Risk Selection Through Service-Level Hospital Networks

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Introduction

- Risk selection is insurers' incentive to enroll healthy instead of sick patients.
- Insurers engage in risk selection by offering a variety of insurance contracts.
- Governments control these incentives using risk adjustment.
- I study a novel mechanism for risk selection: **insurer's service-level hospital networks**.

Institutional background

- Empirical setting is Colombia:
  - Two systems: Contributory (CR) and Subsidized (SR).
  - One national insurance plan, provided by private carriers.
  - Near universal insurance coverage $\rightarrow$ intensive margin.
  - Premiums are set to zero.
  - Cost-sharing and benefits are regulated.
  - Ex-ante risk adjustment controls for sex, age, location.
  - Ex-post risk adjustment controls for non-exhaustive list of diseases.
- Only unregulated dimension are service-level hospital networks (and prices).

Introduction

- Insurers have discretion over which services to cover at which hospitals.
- Insurers can select risks by providing a narrow hospital network in services that costly patients demand the most.
- Narrow network trade-off: better demand composition but lower demand.
- Broad network trade-off: higher demand but higher costs.

Research questions

- To what extent do insurers use their service-specific hospital networks to risk select?

- In a counterfactual with:
  - *alternative risk adjustment*, and
  - *premium deregulation*

  what would service-level hospital networks look like?

Contribution

- The literature has studied several selection mechanisms:
  - Advertising (Aizawa and Kim, 2018),
  - Selective entry (McNamara et. al, 2021),
  - Service-level cost-sharing (Park et al., 2017),
  - Narrow hospital networks (Shepard, 2021; Ho and Lee, 2019; Liebman, 2018; Ghili, 2020).
- This paper identifies a novel mechanism for risk selection: service-level hospital networks.

Contribution

- Most of the work on hospital networks focuses on static profits and choices in environments with dynamic moral hazard.
- Shepard (2021); Prager and Tilipman (2020); Ho and Lee (2019).
- I develop a tractable model of insurer competition in networks.
- Static network choices but with future discounted profits.
- Allows predictions of network breadth under counterfactual market conditions.

Contents

Data

- All enrollees to the CR in Colombia during 2010 and 2011, and claims.
- Current enrollees: enrolled in 2010 and 2011. $N \approx 6M$.
  - Switchers: $N \approx 4,000$
  - Stayers.
- New enrollees: first choice in 2011. $N \approx 2.9M$.
  - People switching from the subsidized to the contributory system.
  - People that failed to enroll.
- Focus on the 14 largest insurers. Account for 97% of enrollees.
- A market is a Colombian state. There are 32 markets in my data.

Data

Table: National market shares in 2011 per sample

Insurer	Current	New
EPS013	18.0	14.7
EPS016	16.1	17.9
EPS037	17.2	17.7
EPS002	7.4	6.8
EPS017	7.4	5.8
EPS010	7.4	5.8
EPS005	5.8	4.0
EPS018	3.7	3.8
EPS003	3.9	3.8
EPS008	4.8	3.6
EPS023	3.0	2.2
EPS009	1.7	1.9
EPS001	2.2	1.9

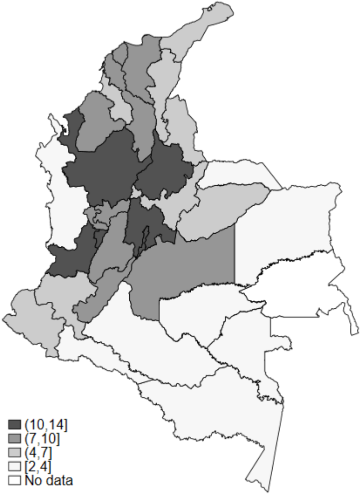

Figure: Number of insurers per market

Data

- Collapse services into 58 categories. Examples:
  - Procedures in cardiac vessels.
  - Procedures in heart valves.
  - Procedures in bones and joints.
  - Procedures in skull and brain.
  - Hospitalization.
  - Consultations.
  - Laboratory.

Data

I recover insurers' service-specific hospital networks from observed claims.

- Sample of hospitals that provide inpatient, surgical, urgent care, and diagnostic services (robust).
- 1,663 hospitals in 2011 and 1,453 hospitals in 2010.
- Sample represents 32% of total costs and 27% of total claims in the CR.

Network measure

- Object of interest is insurers' service-level hospital network breadth.

- Collapse a multi-dimensional object to one dimension per service.

- Prevents from tracking the identity of in-network hospitals.

Descriptive facts

- Current enrollees are more expensive than new enrollees. Stayers are more expensive than switch-ins. Expand
- Insurers are heterogeneous in their profits per enrollee. Expand
- Insurers are heterogeneous in their service network breadth. Expand
- Network breadth is positively correlated with costs. Expand
- Substantial consumer inertia. Expand

Can insurers risk select using their service networks?

I estimate the following regressions in the spirit of Brown et al. (2014):

- In the sample of current enrollees:

$$
\begin{aligned}
ihs(y_{imk}^{2010}) = &\beta_0 + \beta_1 Switch_{ik} \times (H_{j(i)mk}^{2010} - H_{j(i)mk}^{2011}) + \beta_2 Switch_{ik} \\
&+ \beta_3 (H_{j(i)mk}^{2010} - H_{j(i)mk}^{2011}) + \mathbf{d}_i' \beta_4 + \lambda_m + \delta_j + \eta_k + \varepsilon_{imk}
\end{aligned}
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- In the sample of new enrollees:

$$ihs(Risk\ score_{ijk}^{2011}) = \beta_0 + \beta_1 (H_{jk}^{2010} - H_{jk}^{2011}) + \delta_j + \eta_k + \varepsilon_{ijk}$$

Can insurers risk select using their service networks?

