Sorting on Plan Design: Theory and Evidence from the ACA

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Motivation

- Recent trend: private provision of social insurance.
- Health insurance market: regulated competition.
  - Market sponsor sets the rules.
  - Private firms compete within the rules.
- Market design decisions:
  - premium regulation and subsidy;
  - **design of non-pricing attributes**.

Quartz · Prime Gold HSA 3000

Gold | HMO | Plan ID: 37833WI0540045

Estimated monthly premium	Deductible	Out-of-pocket maximum	Copayments / Coinsurance
$345.66	**$3,000** Individual total	**$3,000** Individual total	Emergency room care: No Charge After Deductible Generic drugs: No Charge After Deductible Primary doctor: No Charge After Deductible Specialist doctor: No Charge After Deductible

Quartz · Prime Gold HSA 2000

Gold | HMO | Plan ID: 37833WI0540001

Estimated monthly premium	Deductible	Out-of-pocket maximum	Copayments / Coinsurance
$342.02	**$2,000** Individual total	**$6,650** Individual total	Emergency room care: 10% Coinsurance after deductible Generic drugs: 10% Coinsurance after deductible Primary doctor: 10% Coinsurance after deductible Specialist doctor: 10% Coinsurance after deductible

Motivation

What economic forces drive the variation in plan designs?

- Existing literature on asymmetric information offers an incomplete answer
  - Rothschild and Stiglitz (1976): sorting on level of coverage
- Why variation on richer cost-sharing attributes?

This Paper: Sorting on Plan Design

Asymmetric information creates demand for different designs.

- **Theoretical Model**: allow for rich variation in cost-sharing attributes.
  - Hidden information: loss distribution of individual risk types
  - Higher-risk types: straight-deductible plans
  - Lower-risk types: coinsurance with higher out-of-pocket limit

This Paper: Sorting on Plan Design

- **Empirical Analysis**: identify sorting on designs in the Affordable Care Act (ACA) Marketplace.
  - There exists large variation in plan designs.
  - Consumers sort strongly along different plan designs.
- **Policy Implications**: quantify the potential impacts of allowing design variation.
  - Design variation can support a more efficient market.

Relation to Literature

- Asymmetric information distorts insurance coverage:
  - Exogenous plan offering: Akerlof (1970), Einav, Finkelstein and Cullen (2010), Handel (2013)
  - Contract distortion: Rothschild and Stiglitz (1976), Veiga and Weyl (2016), Azevedo and Gottlieb (2017); Sheppard (2016), Aizawa and Kim (2018), Geruso et al. (2019)
  - **My contribution: sorting on multi-dimensional financial attributes**

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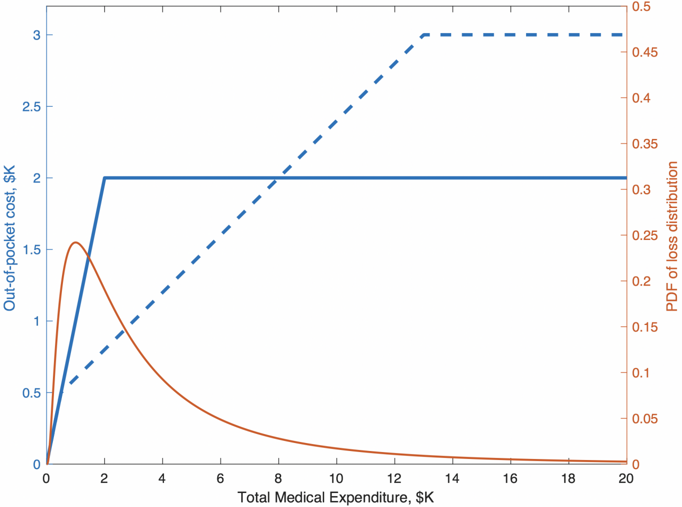
  - **My contribution: sorting on multi-dimensional financial attributes**
- Optimal insurance design literature:
  - Risk protection: Arrow (1965), Gollier and Schlesinger (1995)
  - Moral hazard: Pauly (1968), Zeckhauser (1970)
  - Liquidity constraint: Ericson and Sydnor (2018)
  - **My contribution: optimal design under asymmetric information**

