Non-Price Competition and Risk Selection Through Hospital Networks

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Introduction

- Risk selection is a main concern in insurance markets.
- Health insurers may attempt to enroll healthy (profitable) instead of sick (unprofitable) patients (e.g., through prices, ads, networks).
- Risk selection reduces access to insurance and health care.
- Risk selection may also lead a market to unravel altogether.

Research questions

- **Study whether and how health insurers engage in risk selection through the design of their hospital networks.**

- **What policies reduce the distortion in networks due to selection?**

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  - Supply model to measure how insurers' network choices respond.

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- **What policies reduce the distortion in networks due to selection?**
  - Better risk adjustment (gov. payments to insurers).
  - Modify how insurers compete on premiums.

Contribution

- Document insurers' incentives to use narrow networks to risk-select.
  - Contributes to literature on risk selection mechanisms (Geruso et al., 2019; Aizawa and Kim, 2018).
- Selection on *multidimensional* service-level hospital networks.
  - Builds on Shepard (2022) who studies selection on *one* hospital.
- Endogeneize hospital network breadth in a tractable way.
  - Related papers in this literature are Prager and Tilipman (2020); Ghili (2022); Ho and Lee (2019); Liebman (2018).

Institutional background

- Empirical setting is Colombia:
  - Contributory system (CR) (49% of population).
  - One national insurance plan provided by private insurers.
  - Premiums and cost-sharing are regulated.
  - Gov. risk adjustment formula is coarse. Expand

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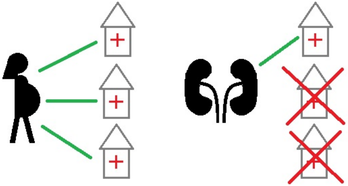

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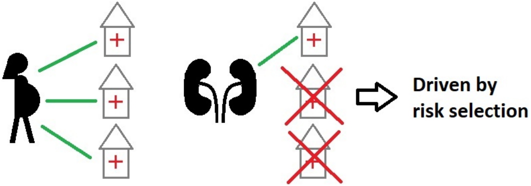

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Data overview: sample of enrollees

- All covered by the CR in 2010-2011 (25 MM) and medical claims (650 MM).

- Continuous enrollment spells (9 MM) and claims (270 MM).
  - 1/3 are *new enrollees* in 2011. Expand

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- Keep 14 largest insurers. Account for 97% of enrollees.
- Market is a Colombian state (similar to MSA). 32 markets.

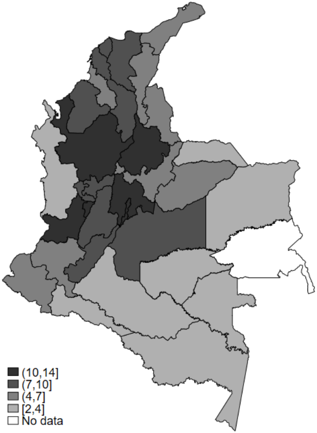

Figure: Insurers per market

Data overview: services and networks

- Collapse 7,000 services codes into 58 categories ("services"). E.g:
  - Procedures in cardiac vessels.
  - Procedures in intestines.
  - Procedures in bones and joints.
  - Procedures in skull and brain.
  - Hospitalization.
  - Consultations.

- Recover service-specific hospital networks from observed claims.

  Service coverage

Network breadth as a means of risk selection

- Narrow networks is one of the main reasons for dissatisfaction with an insurer in Colombia (based on surveys by the Ministry of Health).

- Object of interest is insurer *j*'s service-level hospital network breadth in market *m* and service *k*, $\mathbf{H_{jkm}}$.

Network breadth as a means of risk selection

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- Object of interest is insurer j's service-level hospital network breadth in market m and service k, $\mathbf{H_{jkm}}$.

- $H_{jkm} \in [0, 1]$ is the fraction of hospitals in market m that provide service k that are covered by insurer j.

- Simplicity of H_{jkm} allows for tractability. Limitation is treating hospital quality as constant.