Table: Selection on baseline costs and risk scores

	$ihs(total\ cost^{2010}_{ijmk})$ (1)	$ihs(total\ cost^{2010}_{ijmk})$ (2)	$any\ claim^{2010}_{ijmk}$ (3)	$ihs(Risk\ score^{2011}_{ijmk})$ (4)
Switch $\times$ $(H^{2010}_{jmk} - H^{2011}_{jmk})$	-0.25***	-0.25***	-0.02***	—
	(0.08)	(0.08)	(0.007)	
Switch	-0.08***	-0.09***	-0.007***	—
	(0.02)	(0.02)	(0.001)	
$H^{2010}_{jmk} - H^{2011}_{jmk}$	-0.004***	0.004	-0.0001	-0.17***
	(0.002)	(0.002)	(0.0002)	(0.008)
Demog+Diag	Y	Y	Y	—
Market	Y	Y	Y	Y
Service	Y	Y	Y	—
Insurer	—	Y	Y	Y
N	14,496,230	14,496,230	14,496,230	2,653,415
R^2	0.50	0.50	0.51	0.06

Can insurers risk select using their service networks?

Table: Selection on baseline costs and risk scores

	$ihs(total\ cost^{2010}_{ijmt})$ (1)	$ihs(total\ cost^{2010}_{ijmt})$ (2)	$any\ claim^{2010}_{ijmt}$ (3)	$ihs(Risk\ score^{2011}_{new})$ (4)
Switch × $(H^{2010}_{jmt} - H^{2011}_{jmt})$	-0.25***	-0.25***	-0.02***	—
	(0.08)	(0.08)	(0.007)	
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Econometric model

- Insurer demand: consumers care about network breadth.

- Insurer costs: depend on the composition of enrollee types.

- Key strategic choice is how broad service-level networks are.

Insurer demand

- Static discrete choices of active new enrollees with inertia. Dynamics

- The utility of a new consumer i for insurer j in market k is:

$$u_{ijk} = \beta_i^D \sum_m \gamma_{\theta(i)l(i)mk} H_{jmk} - \alpha_i c_{\theta(i)l(i)y(i)jk} + \delta_j + \varepsilon_{ijk}^D$$

  - m is a service.
  - (θ, l) is a consumer-type.
  - $\theta =$ sex, age group ($<$1, 1-4, 5-14, 15-18, 19-44, 45-49, 50-54, 55-59, 60-64, 65-69, 70-74, $\geq$75)
  - $l \in L = \{$cancer, cardio, diabetes, renal, other, 2 or more diseases, no diseases$\}$

Insurer demand

$$u_{ijk} = \beta_i^D \sum_m \underbrace{\gamma_{\theta(i)l(i)mk}}_{\substack{\text{claim}\\\text{prob.}}} \overbrace{H_{jmk}}^{\substack{\text{network}\\\text{breadth}}} - \alpha_i \underbrace{c_{\theta(i)l(i)y(i)jk}}_{\substack{\text{OOP}\\\text{expenses}}} + \delta_j + \varepsilon_{ijk}^D$$

Insurer demand

$$u_{ijk} = \beta_i^D \sum_m \underbrace{\gamma_{\theta(i)l(i)mk}}_{\substack{\text{claim}\\\text{prob.}}} \overbrace{H_{jmk}}^{\substack{\text{network}\\\text{breadth}}} - \alpha_i \underbrace{c_{\theta(i)l(i)y(i)jk}}_{\substack{\text{OOP}\\\text{expenses}}} + \delta_j + \varepsilon_{ijk}^D$$

- Probability that consumer type (θ, l) makes a claim for service m.
  Variation
- Calculated non-parametrically from data as: $\frac{N_{\theta lmk}}{N_{\theta lk}}$

Insurer demand

$$u_{ijk} = \beta_i^D \sum_m \underbrace{\gamma_{\theta(i)l(i)mk}}_{\substack{\text{claim}\\\text{prob.}}} \overbrace{H_{jmk}}^{\substack{\text{network}\\\text{breadth}}} - \alpha_i \underbrace{c_{\theta(i)l(i)y(i)jk}}_{\substack{\text{OOP}\\\text{expenses}}} + \delta_j + \varepsilon_{ijk}^D$$

- Proportion of hospitals covered by insurer j in service m.

Insurer demand

$$u_{ijk} = \beta_i^D \sum_m \underbrace{\gamma_{\theta(i)l(i)mk}}_{\substack{\text{claim}\\ \text{prob.}}} \overbrace{H_{jmk}}^{\substack{\text{network}\\ \text{breadth}}} - \alpha_i \underbrace{c_{\theta(i)l(i)y(i)jk}}_{\substack{\text{OOP}\\ \text{expenses}}} + \delta_j + \varepsilon_{ijk}^D$$

- Average out-of-pocket expenses of consumer type (θ, l) with income level y.

- Calculated non-parametrically from the data.

Insurer demand

$$u_{ijk} = \beta_i^D \sum_m \underbrace{\gamma_{\theta(i)l(i)mk}}_{\substack{\text{claim}\\ \text{prob.}}} \overbrace{H_{jmk}}^{\substack{\text{network}\\ \text{breadth}}} - \alpha_i \underbrace{c_{\theta(i)l(i)y(i)jk}}_{\substack{\text{OOP}\\ \text{expenses}}} + \delta_j + \varepsilon_{ijk}^D$$

- Insurer fixed effect. Captures quality differences across insurers.

Insurer demand

$$u_{ijk} = \beta_i^D \sum_m \underbrace{\gamma_{\theta(i)l(i)mk}}_{\substack{\text{claim}\\\text{prob.}}} \overbrace{H_{jmk}}^{\substack{\text{network}\\\text{breadth}}} - \alpha_i \underbrace{c_{\theta(i)l(i)y(i)jk}}_{\substack{\text{OOP}\\\text{expenses}}} + \delta_j + \varepsilon_{ijk}^D$$

- Distributed T1EV.

Insurer demand

$$u_{ijk} = \beta_i^D \sum_m \underbrace{\gamma_{\theta(i)l(i)mk}}_{\substack{\text{claim}\\ \text{prob.}}} \overbrace{H_{jmk}}^{\substack{\text{network}\\ \text{breadth}}} - \alpha_i \underbrace{c_{\theta(i)l(i)y(i)jk}}_{\substack{\text{OOP}\\ \text{expenses}}} + \delta_j + \varepsilon_{ijk}^D$$

$$\begin{pmatrix} \beta_i^D \\ \alpha_i \end{pmatrix} = \begin{pmatrix} \beta^D \\ \alpha \end{pmatrix} \mathbf{X}_i$$

- $\mathbf{X}_i$ are observable demographic characteristics and diagnoses.

