Risk Adjustment, Self-Selection and Plan Design in Medicare Advantage

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Background

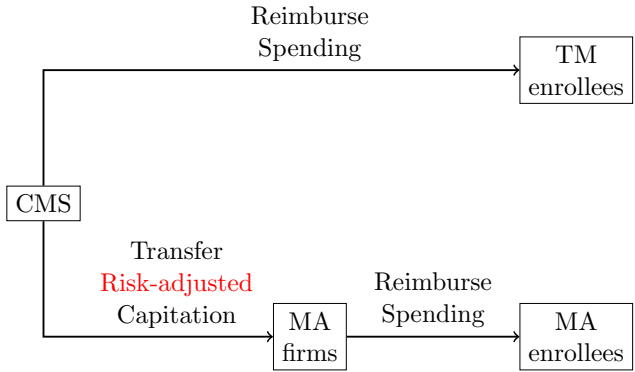
Toy Model

Empirical Model

Estimation

Welfare Outcome

Medicare Market



CMS allows

- Medicare Advantage (MA) firms to design plans,
- Consumers to choose between Traditional Medicare (TM) or MA plans.

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Risk Adjustment

- Spending types: Low spenders (s^L) and high spenders (s^H), with $s^L < s^H$.
- Two age groups of same size:
  - 65-year-olds: 80% low spenders, 20% high spenders
  - 85-year-olds: 20% low spenders, 80% high spenders
- Gov **only observes age, not spending type**. It sets capitation payments based on age: c^{65} for 65-year-olds and c^{85} for 85-year-olds.

$$c^{65} = 0.8s^L + 0.2s^H > s^L, \quad c^{85} = 0.2s^L + 0.8s^H < s^H.$$

- **low spenders**: spending is s^L while the average capitation is $0.8c^{65} + 0.2c^{85} > s^L$.
- **high spenders**: spending is s^H while the average capitation is $0.8c^{65} + 0.2c^{85} < s^H$.

Heterogeneity

Consumer Utility:

- Utility is affected by premium (p) and generosity level (g).
- Consumers privately know their spending type.
- Preferences for plan generosity depend on their spending type (unobservable) rather than age (observable).
- High spenders value plan generosity more than low spenders:

$$u^H = \alpha p + \beta^H g, \quad u^L = \alpha p + \beta^L g, \quad \beta^H > \beta^L$$

Strategic Plan Design with Self-Selection

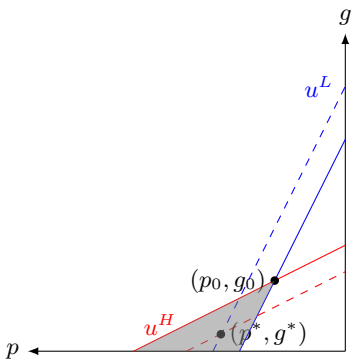

Figure: Indifference Curves with Reversed p axis

Given outside option (p_0, g_0), firm designs plan (p^*, g^*) to ensure self-selection:

$$\begin{cases} \alpha p^* + \beta^L g^* > \alpha p_0 + \beta^L g_0, \\ \alpha p^* + \beta^H g^* < \alpha p_0 + \beta^H g_0, \end{cases}$$

$$\Rightarrow p^* < p_0, \quad g^* < g_0.$$

Results:

- Low spenders prefer inside option (p^*, g^*)
- High spenders prefer outside option (p_0, g_0)
- Firm maximizes profit by offering (p^*, g^*) to attract low spenders.

Research Questions

- How do MA firms strategically design plans to leverage private health perceptions and encourage self-selection among Medicare beneficiaries?
- What are the welfare implications of such strategic behavior?

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Timing

- **Government Sets Capitation:** Determines capitation payments based on observable individual characteristics.
- **Stage 1 - Firm Decision:** Given plan offerings, Firms set the price and generosity levels of their plans to optimize profit after captiation.
- **Stage 2 - Consumer Choice:** Consumers select plans (including outside option) that best suit their own needs, leveraging their own private information.

Demand: Private Information

Each consumer is characterized by two variables:

- observable risk-adjusted capitation rate (k_i), which serves as a proxy for the average expected health expenditure within a similar health cohort.
- unobservable health perception (e_i), which directly influences their preference on plan generosity, and hence their plan choice.

$$\ln(e_i) = \ln(k_i) + \tau_i, \quad \tau_i \sim N(0, \sigma_\tau^2) \tag{1}$$

Demand: Utility

The utility of consumer i from plan j is given by

$$u_{ij} = \beta_i g_j - \alpha_i p_j + \lambda_i^A A_j + \lambda^X X_j + \xi_j + \varepsilon_{ij}. \tag{2}$$