Distribution of H_{jkm}

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

$$u_{ijm} = \beta_i \sum_k \underbrace{q_{\theta km}}_{\substack{\text{claim}\\\text{prob.}}} \underbrace{H_{jkm}}_{\substack{\text{network}\\\text{breadth}}} - \alpha_i \underbrace{c_{\theta jm}(H_{jm})}_{\substack{\text{OOP}\\\text{costs}}} + \phi_{jm} + \varepsilon_{ijm}$$

$$(\alpha_i \quad \beta_i) = (x_i \ y_i)'(\beta \quad \alpha)$$

  - $\theta =$ sex, age group, diagnosis (cancer, cardio, diabetes, renal, pulmonary, arthritis, asthma/smoking, other, healthy).
  - $x_i =$ sex, age, diagnosis, location. $y_i =$ income group.
  - k is a service.
  - $q_{\theta km}$ prediction of a fractional logistic regression, off-line. desc

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$$c_{\theta jm} = \text{Coins}_{\theta jm} + \text{Copay}_{\theta m} + \text{Tax}_{\theta}$$

  - Consumers face a **cost-coverage trade-off**.
  - The magnitude of this trade-off will vary with health status.
  - Allows for healthy individuals to be screened by narrow networks.
  - OOP costs are endogenous to H_{jkm}.

Variation in oop costs

Demand identification

- Preference for network breadth: uses exogenous variation in market demographics.
  - Little concern over insurers targeting demographics with their networks.

- Marginal disutility of OOP costs: endogenous variation in OOP costs across insurers (potentially due to hospital quality) is captured by ϕ_{jm}.

Identification threats Hospital quality

Willingness-to-pay varies across services and health status

- Significant disutility from OOP costs. Avg. elasticity $= -0.88$.
- Strong preferences for broader networks in services they need.
- Insurers can avoid these patients by providing narrow networks.

	Dialysis
Cancer	7.2
Cardiovascular	4.5
Diabetes	6.8
Renal	129.8
Pulmonary	47.6
Arthritis	24.4
Asthma/Smoking	35.0
Other	22.2
Healthy	1.0

Note: Willingness-to-pay for an additional percentage point of network breadth relative to healthy individuals. Willingness-to-pay is calculated as $\frac{1}{-\alpha_i}\frac{\partial s_{ijm}}{\partial H_{jkm}}$.

Demand model fit

Insurer average costs per enrollee

Insurer average costs per enrollee

$$\log(AC_{\theta jm}(H_{jm})) = \tau_0 \overbrace{\left(\sum_k q_{\theta km} A_k\right)}^{\substack{\text{expected service}\\ \text{price}}} + \tau_1 \overbrace{\left(\sum_k q_{\theta km} H_{jkm}\right)}^{\substack{\text{weighted service}\\ \text{network breadth}}}$$

$$+ \frac{1}{2K_m}\tau_2 \underbrace{\sum_k \sum_{l \neq k} q_{\theta km} q_{\theta lm} H_{jkm} H_{jlm}}_{\substack{\text{scope}\\ \text{economies}}} + \lambda_\theta + \eta_m + \delta_j$$

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- Approximation to a price bargaining equilibrium.
- A_k is the government's reference price. Expand
- Insurers observe $q_{\theta km}$.
- Scope economies: insurers that offer broad networks in one service, tend to offer broad networks in other services.

Average cost regression

- Identification relies on variation in market demographics across markets, within insurer.

Table: Average costs per enrollee

Variable	Coefficient	Std. Error
Network breadth	1.81	(0.21)
Scope economies	-134.3	(24.9)
Reference price	20.5	(6.43)
N	40,989	
R^2	0.39	

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

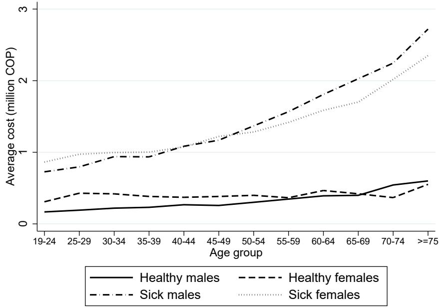

Figure: Predicted average cost

Identification threats

Insurer competition

Competition and equilibrium

Let $\pi_{ijm}(H_m, \theta)$ be insurer j's annual per-enrollee profit. Depends on *own* and *rival* network breadth, $H_m = \{H_{jm}\}_{j=1}^{\#\mathcal{J}_m}$, where $H_{jm} = \{H_{jkm}\}_{k=1}^{\#K_m}$

$$\pi_{ijm}(H_m, \theta) = (\underbrace{R_{\theta m}}_{\substack{\text{govmt} \\ \text{transfer} \\ + \text{ copays}}} - \overbrace{(1 - r_i)}^{\text{1-coins rate}} \underbrace{AC_{\theta jm}(H_{jm})}_{\substack{\text{average} \\ \text{cost}}}) \underbrace{s_{ijm}(H_m)}_{\substack{\text{choice} \\ \text{prob.}}}$$