Insurer average costs

$$\log(AC_{\theta ljk}(H_{jk})) = \beta_0^S \overbrace{\Big(\sum_m \gamma_{\theta lmk} A_m\Big)}^{\substack{\text{expected price} \\ \text{across services}}} + \beta_1^S \overbrace{\Big(\sum_m \gamma_{\theta lmk} H_{jmk}\Big)}^{\substack{\text{weighted service} \\ \text{network breadth}}}$$
$$+ \frac{1}{2M}\beta_2^S \underbrace{\sum_m \sum_{n \neq m} \gamma_{\theta lmk}\gamma_{\theta lnk} H_{jmk} H_{jnk}}_{\substack{\text{scope} \\ \text{economies}}} + \lambda_{\theta l} + \eta_k$$

Insurer average costs

$$\log(AC_{\theta ljk}(H_{jk})) = \beta_0^S \overbrace{\left(\sum_m \gamma_{\theta lmk} A_m\right)}^{\substack{\text{expected price}\\\text{per service}}} + \beta_1^S \overbrace{\left(\sum_m \gamma_{\theta lmk} H_{jmk}\right)}^{\substack{\text{weighted service}\\\text{network breadth}}}$$

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- Reference price for service m (exogenous). Expand

Insurer average costs

$$\log(AC_{\theta ljk}(H_{jk})) = \beta_0^S \overbrace{\left(\sum_m \gamma_{\theta lmk} A_m\right)}^{\text{expected price per service}} + \beta_1^S \overbrace{\left(\sum_m \gamma_{\theta lmk} H_{jmk}\right)}^{\text{weighted service network breadth}}$$

$$+ \frac{1}{2M} \beta_2^S \underbrace{\sum_m \sum_{n \neq m} \gamma_{\theta lmk} \gamma_{\theta lnk} H_{jmk} H_{jnk}}_{\text{scope economies}} + \lambda_{\theta l} + \eta_k$$

- Differences in average cost across consumer types that are driven by differences in the price of the services they need.

Insurer average costs

$$\log(AC_{\theta ljk}(H_{jk})) = \beta_0^S \overbrace{\left(\sum_m \gamma_{\theta lmk} A_m\right)}^{\substack{\text{expected price} \\ \text{per service}}} + \beta_1^S \overbrace{\left(\sum_m \gamma_{\theta lmk} H_{jmk}\right)}^{\substack{\text{weighted service} \\ \text{network breadth}}}$$

$$+ \frac{1}{2M} \beta_2^S \underbrace{\sum_m \sum_{n \neq m} \gamma_{\theta lmk} \gamma_{\theta lnk} H_{jmk} H_{jnk}}_{\substack{\text{scope} \\ \text{economies}}} + \lambda_{\theta l} + \eta_k$$

- γ is common knowledge.
- Higher coverage of m raises the average cost of different consumer types by different magnitudes.

Insurer average costs

$$\log(AC_{\theta ljk}(H_{jk})) = \beta_0^S \overbrace{\left(\sum_m \gamma_{\theta lmk} A_m\right)}^{\substack{\text{expected price}\\\text{per service}}} + \beta_1^S \overbrace{\left(\sum_m \gamma_{\theta lmk} H_{jmk}\right)}^{\substack{\text{weighted service}\\\text{network breadth}}}$$
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- Insurers that offer a broad network in one service tend to offer broad networks in other services.

Insurer average costs

$$\log(AC_{\theta ljk}(H_{jk})) = \beta_0^S \overbrace{\left(\sum_m \gamma_{\theta lmk} A_m\right)}^{\substack{\text{expected price}\\ \text{per service}}} + \beta_1^S \overbrace{\left(\sum_m \gamma_{\theta lmk} H_{jmk}\right)}^{\substack{\text{weighted service}\\ \text{network breadth}}}$$
$$+ \frac{1}{2M} \beta_2^S \underbrace{\sum_m \sum_{n \neq m} \gamma_{\theta lmk} \gamma_{\theta lnk} H_{jmk} H_{jnk}}_{\substack{\text{scope}\\ \text{economies}}} + \lambda_{\theta l} + \eta_k$$

- If negative: economies of scope across services.
- If positive: network breadth choices across services are at least independent.

Insurer average costs: estimation

$$\log(AC_{\theta ljk}(H_{jk})) = \beta_0^S \overbrace{\left(\sum_m \gamma_{\theta lmk} A_m\right)}^{\substack{\text{expected price}\\ \text{per service}}} + \beta_1^S \overbrace{\left(\sum_m \gamma_{\theta lmk} H_{jmk}\right)}^{\substack{\text{weighted service}\\ \text{network breadth}}}$$
$$+ \frac{1}{2M}\beta_2^S \underbrace{\sum_m \sum_{n \neq m} \gamma_{\theta lmk}\gamma_{\theta lnk} H_{jmk} H_{jnk}}_{\substack{\text{scope}\\ \text{economies}}} + \lambda_{\theta l} + \eta_k + \epsilon_{\theta ljk}$$

- Measurement error from estimation.

Competition and equilibrium

Let $\pi_{ijt}(H_t, \theta, l)$ be insurer j's short-run per-enrollee profit:

$$\pi_{ijk}(H_k, \theta, l) = (\underbrace{R_{\theta(i)k}}_{\substack{\text{govmt}\\\text{transfer}}} - \overbrace{(1 - r_{y(i)})}^{\text{1-coins. rate}} \underbrace{AC_{\theta(i)l(i)jk}(H_{jk})}_{\substack{\text{average}\\\text{cost}}}) \underbrace{s_{ijk}(H_k)}_{\substack{\text{choice}\\\text{prob.}}}$$

Competition and equilibrium

Full commitment equilibrium. Insurers choose networks once to maximize:

$$\Pi_{jk}(H_k) = \sum_{\theta,l,k} \Bigg(\underbrace{\pi_{ijk}(H_k, \theta, l) N_{\theta lk}}_{\text{short-run profit}}$$

$$+ \underbrace{\sum_{s=t+1}^{T} \beta^s \sum_{\theta', l'} (1 - \rho_{\theta'(i) l'(i)}) P(l'|\theta, l) \pi_{ijk}(H_k, \theta', l') N_{\theta' l' k} \Bigg)}_{\text{long-run profit}}$$

$$- \underbrace{\sum_m (\omega_0 H_{jmk} + \omega_m + \varepsilon^S_{jmk}) H_{jmk}}_{\text{network formation cost}}$$

$N_{\theta lk}$ is the market size of consumers type (θ, l) in market k.