- g_j and p_j are the generosity and premium of plan j.
- A_j is MA type indicator
- X_j is a vector of other plan characteristics
- ξ_j is the unobserved plan-specific quality
- ε_{ij} is the idiosyncratic error term, following a T1EV distribution

The utilitiy of the outside option (TM + Medigap) is

$$u_{i0} = \beta_i g_0 - \alpha_i p_0 + \xi_0 + \varepsilon_{i0}. \tag{3}$$

Demand: Hetereogeneity

Preferences for plan generosity (β_i) are influenced by health perception e_i

$$\beta_i = \bar{\beta} + \gamma \ln e_i. \tag{4}$$

Preferences for plan premiums (α_i) are associated with income level

$$\alpha_i = \bar{\alpha} + \rho^{\text{inc}} \text{inc}_i. \tag{5}$$

Preferences for the MA type (λ_i^A) relate to demographic factors and existing health coverage, including Medicaid eligibility and employer-sponsored insurance (ESI) coverage

$$\lambda_i^A = \bar{\lambda}^A + \rho^{\text{edu}} \text{edu}_i + \rho^{\text{white}} \text{white}_i + \rho^{\text{Mcd}} \text{Mcd}_i + \rho^{\text{ESI}} \text{ESI}_i. \tag{6}$$

Demand: Plan Mean Utility

The mean utility of plan j relative to the outside option is

$$\delta_j = \bar{\beta}(g_j - g_0) - \bar{\alpha}(p_j - p_0) + \bar{\lambda}^A A_j + \lambda^X X_j + \xi_j - \xi_0, \tag{7}$$

and let the $\mu_i j$ denote the individual-specific deviation from δ_j, we can rewrite the utility function as

$$u_{ij} = \delta_j + \mu_{ij} + \varepsilon_{ij}. \tag{8}$$

Demand: Plan Choice Probability

Considering the T1EV distribution of ε_{ij}, the probability that consumer i chooses plan j is given by

$$s_{ij}(e_i) = \frac{\exp\left(\delta_j + \mu_{ij}(e_i)\right)}{\sum_{j'=0}^{J} \exp\left(\delta_{j'} + \mu_{ij'}(e_i)\right)}. \tag{9}$$

The market share of plan j is given by the weighted sum of the individual choice probabilities

$$q_j = \sum_i w_i \cdot s_{ij}(e_i) = \sum_i w_i \cdot \int s_{ij}(e)\, dF_e(e). \tag{10}$$

- w_i is the sampling weight of consumer i

Supply: Competition Setting

- **Bertrand-Nash**: Firms compete in prices and plan generosity levels, given plan offerings and other exogenous attributes, with each plan having its specific cost functions.
- **Multi-Product Multi-Market**: Firms operate as multi-product entities competing across multiple submarkets.
- **Focus on Short Run**: The model does not account for the entry and exit of plans.

Supply: Costs

This cost is influenced by the plan's generosity level g_j and other observable exogenous attributes X_j. The marginal cost function is expressed as

$$mc_j(g_j) = mc_j^g(g_j) + \underbrace{w^X \cdot X_j + \omega_j}_{\text{predetermined}}, \tag{11}$$

- unobserved plan-specific cost shock ω_j,
- each plan has a unique cost function due to the perdetermined components.

Supply: Profits

The profit function for plan j in county c, which has a market size of M_c, is

$$\pi_j = (b_j - mc_j(g_j)) \cdot M_c \cdot s_{c,j}(g, b). \tag{12}$$

- Supplementary Bid b_j: Price received by the firm.
- Premium p_j: Price paid by the consumer.
- Premium Reduction p^{reduc}: Difference, assumed to be exogenous and fixed.
- Premium Calculation: $p_j = b_j - p^{\text{reduc}}$, linking bid to premium.

Supply: Plan Design Problem

The total profit for a firm in county c is the aggregate of profits from all its offered plans

$$\pi_{f,c} = \sum_{j \in \mathcal{J}_{f,c}} \pi_j. \tag{13}$$

The state-level profit for MA firm f is then the sum of profits across all counties c where firm f operates

$$\pi_f = \sum_{c \in \mathcal{C}_f} \pi_{f,c}, \tag{14}$$

where $\mathcal{C}_f$ denotes the set of counties in which firm f is active.
The firm's plan design problem can be formulated as maximizing state-level profit by strategically setting bid and generosity levels for each plan

$$\max_{b_f, g_f} \pi_f = \sum_{c \in \mathcal{C}_f} \sum_{j \in \mathcal{J}_{f,c}} (b_j - mc_j(g_j)) \cdot M_c \cdot s_{c,j}(g, b), \tag{15}$$