Competition and equilibrium

- Nash equilibrium. Insurers choose networks to maximize:

$$\Pi_{jm}(H_m) = \text{current profit} + \text{future profit} - \text{network formation cost}$$

Competition and equilibrium

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

- Individuals do not switch (switching rate in the data $< 1\%$).
- $\xi_{jkm} = \xi_k + \vartheta_{jkm}$

Game

Competition and equilibrium

FOC at an interior solution $H_{jkm} \in (0,1)$:

$$MVP_{jkm}(H_m) = 2\omega H_{jkm} + \xi_k + \vartheta_{jkm}$$

- MVP_{jkm} is the marginal variable profit.

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- MVP_{jkm} is the marginal variable profit.
- Insurers *internalize* the cost-coverage trade-off from demand.

$$c_{\theta jm} = \mu_y AC_{\theta jm}(H_{jm}) + \epsilon_{\theta jm}$$

- H_{jkm} is observed together with ϑ_{jkm}.

Relation between r and μ

Network formation cost identification and estimation

Identification:

- Variation in average claim probabilities across markets.
- Network breadth in 2010.
- Estimate FOC in 4 largest markets with no corners.

First-stage | Out-of-sample fit

Table: Network formation costs

$\text{asinh}(\text{MVP}_{jmk})$	coef	se
Network breadth	6.86	(0.16)
Service		
Cardiac Vessels	1.47	(0.20)
Stomach	1.25	(0.20)
Intestines	4.77	(0.20)
Imaging	6.64	(0.20)
Consultation	6.37	(0.21)
Laboratory	7.35	(0.20)
Nuclear Medicine	4.67	(0.20)
Hospital Admission	4.90	(0.20)
First stage F-stat	1,718.5	
N	2,262	
R^2	0.76	

Note: 2-step GMM estimation on the subsample of markets 05, 08, 11, 76, and the subsample of the 10 largest insurers in these markets. Robust standard errors in parenthesis and first-stage F-statistic reported.

Model-based evidence of adverse selection

- Insurer average and marginal costs are positively correlated with consumer willingness-to-pay for network breadth.

- *Decomposition exercise*: suppose an insurer deviates and increases network breadth by 10%.
  - **Adverse selection explains 46% of variation in total costs.**
  - Cost heterogeneity explains the rest.

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The effect of risk adjustment of network breadth

- Simulate two counterfactual scenarios:
  - Eliminate risk adjustment.
  - Improve risk adjustment.

- For simplicity, estimate counterfactuals with data only from the capital, Bogotá.
  - Around 1/3 of all enrollees to the contributory regime live in Bogotá.
  - Has presence of all insurers.

No risk adjustment

- Per-capita transfer equals national base transfer times adjustment factor to match observed short-run gov spending:

$$R_{\theta m}^{cf} = \lambda \times R, \quad \forall(\theta, m)$$

- **Prediction: Eliminating risk adjustment should exacerbate risk selection incentives and reduce network breadth.**

Improved risk adjustment

- Counterfactual risk-adjusted transfer is:

$$R^{cf}_{\theta m} = \lambda \times a_m \times 360 \times \frac{\sum_{\theta(i)=\theta} T_i}{\sum_{\theta(i)=\theta} b_i}$$

- T_i is total cost, b_i is number of days enrolled in the year, a_m is a market multiplier, λ is adjustment factor to match gov spending.

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- T_i is total cost, b_i is number of days enrolled in the year, a_m is a market multiplier, λ is adjustment factor to match gov spending.
- *Eliminates demand-side incentives to risk-select.* Shows relative importance of adverse selection vs. cost heterogeneity.
- **Prediction: Improving risk adjustment should reduce risk selection incentives and increase network breadth.**

Better risk adjustment promotes broader networks

Observed risk adjustment is better than no risk adjustment

Table: Networks, costs, and welfare under alternative risk adjustment

Variable	No RA	Improved RA	
		9 diseases	27 diseases
A. Overall			
Median network breadth	-1.9	4.2	4.8
Avg. cost per enrollee	2.4	-0.9	-0.1
Total avg. cost	2.7	-0.4	0.3
Consumer surplus (sick)	-1.1	2.2	2.8
Consumer surplus (healthy)	-0.8	2.0	2.7
B. Service network breadth			
Eyes, ears, nose, mouth	-2.3	2.5	5.9
Heart and cardiac vessels	-0.5	6.7	4.9
Imaging, lab, consultation	0.3	4.5	3.2

Note: Table presents percentage change in counterfactual relative to observed scenario. Baseline average network breadth equals 0.36.