Competition and equilibrium

$$\Pi_{jk}(H_k) = \sum_{\theta,l,k} \Big(\underbrace{\pi_{ijk}(H_k,\theta,l)N_{\theta lk}}_{\text{short-run profit}}$$
$$+ \underbrace{\sum_{s=t+1}^{T} \beta^s \sum_{\theta',l'} (1 - \rho_{\theta'(i)l'(i)}) P(l'|\theta,l)\pi_{ijk}(H_k,\theta',l')N_{\theta' l' k} \Big)}_{\text{long-run profit}}$$
$$- \underbrace{\sum_{m} (\omega_0 H_{jmk} + \omega_m + \varepsilon^S_{jmk}) H_{jmk}}_{\text{network formation cost}}$$

- Exogenous probability of dropping out of contributory system.

Competition and equilibrium

$$\Pi_{jk}(H_k) = \sum_{\theta,l,k} \Big(\underbrace{\pi_{ijk}(H_k,\theta,l)N_{\theta lk}}_{\text{short-run profit}} + \underbrace{\sum_{s=t+1}^{T} \beta^s \sum_{\theta',l'} (1-\rho_{\theta'(i)l'(i)}) P(l'|\theta,l) \pi_{ijk}(H_k,\theta',l') N_{\theta' l' k}}_{\text{long-run profit}} \Big) - \underbrace{\sum_m (\omega_0 H_{jmk} + \omega_m + \varepsilon^S_{jmk}) H_{jmk}}_{\text{network formation cost}}$$

- Transition probability from state (θ, l) in period t to state l' in period $t+1$. Transition across θ is deterministic.

Competition and equilibrium

$$\Pi_{jk}(H_k) = \sum_{\theta,l,k} \Bigg(\underbrace{\pi_{ijk}(H_k,\theta,l)N_{\theta lk}}_{\text{short-run profit}} + \underbrace{\sum_{s=t+1}^{T} \beta^s \sum_{\theta',l'} (1-\rho_{\theta(i)l(i)})P(l'|\theta,l)\pi_{ijk}(H_k,\theta',l')N_{\theta' l' k}}_{\text{long-run profit}} \Bigg) - \underbrace{\sum_m (\omega_0 H_{jmk} + \omega_m + \varepsilon^S_{jmk})H_{jmk}}_{\text{network formation cost}}$$

- Bargaining or administrative cost.
- Can't distinguish between one-time sunk cost or recurrent fixed cost.

Competition and equilibrium

FOC:

$$MR_{jmk}(H_k) = \phi_{jk} MC_{jmk}(H_k) + 2\omega_0 H_{jmt} + \omega_m + \varepsilon^S_{jmk}$$

- $J \times M \times K$ FOCs. Exactly identified.
- Left-side: marginal revenue.
- Right-side: marginal cost plus marginal network formation cost.
- $\phi_{jk} = \phi_0 + \phi_j + \phi_k$ captures unobserved (to econometrician) factors that affect cost derivatives.
- FOC can be used to find the vector of network breadth under counterfactual market conditions.

Estimation

1. New enrollees' demand for insurers: conditional logit.
2. Insurer average costs: OLS.
3. Insurer cost of network formation: OLS.

Table: Insurer demand

Insurer choice		Coefficient	Std. Error
Network		3.589***	0.015
OOP spending		-7.155***	0.212
Interactions			
Network	Male	0.762***	0.011
	Age	-0.018***	0.000
	Cancer	-1.017***	0.025
	Cardiovascular	-1.181***	0.019
	Diabetes	-1.326***	0.050
	Renal	-1.597***	0.100
	Other	-1.351***	0.026
	>=2 diseases	-1.561***	0.021
	Healthy	(ref)	(ref)
	Normal	0.050***	0.011
	Special	0.992***	0.058
	Urban	(ref)	(ref)
OOP spending	Male	0.118	0.083
	Age	-0.007***	0.002
	Cancer	5.916***	0.225
	Cardiovascular	6.446***	0.183
	Diabetes	6.411***	0.311
	Renal	6.837***	0.203
	Other	6.133***	0.201
	>=2 diseases	6.481***	0.184
	Healthy	(ref)	(ref)
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N		5,800,610	
Pseudo-R^2		0.17	

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Demand results

Table: Average willingness-to-pay

Characteristic	WTP
Diagnosis:	
Sick	1.074
Healthy	0.013
Sex:	
Male	0.553
Female	0.495
Age group:	
<1	0.183
1-4	0.316
5-14	0.794
15-18	0.224
19-44	0.344
45-49	0.262
50-54	2.426
55-59	0.577
60-64	0.952
65-69	1.708
70-74	0.653
$\geq$75	0.103

Average cost results

- A 1% increase in network breadth for service m:
  - Increases average costs per consumer type by 2.1%.
  - Decreases the average cost of providing coverage for service $n \neq m$ by 0.7%.

- Conditional on enrollee type composition, predicted average costs are:
  - U-shaped in age.
  - Hump-shaped in network breadth.

Regression

Average cost results

Table: Predicted change in average cost per enrollee by type of carrier

Service category	Narrow	Broad
Cardiac vessels	4.6 (60.2)	3.3 (65.7)
Stomach	10.4 (57.1)	2.1 (22.7)
Intestines	163.8 (485.8)	127.8 (593.0)
Imaging	2,801.8 (6,904.4)	1,749.5 (5,637.0)
Consultations	7,597.7 (9,697.2)	4,730.3 (5,999.4)
Laboratory	3,626.1 (8,903.8)	3,022.0 (9,398.5)
Nuclear medicine	164.1 (2,779.3)	460.5 (4,929.2)
Hospital admissions	500.9 (3,306.2)	937.6 (6,349.8)

Network formation cost results

- Network formation costs are weakly convex in network breadth.
- Increasing network breadth for the average service by:
  - 1 sd, increases network formation costs by \$8.6 million pesos.
  - 2 sd, increases network formation costs by \$17.3 million pesos.
- Average predicted network formation cost per market is between 7% and 31% of an insurer's total variable profits.