Supply: Necessary Optimality Conditions

The first-order conditions for the firm's plan design problem are

$$\{b_j\}: \quad \sum_{c \in \mathcal{C}_f} M_c \left(s_{c,j} + \sum_{j \in \mathcal{J}_{f,c}} (b_j - mc_j) \cdot \frac{\partial s_{c,j}}{\partial b_j} \cdot \frac{\partial b_j}{\partial p_j} \right) = 0 \quad \forall j, \tag{16}$$

$$\{g_j\}: \quad \sum_{c \in \mathcal{C}_f} M_c \left(\frac{\partial mc_j}{\partial g_j} \cdot s_{c,j} - \sum_{j \in \mathcal{J}_{f,c}} (b_j - mc_j) \cdot \frac{\partial s_{c,j}}{\partial g_j} \right) = 0 \quad \forall j, \tag{17}$$

where $\frac{\partial b_j}{\partial p_j} = 1$.
Each firm faces unique optimization conditions due to differences in plan offerings and the specifics of their cost functions (see Equation 11).

Estimation: Demand Overview

Two step estimation by Goolsbee and Petrin (2004)

- Weighted MLE of the heterogeneity parameters and mean utilities.
- IV estimation of the mean utility parameters.

Weighted MLE

Find ϑ that maximizes the likelihood of the observed individual choices, while ensuring that the implied market shares match the observed market shares.

$$\max_{\vartheta} \underbrace{\sum_{c}\sum_{i} w_{ci} \cdot \sum_{j \in \mathcal{J}_c} y_{cij} \cdot \ln(s_{cij}(\vartheta))}_{\text{Weighted log-likelihood}}$$
$$\text{s.t.} \quad \underbrace{s^*_{cj} = \sum_{i} w_{ci} \cdot s_{cij}(\vartheta)}_{\text{Market share matching condition}} \qquad \forall j = 1, ...J, \quad \forall c, \tag{18}$$

- y_{cij} is the indicator of the observed individual choice of plan j in county c,
- s^*_{cij} is the observed market share of plan j in county c.

Estimation: Consumer Heterogeneity

Table: Estimation Results of Consumer Preference Heterogeneity

Variable	Parameter	Estimate	Std Error
Generosity Preference			
Health Perception	γ	0.115	(0.052)
Premium Preference			
High Income Level	ρ^{inc}	-0.473	(0.248)
MA Type Preference			
High Education Level	ρ^{edu}	-0.275	(0.203)
White Race	ρ^{white}	-0.173	(0.280)
Medicaid Coverage	ρ^{Mcd}	0.039	(0.244)
ESI Coverage	ρ^{ESI}	-2.543	(0.404)
Private Information Distribution			
SD of Health Perception	σ_τ	3.983	(2.733)

Note: ESI stands for employer-sponsored insurance.

IV

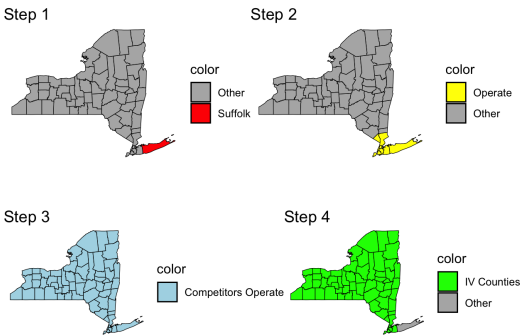

Figure: IV Construction Process

Based on methodology from Fan (2013).

- **IV Construction Rationale:** Utilizes demographics from markets where the plan does not operate but its overlapping competitors do.
- **Key Insight:** Demographics in non-operating markets influence competitor actions, only indirectly affecting the plan of interest through competition in plan design.

Plan Mean Utility

Table: Estimation Results of Plan Mean Utility

Variable	Parameter	Estimate	Std Error
Coverage			
MA Type	$\bar{\lambda}^A$	-1.917	(0.224)
Premium	$\bar{\alpha}$	-1.316	(0.354)
Generosity	$\bar{\beta}$	1.006	(0.388)
Network			
Rating (per star)	-	0.282	(0.028)
HMO	-	0.204	(0.029)
Additional Benefits			
Dental	-	-0.077	(0.033)
Vision	-	-0.015	(0.031)
Hearing	-	0.031	(0.034)

Estimation: Supply Overview

- Estimation builds on first-order conditions from supply model, integrating estimated consumer response from demand side.
- Similar to demand side, supply side estimation faces issues due to unobservable factors correlating with plan design variables.
- Utilizes the same IV strategy as in demand estimation to address endogeneity.