Model

Arrow (1963): Optimality of Deductible Plans



Relation to Literature

	Single Loss State	Multiple Loss States
Full Information		Arrow (1963)
Asymmetric Information	Rothschild and Stiglitz (1976)	This paper

Setting: Demand

- Consumers:

$$\max_{j \in \mathbf{A}} \int u_i(w_i - oop_j(x) - p_j) d\mathbf{F_i}(x), \forall i$$

  - $i = L, H$, where H has a loss distribution weighted more heavily towards large losses.
  - $u' > 0$, $u'' < 0$
  - $x \sim F_i$, with a PDF f_i
  - A: set of plans consumers can choose from.
- Departure from literature:
  - Multiple loss states
  - A contains plans with multi-dimensional cost-sharing attributes.

Setting: Supply

- Insurers' profits if type i enrolled in j:

$$\pi_j^i = p_j - (\theta b_j^i - \mathbf{r_j^i}).$$

  - b_j^i: expected covered spending.
  - θ: fixed proportional loading factor. $\theta \geq 1$
  - r_j^i: transfers from the market sponsor.
- Insurers are perfectly competitive.
  - The Bertrand-Nash Equilibrium implies zero profits.
- Departure from literature:
  - Allowing risk transfers ("risk adjustment")

Market Condition 1: Asymmetric Information without Risk Adjustment

- H chooses the optimal plan under full information: straight-deductible plan.
- L chooses from plans make H not deviate:

$$j \in A : EU_H(j) \leq EU_H(j^*).$$

- Each plan breaks even: $p_j = \theta b_j^i$.

Theorem (Optimal Design in a Separating Equilibrium)

Assume that for any two loss states, $\frac{f_H(s)}{f_L(s)}$ is different from $\frac{f_H(t)}{f_L(t)}$. Among all contracts giving H the same utility as the optimal contract for H under full information, the one that maximizes the utility of L has a **non-straight-deductible** *design.*

graph

Market Condition 2: Asymmetric Information with Perfect Risk Adjustment

- Risk adjustment compensates insurers enrolling higher-risk individuals: cross-subsidization from L to H.
- Examples: Medicare, ACA Marketplace.
- $p_j = \theta \sum_i a_i b_j^i$.
- A: All plans.

Theorem (Optimal Design under Perfect Risk Adjustment)

Assume that for any two loss states $\frac{f_H(s)}{f_L(s)}$ is decreasing with regard to s. Among all plans with a perfectly risk adjusted premium, H sorts into a **straight-deductible** *plan, L sorts into a* **non-straight-deductible** *design.*

Summary

	Full Information	Asymmetric Information: No risk adjustment	Asymmetric Information: Perfect risk adjustment
Set of Plans A	All plans	Incentive compatible plans: L chooses from plans makes H indifferent from deviating	All plans
Premium	$p_{ij} = \theta b_j^i$	$p_j = \theta b_j^i$	$p_j = \theta \sum_i a_i b_j^i$
Plans: H	Straight deductible	Straight deductible	Straight deductible
Plans: L	Straight deductible	Non-straight deductible	Non-straight deductible