Regression

Checking Nash equilibrium conditions

Table: Decomposition of profit changes after network breadth increase

Service	$\%\Delta s_{ijk}$ (1)	$\%\Delta R_{\theta t} s_{ijk}$ (2)	$\%\Delta AC_{\theta ljk} s_{ijk}$ (3)	$\%\Delta AC_{\theta ljk}$ (4)	$\%\Delta F_{jk}$ (5)
Cardiac vessels	0.00	0.00	0.01	0.00	0.00
Stomach	0.01	0.01	0.02	0.00	0.00
Intestines	0.19	0.28	0.33	0.02	0.14
Imaging	3.82	4.70	5.99	0.39	1.21
Consultations	15.06	14.94	18.18	1.43	5.07
Laboratory	4.77	5.66	7.04	0.48	1.77
Nuclear medicine	0.04	0.06	0.10	0.01	-0.01
Hospital admissions	0.46	0.58	0.76	0.04	0.14

In NE: (2)-(3)-(5)≤ 0

The effect of risk adjustment of network breadth

Use the model to simulate two counterfactual scenarios:

- Eliminate risk adjustment.
- Improve the government's ex-ante risk adjustment formula to compensate for diagnoses.

No risk adjustment

- The per-capita revenue to the insurer equals the national base transfer:

$$R^{cf}_{\theta lk} = UPC_{National}, \quad \forall(\theta, l, k)$$

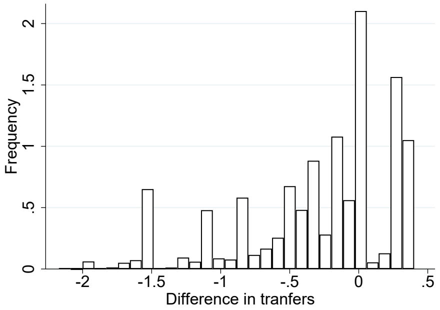

Figure: Counterfactual minus observed transfers

No risk adjustment

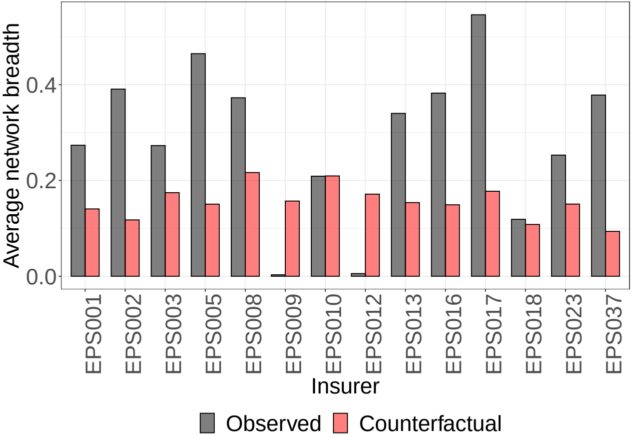

Figure: Average network breadth under no risk adjustment

No risk adjustment

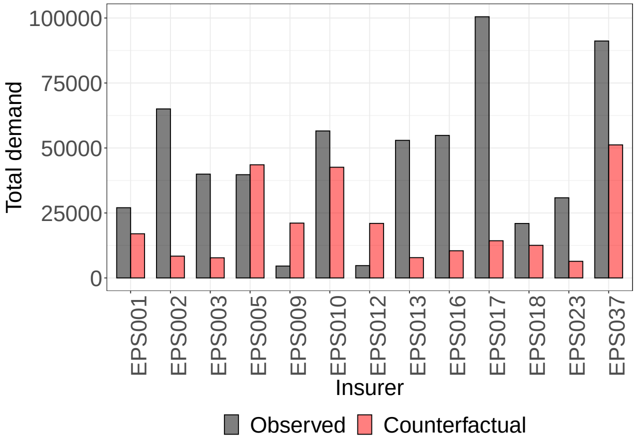

Figure: Total demand under no risk adjustment

No risk adjustment

Table: Health care system costs and welfare under no risk adjustment

	Insurer revenue (1)	Insurer total avg. cost (2)	Short-run avg. cost (3)	Short-run Gov. spend. (4)	Short-run welfare (5)
Observed	387,265	195,741	1.78	17,214,070	10,333
Counterfactual	395,040	220,310	1.48	17,161,741	4,513
%Δ	2.01	12.55	-17.12	-0.30	-56.33

Note: Columns (1), (2), (3) and (5) are calculated with data only from Bogotá. Column (4) is calculated using data from all the country. Units are in millions of COP.

Improved risk adjustment

The counterfactual risk-adjusted transfer is:

$$R^{cf}_{\theta lk} = a_k \times 360 \times \frac{\sum_{i \in \theta l} X_i}{\sum_{i \in \theta l} d_i}$$

- X_i is total healthcare cost of individual i.
- d_i is number of days enrolled to the CR in a year.
- a_k is the market multiplier from current risk adjustment system.