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The effect of premiums on network breadth

- Insurers compete simultaneously in premiums and networks.
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- Insurers compete simultaneously in premiums and networks.
- Insurers can discriminate premiums along sex, age, and income.
- In the observed scenario:

$$c_{\theta jm} = \text{Coins}_{\theta jm} + \text{Copay}_{\theta m} + \underbrace{\text{Tax}_{\theta}}_{\text{1/3 of total taxes}}$$

- In counterfactual, let $\theta = (\theta_1, \theta_2)$, where θ_2 are diagnoses.

$$\text{Coins}_{\theta jm} + \text{Copay}_{\theta m} + \text{Tax}_{\theta} + (1/3) \times \tilde{P}_{\theta_1 jm}$$

- Calibrate α to (roughly) match average elasticity from other papers: Abaluck and Gruber (2011) -1.17; Shepard (2022) -1.48.

Profit function

Premiums reflect risk pooling

Table: Average premiums

Variable		Low price sens.	Med price sens.
Sex	Female	127	120
	Male	221	269
Age group	19-24	173	154
	25-29	171	161
	30-34	183	220
	35-39	288	298
	40-44	280	305
	45-49	243	284
	50-54	212	232
	55-59	187	232
	60-64	132	192
	65-69	121	172
	70-74	53	49
	$\geq$75	45	34
Income group	Low	81	61
	Medium	178	200
	High	—	—

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Premiums and networks are substitutes for risk selection

Table: Networks, costs, and welfare under premium deregulation

Variable	Low price sens.	Med price sens.
A. Overall		
Median network breadth	24.2	21.2
Avg. cost per enrollee	9.2	8.1
Total avg. cost	8.2	6.4
Consumer surplus (sick)	-6.7	-9.6
Consumer surplus (healthy)	-5.5	-8.4
Elasticity	-1.8	-2.0
B. Service network breadth		
Skull, spine, nerves, glands	29.3	23.7
Abdominal wall	24.4	22.7
Imaging, lab, consultation	20.1	23.1

Note: Table presents percentage change in counterfactual relative to observed scenario. Baseline average network breadth equals 0.36.

Premiums and networks are substitutes for risk selection

Table: Networks, costs, and welfare under premium deregulation

Variable	Low price sens.	Med price sens.
A. Overall		
Median network breadth	24.2	21.2
Avg. cost per enrollee	9.2	8.1
Total avg. cost	8.2	6.4
Consumer surplus (sick)	-6.7	-9.6
Consumer surplus (healthy)	-5.5	-8.4
Elasticity	-1.8	-2.0
B. Service network breadth		
Eyes, ears, nose, mouth	30.8	31.6
Heart and cardiac vessels	21.7	11.6
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Conclusions

- Study how insurers use their hospital networks to risk-select.
- In a setting where hospital networks are service specific:
  - Consumers choose insurers with broad networks in services they need.
  - Insurers choose their hospital networks per service to select the most profitable consumers.
- Better risk adjustment can increase network breadth by 4.8%, holding government spending fixed.
- Premiums and hospital networks are substitutes for risk selection.
- Zero premiums lead to narrow networks.

Thank you

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Risk adjustment

- Risk-adjusted capitated payments from gov. to insurers.
- Payments equal average health care cost per risk pool.
- Ex-ante risk adjustment:
  - Paid at the beginning of every year.
  - Risk pool is a combination of sex, age group, location.
- Ex-post risk adjustment:
  - Paid at the end of every year.
  - Insurers with above-average share of patients with certain diseases receive payments from those with below-average share.

Back

New enrollees

- People who move from subsidized (SR) to contributory system.
- People who age into the contributory system.
- Insurers in the CR participate in the SR.
- 1/6 of my sample moved from only one insurer in the SR to the CR.
- People with 3 continuous months of non-payment of taxes would be disenrolled and information removed from system → "fresh start".