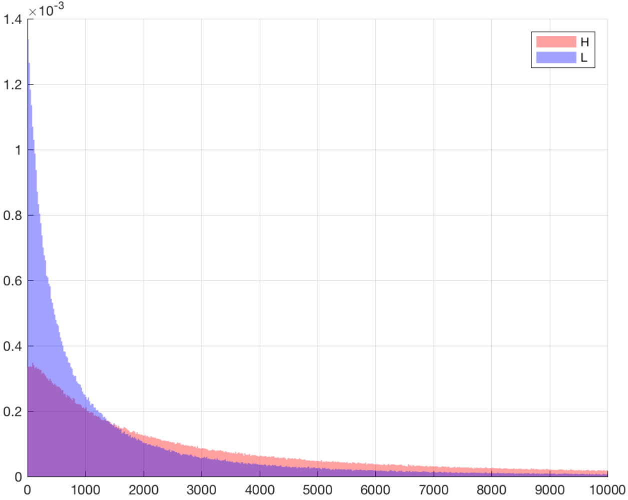
Example Simulation

- Choice set:
  - three-arm designs: d, m, c_1, c_2
  - constant coinsurance plans
  - no insurance
- Preferences: CARA ($\gamma = 0.0004$)
- Proportional loading factor $\theta = 1.2$
- Simulate plans chosen under
  - Full information
  - Separating equilibrium (Azevedo and Gottlieb 2017)
  - Perfect risk adjustment

Construct Medical Expenditure Distributions

- Data: Truven MarketScan Claim Database 2012–2013.
  - ~ 1 million U.S. working population.
- Algorithm:
  - K-means clustering (Rosenberg et al. 2019)
    - Variables in classification: age, gender, pre-existing conditions, total medical expenditure in 2012.
  - Fit a three-parameter log-normal distribution on 2013 expenditure: (μ, σ, k) (Einav et al. 2013).
  - Shfit means to match the 2017 expenditure level.
- Robustness check: supervised learning methods.

Medical Expenditure Distributions



Optimal Plans under Full Information

	Risk type	deductible	OOP-limit	coins1	coins2	% losses covered
Single Risk Type/Risk-Based Pricing						
(1)	H	1,820	1,820	1	0	83%
(2)	L	933	933	1	0	77%
Asymmetric Information with Separating Equilibrium						
(3)	H	1,820	1,820	1	0	83%
(4)	L	0	/	0.23	0.23	77%
Asymmetric Information with Perfect Risk Adjustment						
(5)	H	677	677	1	0	92%
(6)	L	7,300	20,500	1	0.20	28%

Design Distortion: Competitive Separating Equilibrium

	Risk type	deductible	OOP-limit	coins1	coins2	% losses covered
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Model Generalization

Sorting on plan design persists with:

- more than two risk types Ex
- non-CARA utility function and heterogeneity in risk aversion Ex
- moral hazard model res

The model does not incorporate:

- market power

Empirical Analysis

ACA Federal Marketplace

- Private health insurance marketplace launched in 2014.
- Covers about 40 states, $\sim$ 10 million working-age population.

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Why studying ACA?

- Many plan options: an average consumers face 30 choices.
- Regulations on plan design:
  - Plans are grouped into 4 coverage tiers based on overall generosity.
  - No restriction in designs within a tier.
- Risk adjustment

Data

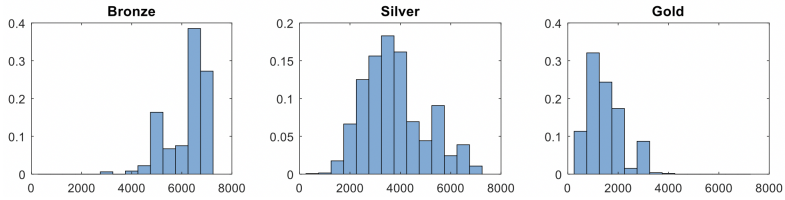
- The universe of 2014-2017 ACA plans:
  - cost-sharing attributes: deductible, oop-limits, coinsurance rates
  - premiums
  - market share
  - network types, counties launched, brand name
- Claim information collected from required financial reports:
  - plan level claim costs: half plans
  - insurer level claim costs and risk transfers: all insurers

Substantial Demand for Both Designs

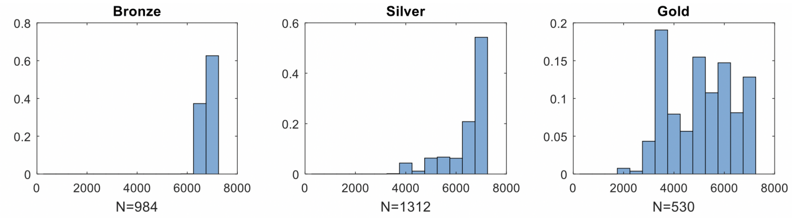
year	% plans that are straight-deductible	Total number of plans	% of consumers choosing straight deductible	Total number of consumers (mm)
2014	10.5%	2,864	5.7%	5.5
2015	9.6%	4,573	7.5%	9.2
2016	13.0%	3,966	8.3%	9.7
2017	11.1%	3,106	4.7%	9.0

