reported. $^{***}$p<0.01, $^{**}$p<0.05, $^{*}$p<0.1.

Appendix Table 16: Predicted average total network formation cost per market

| Insurer | (1) Total | (2) % |
|---|---|---|
| EPS001 | 1,381 | 14 |
| EPS002 | 16,810 | 134 |
| EPS003 | 6,917 | 85 |
| EPS005 | -2,576 | -105 |
| EPS010 | 11,721 | 91 |
| EPS013 | 13,084 | 98 |
| EPS016 | 23,851 | 83 |
| EPS017 | 13,208 | 66 |
| EPS018 | 10,545 | 90 |
| EPS037 | 19,541 | 92 |

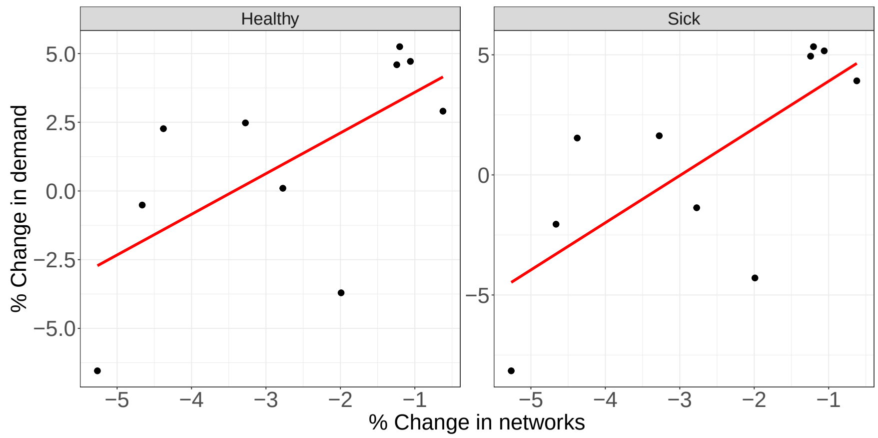
*Note*: Column (1) presents the predicted average total cost of network formation in millions of pesos across markets and column (2) presents this cost as a percentage of total variable profits.

Appendix Table 17: Decomposition of profit changes after network breadth increase by diagnosis

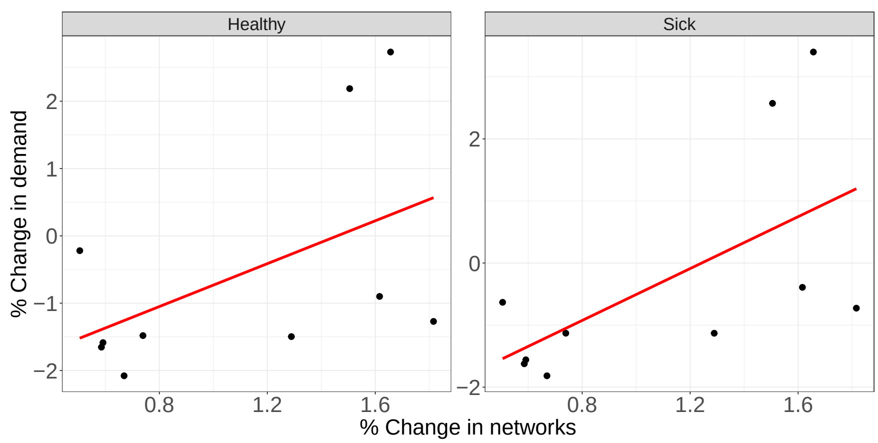
| | Healthy | | Renal | | Other disease | |
|---|---|---|---|---|---|---|
| Service | $\%\Delta s_{ijk}$ | $\%\Delta AC_{\theta ljk}$ | $\%\Delta s_{ijk}$ | $\%\Delta AC_{\theta ljk}$ | $\%\Delta s_{ijk}$ | $\%\Delta AC_{\theta ljk}$ |
| Cardiac vessels | 0.01 | 0.00 | 0.03 | 0.00 | 0.02 | 0.00 |
| Stomach | 0.01 | 0.00 | 0.03 | 0.00 | 0.03 | 0.00 |
| Intestines | 0.25 | 0.02 | 0.60 | 0.02 | 0.49 | 0.02 |
| Imaging | 3.98 | 0.29 | 6.08 | 0.31 | 5.62 | 0.33 |
| Consultations | 13.17 | 1.24 | 12.35 | 0.95 | 13.07 | 1.01 |
| Laboratory | 5.45 | 0.43 | 7.19 | 0.41 | 6.97 | 0.43 |
| Nuclear medicine | 0.07 | 0.01 | 0.18 | 0.01 | 0.15 | 0.01 |
| Hospital admissions | 0.67 | 0.05 | 1.56 | 0.07 | 1.27 | 0.06 |

*Note*: This table shows the average percentage change in demand ($\%\Delta s_{ijk}$) and average costs per enrollee ($\%\Delta AC_{\theta ljk}$) for healthy individuals, patients with renal disease, and patients with other chronic conditions, after a 10% unilateral increase in network breadth for the service in the row by insurer $j$, while holding its competitors' choices fixed.