Back

Service coverage within hospital

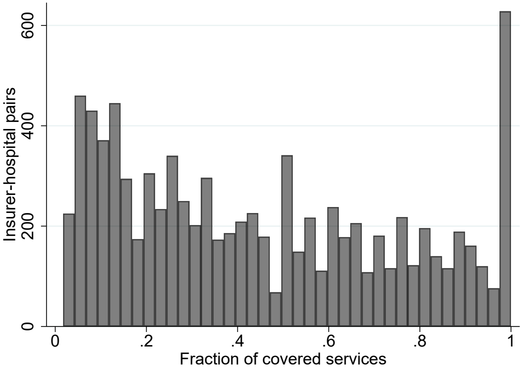

Figure: Fraction of services covered per hospital (zero is 60%)

Back

H_{jkm} varies either because of selection or cost differences

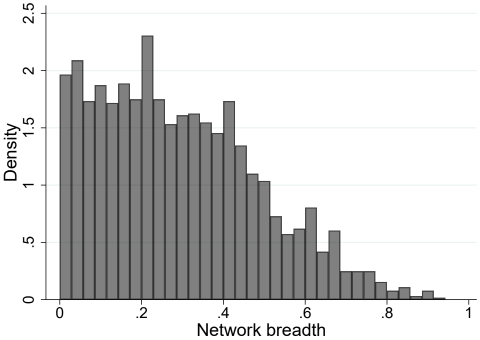

Figure: Distribution of network breadth

Note: Distribution of service-level network breadth conditional on four largest markets.

- Variation: 30% insurer, 10% service, 4% market. Back

Do risk selection incentives exist? (Geruso et al., 2019)

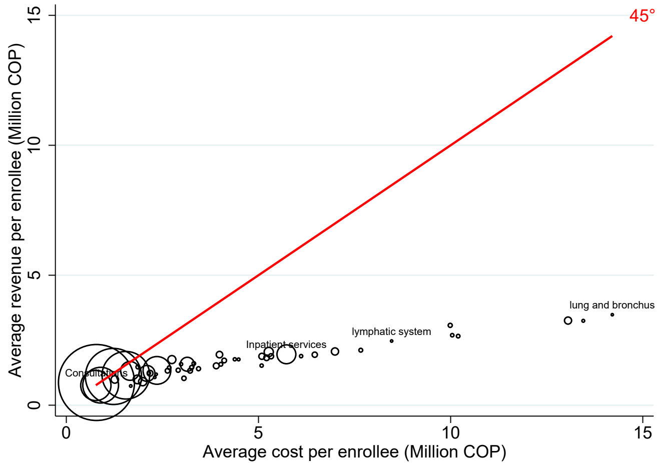

Figure: Service-level selection incentives after risk adjustment

Note: Dots are services weighted by number of enrollees who make claims for the service. One enrollee can appear in multiple dots. Enrollees who make no claims are not represented in this figure.

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Distribution of health care costs

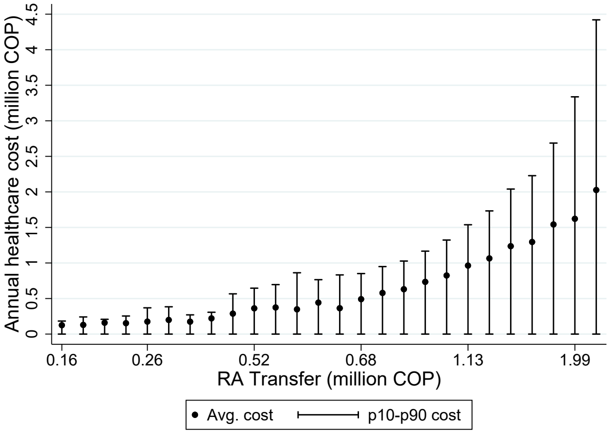

Figure: Health care cost by risk-adjusted transfer

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H_{jkm} covaries with service profitability – selection story

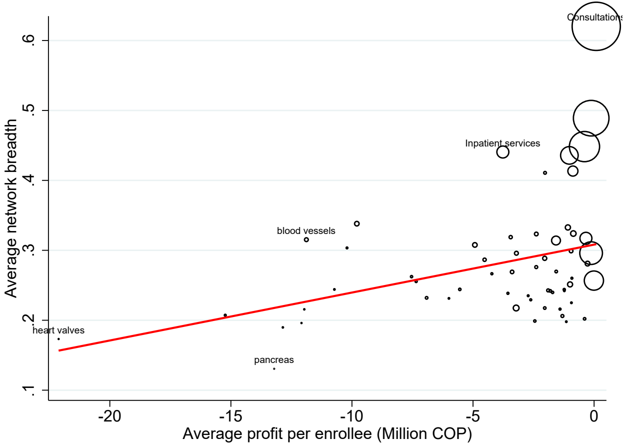

Figure: Correlation between network breadth and service profitability

Note: Dots are services weighted by number of enrollees who make claims for the service. One enrollee can appear in multiple dots. Enrollees who make no claims are not represented in this figure.