Large Variation in Plan Designs

Deductible



Out-of-pocket limit:

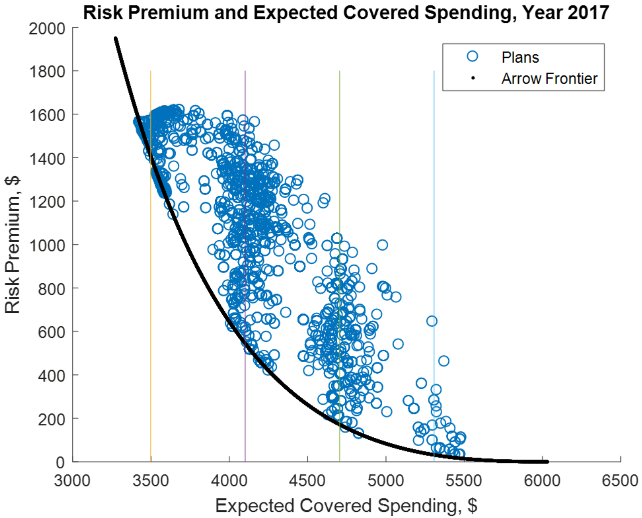


Large Variation in Plan Designs

- I calculate the economic value of each plan to individuals with market-average risk (CMS, 2017)
- Plans in the same tier have the same expected covered spending, but differ in the risk protection provided.
- Risk premium R:

$$EU(w-a) = U(w - E(a) - R)$$

Large Variation in Plan Designs



confusion

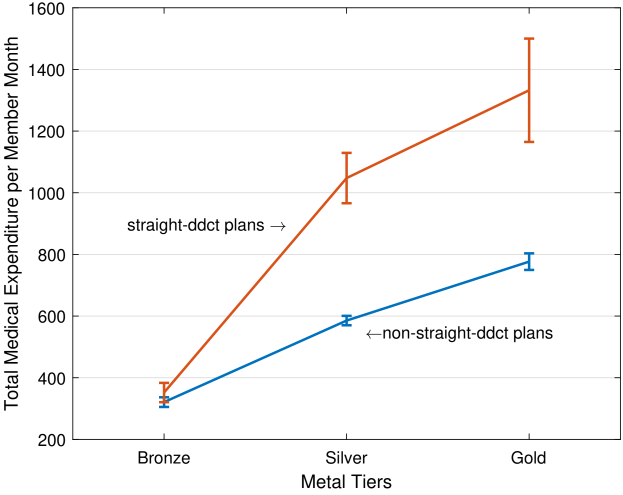
Stylized Facts

- Plan design variation does not converge over time. time

Plan design variation is prevalent across

- Geographic regions county size county ins
- Insurers ins profit ins size
- Network types network

Straight-Deductible Plans Have Higher Expenditure



Regression: Plan-Level Analyses

Panel data model with insurer-year fixed effects

$$y_{jt} = \alpha_{ist} + \lambda strddct_{jt} + \beta X_{jt} + \epsilon_{jt},$$

with

- y_{jt} = plan j's total medical expenditure, premium
- $strddct$ = dummy indicating straight-deductible design
- α_{ist} = insurer X service area X year fixed effects
- X_{jt} = actuarial value, metal tier, network type

Straight Deductible Plans Have Higher Expenditure

Monthly:

	(1)	(2)	(3)
	monthly medical expenditure	monthly premium	
		subset	all
straight-ddct	156.47***	-1.13	-0.46
	(23.46)	(3.14)	(1.62)
N	7369	7369	73102
R2	0.30	0.28	0.57
y-mean	586.4	404.4	302.5
y-sd	593.6	233.5	105.0
Controls	actuarial value, metal tier, network type		
Fixed Effects	insurer by service area by year		insurer-year, rating area

Moral Hazard or Selection?