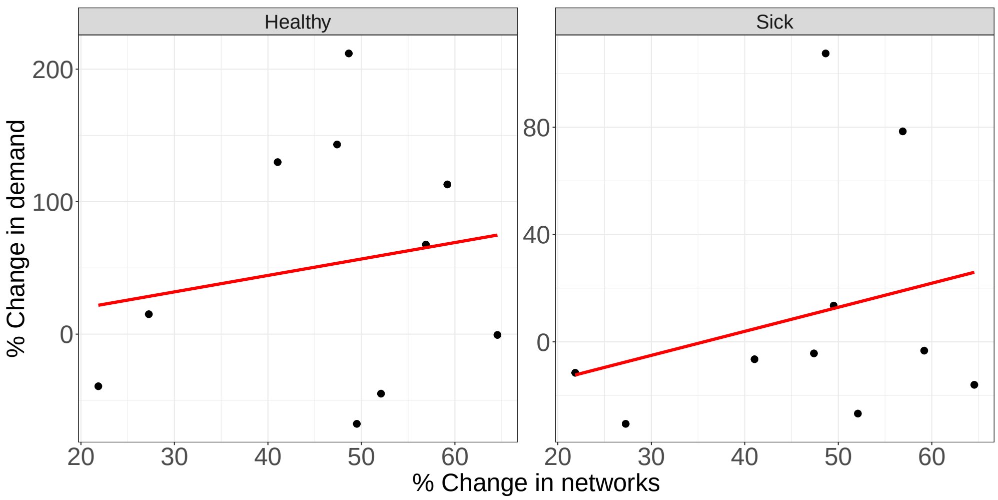
# Appendix 10 Additional counterfactual results



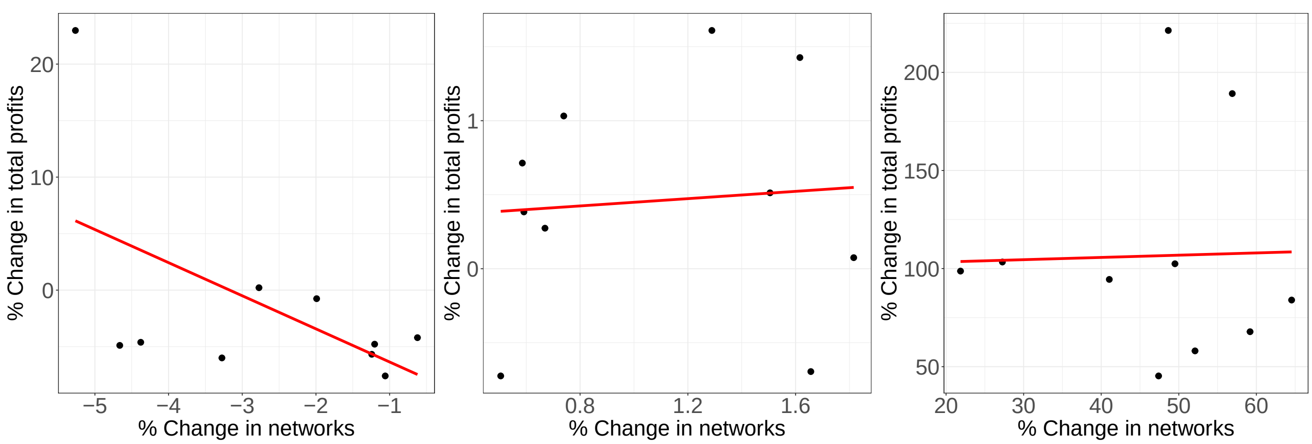

Appendix Figure 10: Correlation between network changes and changes in demand under no risk adjustment




Appendix Figure 11: Correlation between network changes and changes in demand under no improved adjustment




Appendix Figure 12: Correlation between network changes and changes in demand under premium deregulation




(a) No risk adjustment (b) Improved risk adjustment (c) Premium deregulation

Appendix Figure 13: Correlation between profit and network changes in counterfactual

Appendix Table 18: Welfare changes by consumer subgroups

| | No risk adjustment (1) | Improved risk adjustment (2) | Premium deregulation (3) |
|---|---|---|---|
| Sex | | | |
| Female | -7.1 | 3.3 | -80.8 |
| Male | -7.5 | 3.5 | -88.7 |
| Age group | | | |
| 5-14 | -6.8 | 3.2 | -89.4 |
| 15-18 | -5.1 | 2.2 | -78.0 |
| 19-44 | -6.5 | 2.9 | -11.9 |
| 45-49 | -7.5 | 3.5 | -88.4 |
| 50-54 | -6.8 | 3.1 | -34.0 |
| 55-59 | -5.3 | 2.3 | -75.0 |
| 60-64 | -7.7 | 3.5 | -92.2 |
| 65-69 | -6.2 | 2.7 | -72.7 |
| 70-74 | -5.8 | 2.5 | -69.2 |
| >=75 | -5.4 | 2.4 | -69.7 |
| Diagnoses | | | |
| Cancer | -8.6 | 3.5 | 39.1 |
| Cardiovascular | -7.2 | 3.0 | 55.8 |
| Diabetes | -6.8 | 2.9 | 42.9 |
| Renal | -9.0 | 3.7 | 114.0 |
| Other | -7.8 | 3.2 | 41.4 |
| >=2 diseases | -7.5 | 3.0 | 59.8 |
| No diseases | -7.4 | 3.5 | -87.5 |

*Note*: This table shows the welfare change for subgroups of consumers under the no risk adjustment counterfactual in column (1), the improved risk adjustment counterfactual in column (2), and the premium deregulation counterfactual in column (3), relative to the model's predictions in the observed scenario.