Back

Do consumers respond to H_{jkm}?

- Claim probability is positively correlated with network breadth.
  - Women in childbearing ages choose insurers with broad networks for delivery.
  - Higher likelihood of dialysis and chemo claims the broader the networks for renal disease and cancer treatment.
- People switch towards insurers with broad networks after health shock (.06% of current).
  - The newly diagnosed with arthritis switch to insurer with broad network for procedures in bones and joints.
- Insurers with broad networks imply higher out-of-pocket costs.

Regressions Back

Selection into moral hazard

Table: Service-specific network breadth and types of claims

	(1) Current	(2) Full
(1) Any childbirth claim		
H_{jm} Delivery	0.02***	0.01***
	(0.001)	(0.001)
N	1,085,206	3,078,555
(2) Any dialysis claim		
H_{jm} Dialysis	0.03***	0.03***
	(0.004)	(0.003)
N	83,768	120,330
(3) Any antirheumatic drug claim		
H_{jm} Bones and Joints	0.002	0.002**
	(0.001)	(0.001)
N	102,612	156,385
(4) Any chemotherapy claim		
H_{jm} Therapy	0.003*	-0.002
	(0.002)	(0.001)
N	439,176	785,727

Note: Each regression is conditional on the sample of individuals who received a diagnosis during 2010. All regressions include market fixed effects and control for sex and age group. Robust standard errors in parenthesis. $^{***}p<0.01$, $^{**}p<0.05$, $^{*}p<0.1$.

Where do people switch after receiving a diagnosis?

Table: Insurer choice among switchers with changes in health status

	Insurer choice
(1) Women in childbearing ages	
$H_{jm}^{2010} - H_{j'm}^{2011}$ Delivery	-2.77***
	(0.12)
N	14,958
(2) Additional diagnosis of renal disease	
$H_{jm}^{2010} - H_{j'm}^{2011}$ Dialysis	-1.51*
	(0.84)
N	40
(3) Additional diagnosis of cancer	
$H_{jm}^{2010} - H_{j'm}^{2011}$ Therapy	-3.23***
	(0.37)
N	1,658
(5) Newly diagnosed	
$H_{jm}^{2010} - H_{j'm}^{2011}$ Hospital admissions	-1.94***
	(0.21)
N	5,787

Note: Conditional logit estimated on the sample of switchers with a new diagnosis. The main explanatory variable is the difference in network breadth for delivery services between the incumbent insurer j and all other insurers j'. Robust standard errors in parenthesis. ***p<0.01, **p<0.05, *p<0.1. Back

Variation in OOP costs

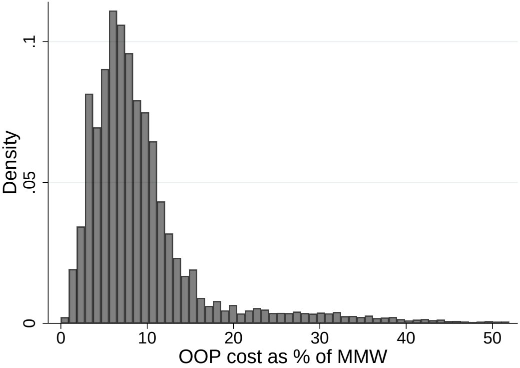

Figure: Distribution of OOP costs as percentage of monthly minimum wage

Note: Conditional on observed choices.

- Explained variation: 66% consumer types, 33% insurer-market.

OOP costs and network breadth

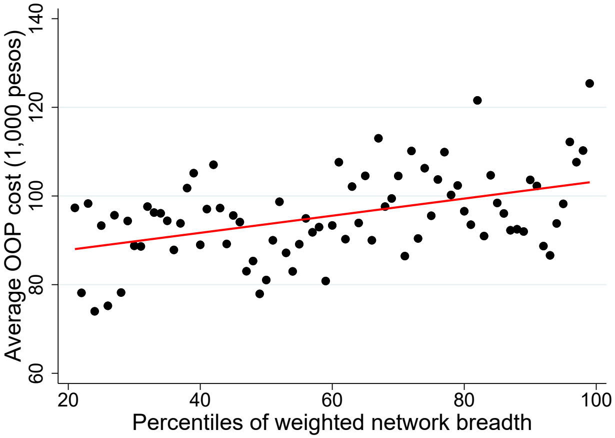

Figure: Correlation between OOP costs and network breadth

Back

Relation between r_y and μ_y

- If OOP costs were only coinsurance payments, then $r_y = \mu_y$.
- OOP costs include other components that the insurer does not cover (taxes and copays), so we can expect $r_y \geq \mu_y$