Total medical expenditure reflects selection and/or moral hazard.

- Risk scores reflect ex-ante risks rather than ex-post expenditure:

$$RiskScores = f(age, gender, diagnosis).$$

- Comparison in risk transfers reflect ex-ante risk driven purely by selection, not moral hazard.

Regression: Insurer-Level Analyses

$$y_{it} = \alpha_s + \gamma_t + \lambda strddct_{it} + \beta X_{it} + \epsilon_{it}.$$

- *strddct*: fraction of enrollment in straight-deductible plans
- α_s: state fixed effects; γ_t: year fixed effects
- X_{it}: average actuarial value, enrollment share in metal tier, network type
- y_{jt}: average per-month value across plans weighted by enrollment
  - total medical expenditure
  - premium collected
  - **risk transfers**

Straight-Deductible Plans Have Higher Risk Score

Per month:	(1) medical expenditure	(2) insurer liability	(3) risk transfers	(4) average premium
straight-ddct	275.25***	235.81***	$\boxed{142.93^{**}}$	61.68
	(99.95)	(79.89)	$\boxed{(63.26)}$	(63.47)
N	617	617	617	617
R2	0.37	0.35	0.14	0.63
y-mean	474.66	357.1	-6.2	381.1
y-sd	124.11	102.5	66.0	97.4
Controls	AV, metal tier, network type, state, year fixed effects			

LargeSample MLR RiskPremium

Policy Implications

Plan Design Regulation

What are the welfare effects of removing design variation?

- Consumer confusion: Abaluck and Gruber (2011, 2019)
- Some health insurance markets only allow certain designs
  - California State Marketplace: non-straight deductible design
  - Netherlands: straight-deductible plans
  - ...

Plan Design Regulation

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  - ...

Two choice sets:

1. Actual plans launched in the 2017 ACA Marketplace
2. Plans with a straight-deductible design and the same premium

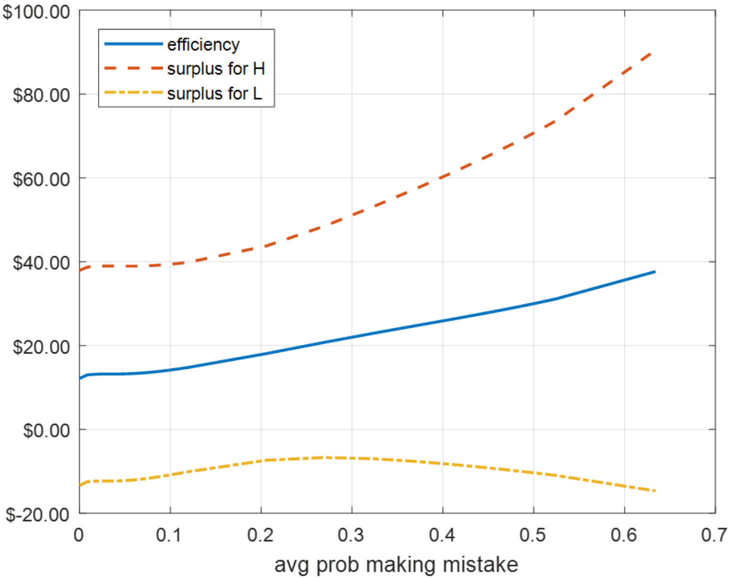
A Model with Confusion

Consumer utility function: multinomial logit

$$v_{ij} = \underbrace{\overbrace{\int u(-oop_j(x) - p_j; \gamma) dF_i(x)}^{\text{welfare-relevant utility}} + \beta \epsilon_{ij}}_{\text{decision utility}}.$$

- u: CARA with $\gamma = 0.0004$.
- F_i: Truven MarketScan data with 100 types
- ϵ_{ij} is drawn, iid, from a type 1 extreme value distribution.
- Variation in β captures level of confusion.