Improved risk adjustment

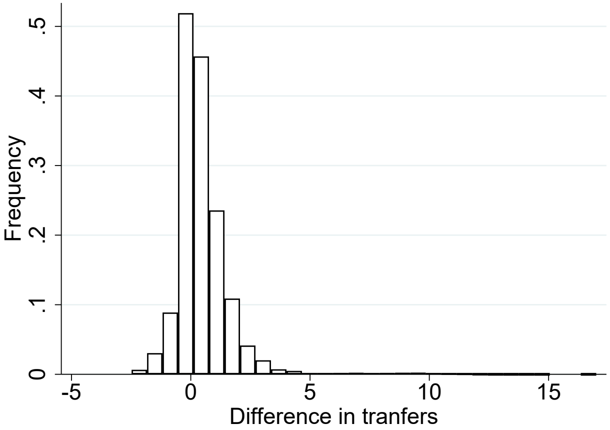

Figure: Counterfactual minus observed transfers

Improved risk adjustment

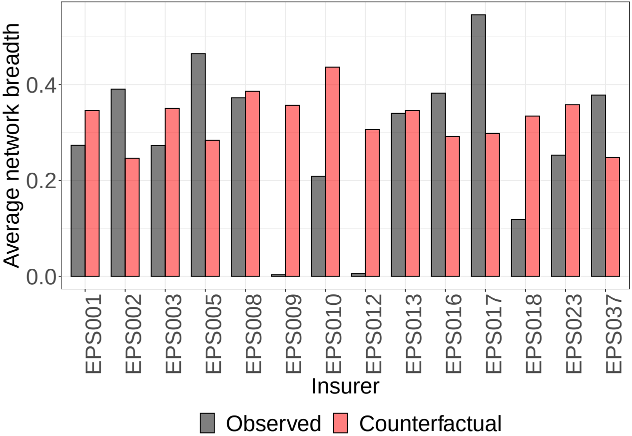

Figure: Average network breadth under improved risk adjustment

Improved risk adjustment

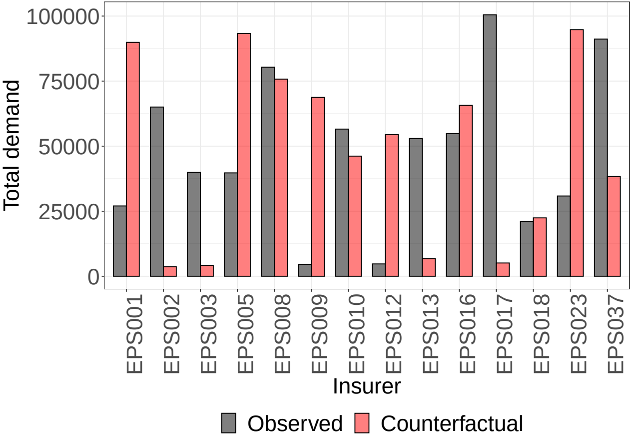

Figure: Total demand under improved risk adjustment

Improved risk adjustment

Table: Health care system costs under improved risk adjustment

	Insurer revenue (1)	Insurer total avg. cost (2)	Short-run avg. cost (3)	Short-run Gov. spend. (4)	Short-run welfare (5)
Observed	387,265	195,741	1.78	17,214,070	10,333
Counterfactual	382,421	218,280	1.81	16,893,297	12,310
%Δ	-1.25	11.51	1.81	-1.86	19.13

Note: Columns (1), (2), (3) and (5) are calculated with data only from Bogotá. Column (4) is calculated using data from all the country. Units are in millions of COP.

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Current enrollees are “riskier” than new enrollees

Table: Demographic characteristics of current and new enrollees

	Stayers 2011			Switch-ins 2011			New enrollees 2011		
Insurer	Age	Male	Chronic	Age	Male	Chronic	Age	Male	Chronic
EPS013	37.3	44.3	32.6	38.4	39.3	37.6	30.4	58.7	7.2
EPS016	37.6	43.1	33.3	32.9	48.4	28.9	32.1	55.3	6.5
EPS037	52.9	39.6	48.9	42.3	37.2	29.4	42.7	50.6	9.5
EPS002	36.6	44.1	35.8	31.8	45.4	26.7	31.3	59.0	8.8
EPS017	35.2	43.4	30.1	32.7	44.4	23.1	31.9	60.0	9.5
EPS010	37.9	43.3	33.1	29.5	44.0	21.6	33.9	56.3	6.7
EPS018	38.1	44.6	25.9	31.2	40.6	16.4	30.5	56.2	7.4
EPS005	45.4	40.9	19.6	38.8	37.2	21.6	34.9	55.9	5.0
EPS003	38.7	44.0	32.1	37.4	34.6	19.8	33.9	56.2	5.9
EPS008	37.6	42.4	25.3	34.6	41.0	20.8	32.9	57.7	8.8
EPS023	35.0	45.2	27.0	30.3	43.2	18.2	29.3	60.8	6.4
EPS009	38.7	42.5	32.7	33.5	47.2	22.6	32.8	56.7	7.7
EPS012	40.5	43.7	39.3	33.6	39.4	33.3	31.7	58.0	9.7
EPS001	41.7	44.3	27.9	32.1	40.4	11.9	36.6	50.8	4.8

Current enrollees are more expensive than new enrollees

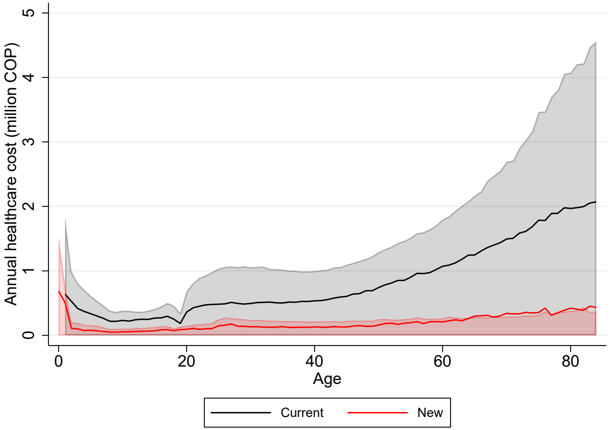

Figure: Average healthcare cost by age

Note: Average healthcare cost during 2011 by age in the solid line and its associated 1st and 99th percentiles in the shaded area.

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Differences in risk generate differences in surplus

Table: Distribution of surplus per enrollee by switching status

	Stayers 2011			Switch-ins 2011			Newly enrolled 2011		
Insurer	Mean	P1	P99	Mean	P1	P99	Mean	P1	P99
EPS013	0.08	-5.30	1.86	-0.03	-4.24	1.68	0.34	-1.00	1.99
EPS016	0.08	-6.25	1.90	0.08	-4.80	1.64	0.38	-1.27	1.99
EPS037	0.13	-17.16	2.15	0.49	-1.51	1.99	0.66	-1.34	3.12
EPS002	0.09	-5.62	1.82	0.24	-1.89	1.47	0.35	-1.12	1.99
EPS017	0.04	-6.23	1.83	-0.33	-26.33	1.29	0.31	-1.60	1.99
EPS010	0.10	-5.69	1.87	0.10	-3.82	0.82	0.39	-1.03	2.11
EPS005	0.14	-8.38	1.99	0.12	-7.47	1.67	0.39	-1.62	2.11
EPS018	0.04	-6.23	1.83	0.14	-2.57	1.07	0.28	-1.63	1.68
EPS003	0.07	-5.93	1.88	0.13	-7.64	1.63	0.42	-0.82	2.11
EPS008	0.08	-6.54	1.88	0.02	-5.97	1.59	0.30	-2.40	2.02
EPS023	0.10	-4.51	1.68	0.18	-1.86	1.94	0.33	-0.82	1.68
EPS009	-0.36	-15.25	1.87	0.21	-2.67	2.11	0.26	-3.32	1.99
EPS001	0.15	-7.76	2.06	0.35	-1.14	1.40	0.49	-0.73	2.11
EPS012	0.08	-6.35	1.80	0.30	-1.48	1.72	0.36	-1.00	1.90
Total	0.08	-7.76	1.99	0.13	-3.70	1.63	0.44	-1.14	2.11