Table: Pass-through of average costs to out-of-pocket costs

	Out-of-pocket cost		
	(1) Low income	(2) Middle income	(3) High income
$AC_{\theta jm}$	11.21	13.02	18.59
	(0.00)	(0.01)	(0.15)
Constant	-0.17	1.14	0.62
	(0.00)	(0.01)	(0.12)
N	178,533	318,588	2,879
R^2	0.97	0.88	0.84

Note: Regression of out-of-pocket costs on observed average cost per enrollee conditional on observed insurer choices. Column (1) uses the sample of individuals earning less than 2 times the monthly minimum wage (MMW), column (2) uses the sample of individuals earning between 2 and 5 times the MMW, and column (3) uses the sample of individuals earning more than 5 times the MMW. Robust standard errors in parenthesis.

Back

Game

- Players: insurers, $j \in \mathcal{J}_m$

- Payoffs: $\Pi_{jm}(H_m, \vartheta_{jkm}) \in \mathbb{R}$,
  where $H_m = \{H_{jm}\}_{j=1}^{\#\mathcal{J}_m}$ and $H_{jm} = \{H_{jkm}\}_{k=1}^{\#K_m}$

- Strategies: $\mathbb{R} \to [0,1]^{58}$

- Information: ϑ_{jkm} is private information. Rest is common knowledge (q_{jkm}, ρ_θ, $\mathcal{P}(\theta'|\theta)$).

Back

Reference service prices

- In 2005 the Colombian government published a list of reference prices for each service in the national plan.
- 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

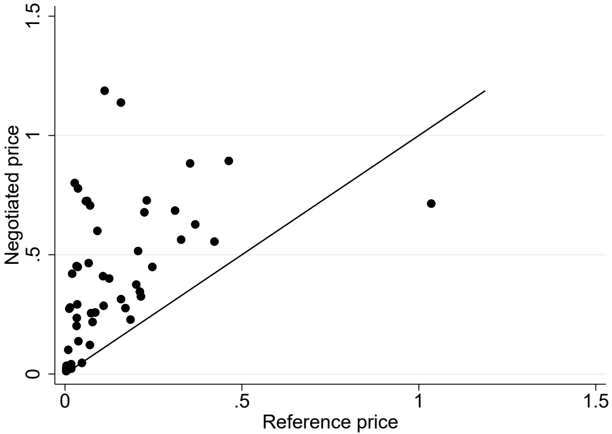

Figure: Correlation between average negotiated price and reference price

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Identification threats in demand

Network breadth may be correlated with unobserved insurer quality. Robustness checks:

- Include other insurer quality measures (enrollee satisfaction score, avg. wait times).
- Include a star hospital coverage indicator.
- Subsample of markets without star hospitals.

Back

Network breadth and hospital quality

- Network breadth assumes hospital quality as a constant.
- Problematic if it matters which hospitals are included and not just how many (e.g, star hospitals).

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  2. Bias.

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     - Arises if network breadth is negatively correlated with hospital quality – this is not the case.
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- Ignoring hospital quality could be problematic for:
  1. Model specification.
     - ⋆ Arises if network breadth is negatively correlated with hospital quality – this is not the case.
  2. Bias.
     - ⋆ Arises if there is significant variation in hospital quality within service – robustness checks suggest otherwise.

Back

Identification threats in cost

- There may be unobserved cost variation within consumer type.

- Adverse selection can bias coefficients in average cost function.
  - Robustness check using patient-level data.