Surplus Changes under the Design Regulation



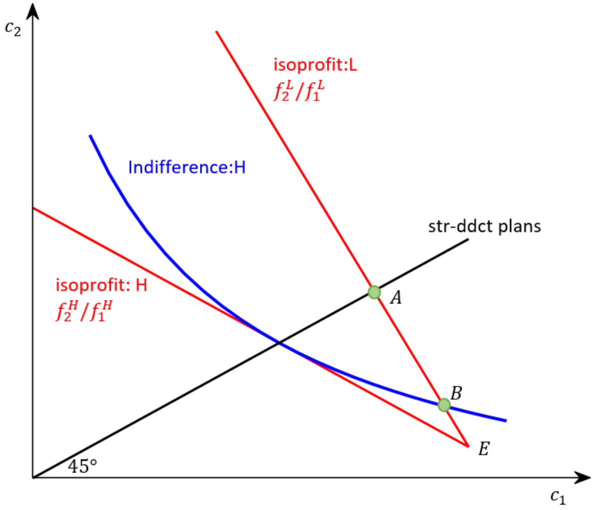
No Risk Adjustment: Design Variation Supports Efficiency

		deductible	out-of-pocket limit	co1	co2	% losses covered	surplus
Risk-based pricing	(1)	933	933	1	0	77%	0
No regulation	(2)	0	/	0.23	0.23	77%	-$561
Design regulation	(3)	13,154	13,154	1	0	23%	-$1,256

Conclusion

1. Asymmetric information creates sorting on plan design: H sorts into straight-deductible plans, but not L.
2. There is a systematic sorting pattern by risk types into different plan designs in the ACA Exchanges.
3. Regulation on plan designs may or may not improve efficiency, depending on the existence of consumer confusion and risk adjustment.

Intuition



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Calculate Competitive Equilibrium

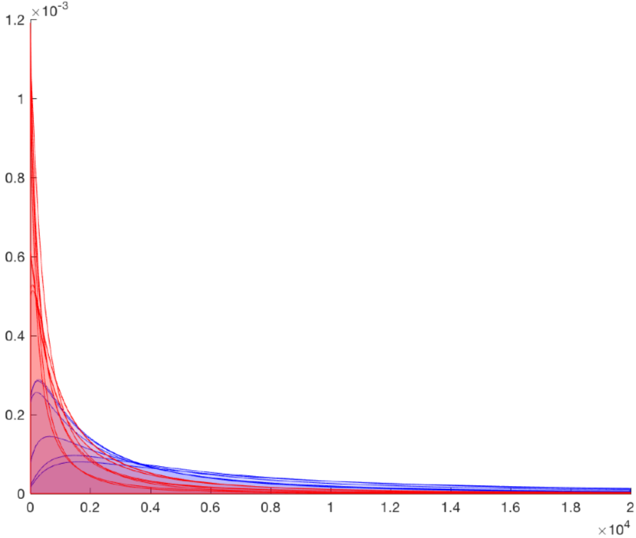
The Azevedo and Gottlieb (2017) equilibrium is defined as:

- Weak equilibrium:
  - Individuals optimize
  - Each contract breaks even given who buys it
- The equilibrium is stable with regard to "perturbation" created by a fraction of behavioral types
- Such equilibrium always exists and may not be unique.
- I calculate the one giving the highest utility to L.

return

More Risk Types

15 risk types: return



Negative Correlation between Risk and Risk Aversion

return

Risk types	r	deduct	OOP-limit	coins1	coins2	*prm*
H	5×10^{-5}	1234	1234	/	/	6,200
L	2×10^{-3}	700	3200	1	0.1	6,200

Moral Hazard

Based on Einav et al. (2013)

$$u(m; x, \omega, j) = [(m - x) - \frac{(m-x)^2}{2\omega}] + [w - p_j - oop_j(m)]$$