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Insurers are heterogeneous in networks

Table: Distribution of number of in-network providers across departments

	2010				2011			
Insurer	Mean	SD	P25	P75	Mean	SD	P25	P75
EPS013	88.7	11.5	81.0	98.3	85.6	12.5	72.9	95.2
EPS016	83.5	9.8	76.7	92.9	84.7	11.6	79.5	92.3
EPS037	76.7	22.1	70.3	93.5	61.0	25.2	38.0	80.5
EPS002	75.2	11.4	67.7	82.4	78.3	14.4	70.9	88.4
EPS017	50.2	22.3	34.1	70.8	43.5	20.6	32.1	52.2
EPS010	54.6	22.6	33.3	72.3	55.2	21.5	37.7	71.7
EPS005	61.3	22.0	51.2	75.9	58.9	22.0	42.5	71.7
EPS018	44.2	31.4	17.8	74.1	38.9	28.5	11.2	64.7
EPS003	69.4	22.3	56.1	88.9	69.4	21.5	57.8	87.0
EPS008	46.8	25.2	19.9	66.1	43.8	30.0	16.0	71.2
EPS023	53.4	24.8	41.2	71.2	57.1	24.4	47.8	79.0
EPS009	40.7	37.2	13.1	84.3	35.0	38.8	4.7	84.6
EPS001	48.8	15.7	35.6	61.0	44.0	12.4	39.0	50.0
EPS012	50.7	26.6	23.5	76.7	51.4	39.3	6.0	75.5

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Networks breadth is correlated with insurer costs

$$ihs(y_{ij(i)t}) = \beta_0 + \beta_1 G_{j(i)t} + \mathbf{d}_i' \beta_2 + \gamma_t + \varepsilon_{ij(i)t}$$

Networks breadth is correlated with insurer costs

$$ihs(y_{ij(i)t}) = \beta_0 + \beta_1 G_{j(i)t} + \mathbf{d}_i' \beta_2 + \gamma_t + \varepsilon_{ij(i)t}$$

Table: Network breadth, utilization, and costs

	(1) ihs(total cost)		(2) ihs(total service cost)	
	Stayers	New	Stayers	New
G_{jt}	0.67***	1.17***	0.06***	0.03***
	(0.02)	(0.03)	(0.003)	(0.001)
Demog + Diag	Y	Y	Y	Y
Market	Y	Y	Y	Y
Service	—	—	Y	Y
N	6,002,955	2,653,829	14,487,530	14,496,056
R^2	0.17	0.15	0.44	0.22

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Switching costs affect consumer choices

Only 0.06% of continuously enrolled current enrollees switch. Now compare choices of current and new enrollees in markets where no insurer changed their total network breadth.

Switching costs affect consumer choices

Only 0.06% of continuously enrolled current enrollees switch. Now compare choices of current and new enrollees in markets where no insurer changed their total network breadth.

Table: 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

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Dynamics and networks

Consumer inertia can generate two types of dynamics:

1. From the insurers' perspective: invest-harvest incentives.
   - Not enough years to observe harvest incentives.
2. From the consumers' perspective: shocks to health status that induce switching.
   - Switching rate is very small conditional on age and additional diagnoses.

Can I assume steady state?

- Steady state assumptions do not hold: transition probabilities not equal to cross sectional probabilities.
- Variation in networks over time is not negligible.

Variation in networks over time

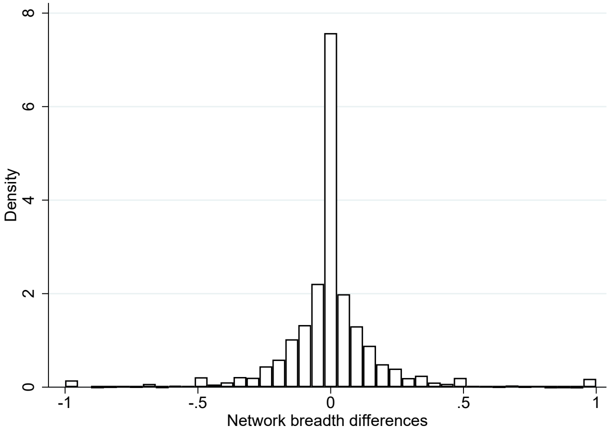
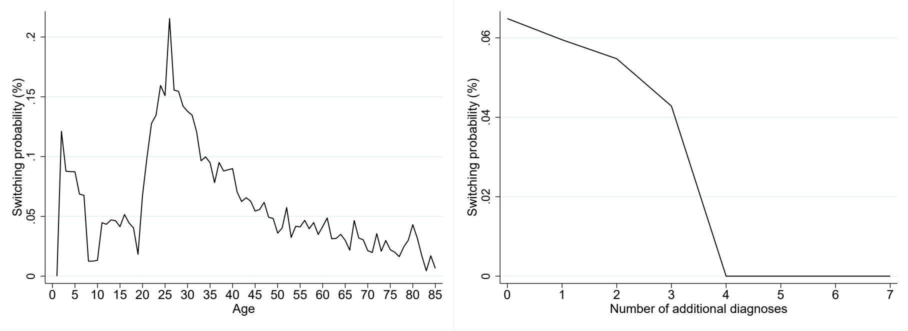