Back

Variation in $q_{\theta km}$

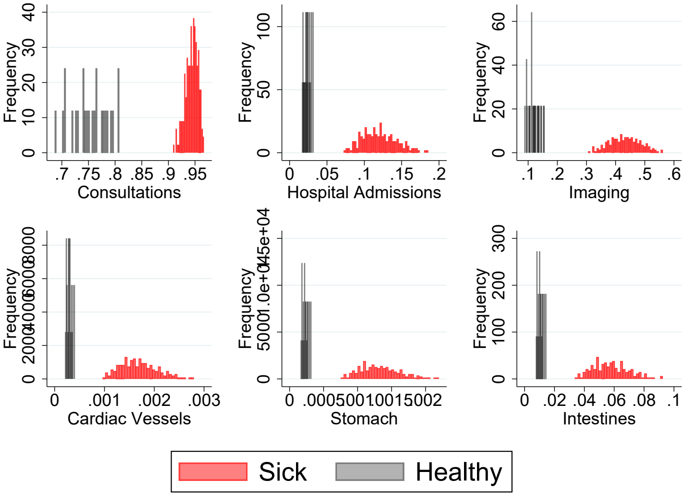

Figure: Variation in service claim probability

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In-sample demand model fit

Table: National market shares

Insurer	Observed	Predicted
EPS001	2.15	2.16
EPS002	7.23	7.28
EPS003	3.94	3.94
EPS005	4.39	4.41
EPS008	4.03	4.04
EPS009	2.10	2.09
EPS010	6.87	6.85
EPS012	1.17	1.19
EPS013	14.64	14.61
EPS016	19.51	19.47
EPS017	6.30	6.29
EPS018	3.91	3.86
EPS023	2.00	2.00
EPS037	21.75	21.79

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Marginal variable profits

Table: Summary statistics of marginal variable profits per insurer

Insurer	mean	sd
EPS001	1,046	6,746
EPS002	3,124	17,865
EPS003	2,414	16,812
EPS005	2,084	15,493
EPS010	1,995	9,205
EPS013	2,570	13,594
EPS016	3,459	12,803
EPS017	3,412	27,619
EPS018	1,406	9,073
EPS037	3,942	20,676

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

First-stage

Table: First stage regression of network breadth

H_{jkm}	coef	se
H_{jkm}^{t-1}	0.85	(0.01)
$H_{jkm}^{t-1} \times \overline{q}_{\text{age 19-24, k}}$	-10.43	(10.01)
$H_{jkm}^{t-1} \times \overline{q}_{\text{age 25-29, k}}$	16.21	(37.19)
$H_{jkm}^{t-1} \times \overline{q}_{\text{age 30-34, k}}$	-5.19	(31.74)
Service		
Cardiac vessels	0.00	(0.02)
Imaging	-0.01	(0.02)
Consultation	-0.03	(0.05)
Laboratory	-0.01	(0.02)
Nuclear Medicine	0.03	(0.01)
Hospital Admission	0.06	(0.02)
F-statistic	1,718.5	
N	2,262	

Note: First stage of the 2-step GMM estimation of network formation costs. H_{jkm}^{t-1} is network breadth in 2010. $\overline{q}_{i,k}$ is the average probability that a consumer with characteristic i makes a claim for service k. The specification includes service fixed effects. Robust standard errors in parenthesis and first-stage F-statistic reported.

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Out-of-sample fit

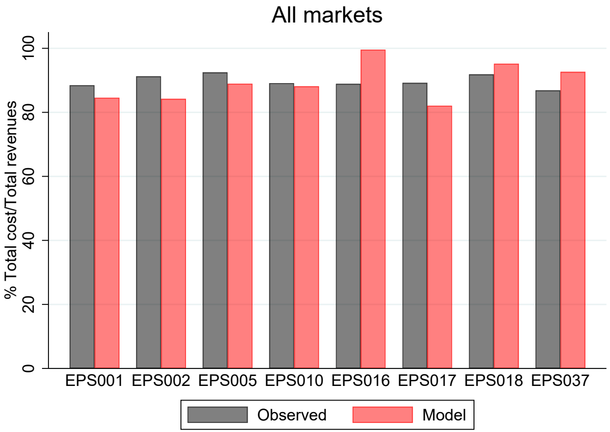

Figure: Comparison of model's predictions to public income statements

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Insurer profit function with premiums

- Let $P_m = \{\{P_{\theta_1 jm}\}_{\theta_1}\}_{j=1}^{\#\mathcal{J}_m}$. The annual per-enrollee profit is:

$$\pi_{ijm}(H_m, P_m, \theta) = (\underbrace{R_{\theta m}}_{\substack{\text{govmt}\\ \text{transfer}\\ +\text{ copays}}} + \underbrace{P_{\theta_1 jm}}_{\text{premium}} - \overbrace{(1 - r_i)}^{\text{1-coins.rate}} \underbrace{AC_{\theta jm}(H_{jm})}_{\substack{\text{average}\\ \text{cost}}}) \underbrace{s_{ijm}(H_m, P_m)}_{\substack{\text{choice}\\ \text{prob.}}}$$

- FOC w.r.t to $P_{\theta jm}$ defines a fixed point in premiums.
- FOC w.r.t to H_{jkm} defines a fixed point in networks.
- Simulation is a nested fixed point.

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