- m: ex-post medical expenditure
- x: ex-ante medical shocks
- ω represents over spending from no insurance to full insurance
- Brot-Goldberg et al. (2018): $\omega = 0.4x$

return

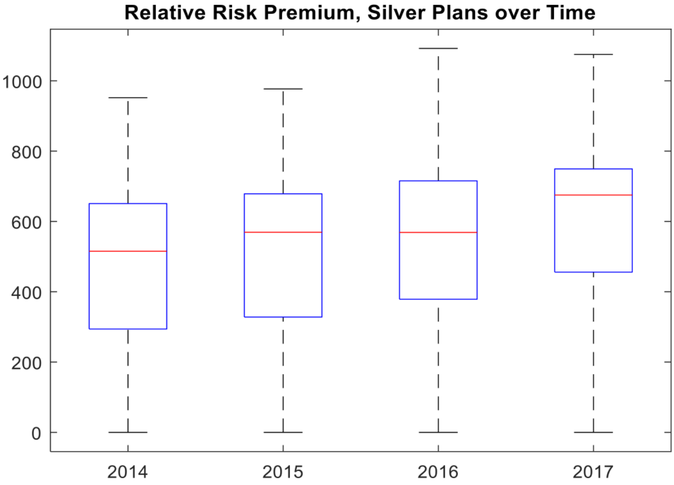
Moral Hazard

Plans chosen under moral hazard

scheme	Risk Type	deductible	OOP-limit	coins1	coins2
Full information	H	5,176	5,176	1	0
	L	2,856	2,856	1	0
Perfect risk adjustment	H	3,081	3,081	1	0
	L	4,900	10,000	1	0.1

return

Plan variation is stable over time



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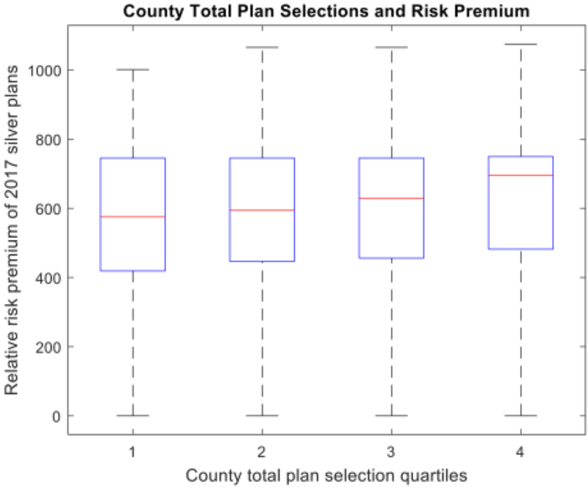
County Size



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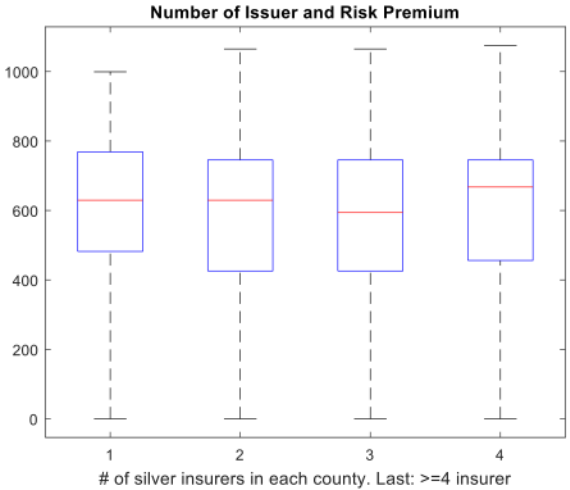
Market Competitiveness