Figure: Differences in network breadth over time

Conditional switching rates



(a) Switching by age (b) Switching by diagnosis

Figure: Switching probability

Steady state assumption

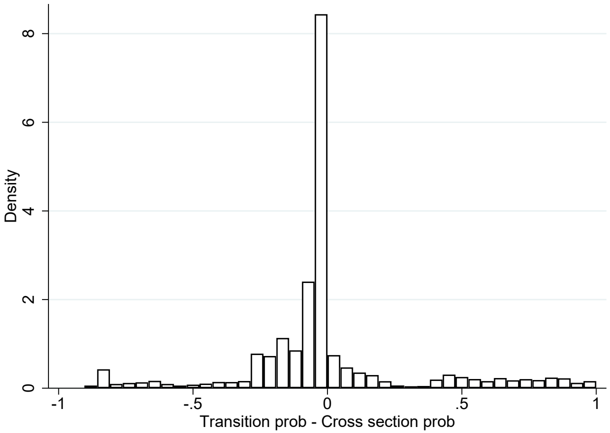


Figure: Steady state diagnosis probability

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Variation in $\gamma_{\theta,l,m,k}$

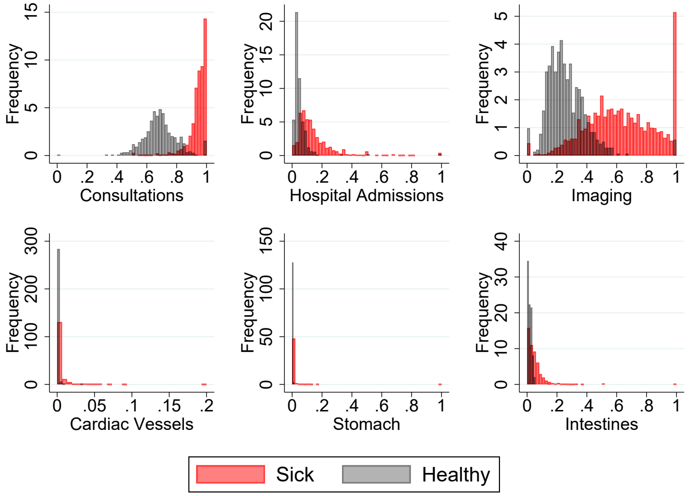

Figure: Variation in claim probability within service category

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Reference service prices

- In 2005, the Colombian government published a list of reference prices.
- Hospitals are reimbursed with these prices in three situations: terrorist attacks, car accidents, natural disasters.
- Reference prices were not meant to guide insurer-hospital negotiations. But insurers use them as a starting point.

Reference service prices

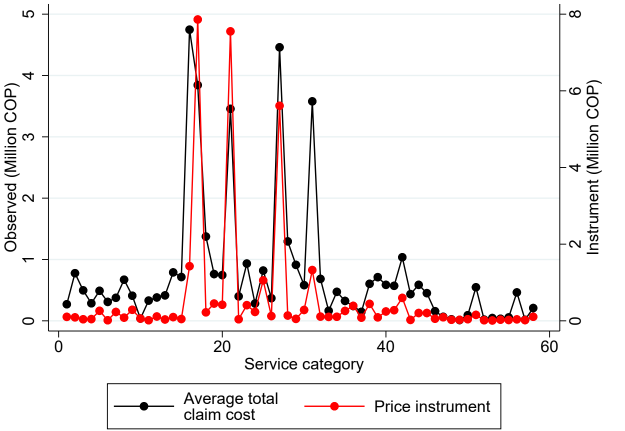

Figure: Correlation between average negotiated price and reference price

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Average cost regression

Table: Insurer average costs

Variable	Coefficient	Std. Error
Network	0.407***	0.047
Scope economies	-6.599***	1.425
Avg. ref. price	1.908***	0.203
EPS001	-0.003	0.036
EPS002	-0.495***	0.028
EPS003	-0.211***	0.024
EPS005	0.035*	0.020
EPS008	0.193***	0.073
EPS009	0.134**	0.066
EPS010	-0.154***	0.029
EPS012	-0.233***	0.043
EPS013	-0.137***	0.020
EPS016	-0.250***	0.019
EPS017	-0.263***	0.035
EPS018	-0.157***	0.039
EPS023	-0.268***	0.032
N	27,747	
R^2	0.44	

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FOC

Table: Summary statistics of marginal variable profits per insurer

Insurer	Marginal revenue	Marginal cost
EPS001	185 (1,409)	95 (793)
EPS002	446 (3,019)	171 (1,240)
EPS003	335 (2,160)	165 (1,131)
EPS005	187 (1,487)	117 (1,042)
EPS008	962 (5,986)	679 (4,566)
EPS009	379 (2,678)	285 (2,190)
EPS010	775 (4,097)	380 (2,113)
EPS012	493 (2,305)	231 (1,137)
EPS013	543 (3,289)	320 (2,110)
EPS016	761 (4,593)	403 (2,665)
EPS017	376 (4,014)	185 (2,154)
EPS018	520 (3,238)	283 (1,918)
EPS023	338 (2,089)	158 (1,047)
EPS037	641 (4,422)	399 (2,930)

FOC

Table: Model of insurer network formation costs

Marginal revenue	Coefficient	Std. Error
Marginal cost	1.45***	0.03
Network	0.37	3.61
Interactions of MC		
EPS001	(Ref)	(Ref)
EPS002	0.67***	0.04
EPS003	0.17***	0.03
EPS005	-0.33***	0.02
EPS008	-0.42***	0.03
EPS009	-0.25***	0.03
EPS010	0.28***	0.05
EPS012	0.38***	0.04
EPS013	-0.04	0.03
EPS016	0.15***	0.04
EPS017	0.13***	0.03
EPS018	0.06	0.04
EPS023	0.25***	0.03
EPS037	-0.11***	0.03
N	13,572	
R^2	0.999	

Network formation cost results

Table: Average predicted network formation cost per market

Insurer	Total	%
EPS001	568	10
EPS002	1,393	17
EPS003	1,344	27
EPS005	871	74
EPS008	421	19
EPS009	108	11
EPS010	808	7
EPS012	745	7
EPS013	1,866	31
EPS016	1,314	14
EPS017	1,344	14
EPS018	850	12
EPS023	1,138	25
EPS037	1,177	16

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