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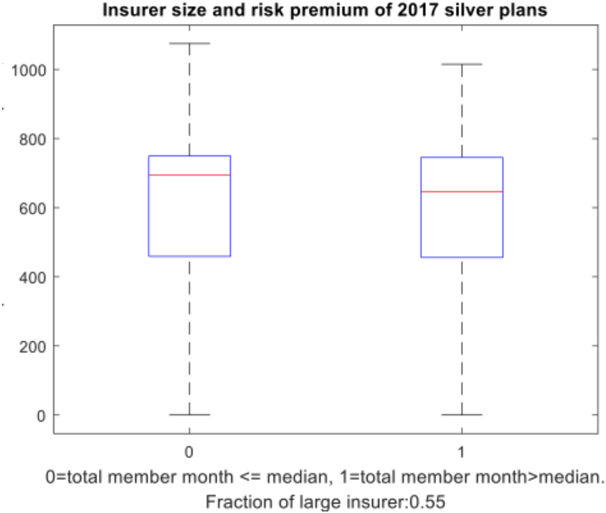
Insurer For-profit

return

Insurer Size



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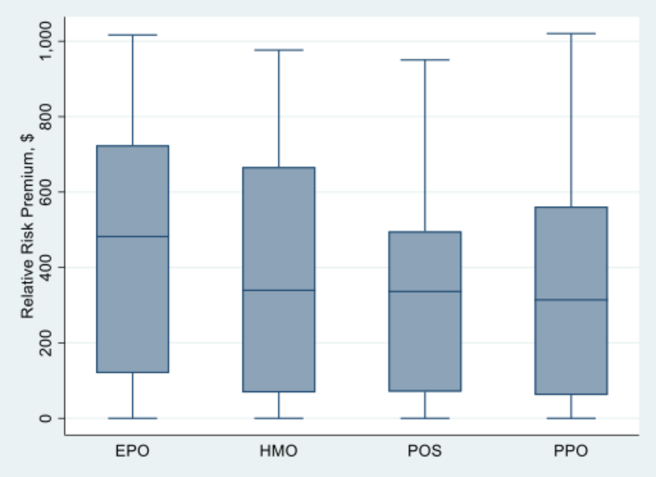
Network



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Sample Description

Datasets	# of insurer-year: 2014-2017	% matched
Insurer-year with plan information	838	100%
Uniform Rate Review (benchmark insurer sample)	617	73.6%
Medical Loss Ratio filings	522	62.3%
Combined – premium, insurer claim costs	815	97.3%
Combined – risk adjustment	744	88.8%
Combined – total medical expenditure	617	73.6%

return

Regression Results with Larger Sample

	(1)	(2)	(3)
Per month:	insurer liability	risk transfers	average premium
straight-ddct	161.85**	114.75**	8.30
	(69.25)	(48.35)	(53.91)
AV	1520.32***	549.33***	607.09**
	(417.41)	(194.71)	(295.92)
N	815	744	815
R2	0.17	0.12	0.54
y-mean	359.3	-6.1	379.8
y-sd	141.4	63.4	101.8
Controls	metal tier, network type, state fixed effects		

return

Regression Results with Risk Premium as Independent Variables

	(1)	(2)	(3)	(4)
Per month:	total expenditure	insurer liability	risk transfers	average premium
relative risk premium	-24.96***	-21.01***	-18.34***	-8.27
	(6.77)	(5.62)	(3.89)	(4.02)
AV	-1279.37**	-1308.85***	-762.29***	-357.09
	(552.75)	(468.51)	(209.85)	(350.69)
N	617	617	617	617
R2	0.66	0.43	0.23	0.64
y-mean	381.1	357.1	-6.2	381.1
y-sd	97.4	102.2	66.0	97.4
Controls	metal tier, network type, state fixed effects			

return

Marginal Effects under Risk Adjustment

Design regulation: only straight-deductible plans are allowed

		Risk type	deductible	Out-of-pocket limit	co1	co2	% losses covered	Consumer Surplus	Average Surplus
Risk-based pricing	(1)	H	1,820	1,820	1	0	83%	0	0
	(2)	L	933	933	1	0	77%	0	
No Design Regulation	(3)	H	677	677	1	0	92%	$1107	-$304
	(4)	L	7,300	20,500	1	0.2	28%	-$4230	
Design Regulation	(5)	H	677	677	1	0	92%	$1110	-$318
	(6)	L	10,971	10,971	1	0	26%	-$4292	

return