Plan Costs

Table: Estimation of Plan Marginal Cost

	I		II	
Variable	**Estimate**	**Std Error**	**Estimate**	**Std Error**
Coverage				
Generosity	1.353	(0.171)	1.367	(0.174)
Generosity^2	0.160	(0.020)	0.140	(0.021)
Network				
Rating (per star)	0.150	(0.019)	0.157	(0.020)
HMO	0.237	(0.022)	0.247	(0.023)
Additional Benefits				
Dental	0.170	(0.023)	0.158	(0.025)
Vision	0.039	(0.055)	0.045	(0.055)
Hearing	0.095	(0.026)	0.118	(0.027)
Firm Fixed Effect				
Aetna	-	-	-0.017	(0.033)
Anthem	-	-	-0.181	(0.049)
UHG	-	-	-0.079	(0.030)

Summary by Plan Generosity Choices

Table: Summary of Plan Costs by Generosity Quartile

Generosity Quartile	**Cost**	**Capitation**	**Capitation – Cost**	**Bid**
1st Quartile (Lowest)	9.136	9.560	0.424	0.556
2nd Quartile	9.629	9.931	0.305	0.701
3rd Quartile	10.364	10.495	0.134	0.900
4th Quartile (Highest)	12.516	12.168	-0.348	1.417

Note: Values are in thousand dollars. The capitation represents the subsidy received by MA firms from CMS. Bid refers to the supplemental bid that supposed to cover the cost of additional benefits. The difference between capitation and cost is the profit margin of the plan without bid.

Summary by Plan Generosity Choices

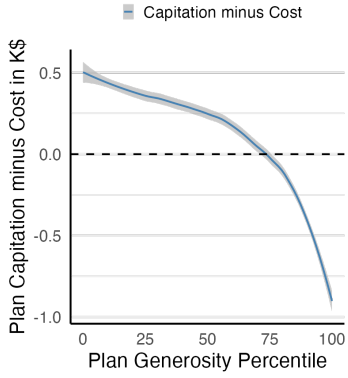

Figure: Capitation minus Cost by Plan Generosity Percentile

Note: The 95% confidence interval is depicted in the plot.

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Welfare Analysis

Table: Summary of Current Market

Category	**Per Capita**	**National Total**
Consumer Surplus	$382	$22.08 billion
Producer Surplus	$1,068	$14.45 billion
Gov Spending on TM	-	$370.26 billion
Gov Spending on MA	-	$163.51 billion
Total Gov Spending	-	$533.77 billion

Future Work

Counterfactual Simulation

- **Simulate Equal-Profit**: profit only depends on quantities, not the type of enrollees. No gaming incentives for firms.
- **Quantify Selection Effect**: the welfare difference between the observed and counterfactual market outcome.

Thank You!

References

Fan, Ying, "Ownership Consolidation and Product Characteristics: A Study of the US Daily Newspaper Market," *American Economic Review*, 2013, *103* (5), 1598–1628.

Goolsbee, Austan and Amil Petrin, "The Consumer Gains from Direct Broadcast Satellites and the Competition with Cable TV," *Econometrica*, 2004, *72* (2), 351–381.

Appendix

Appendix: Risk Adjustment Generation

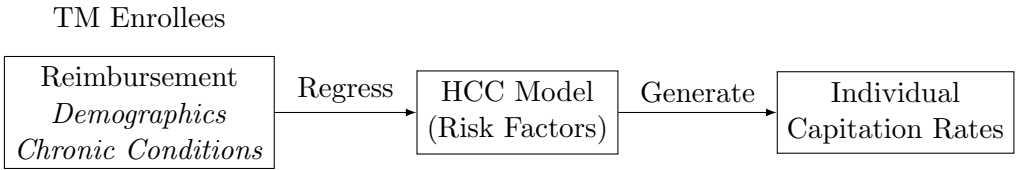

Figure: Capitation Rate Generation Process

Appendix: Risk Adjustment Outcomes

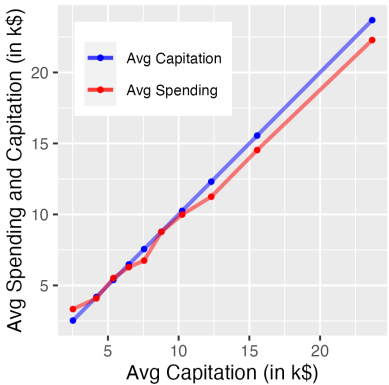

Figure: Conditional on Capitation Deciles

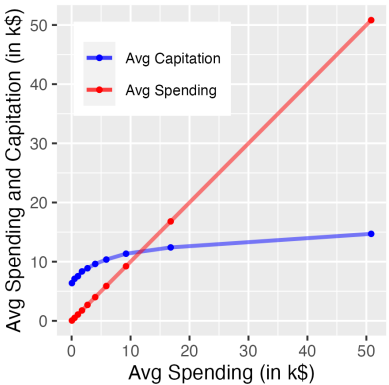

Figure: Conditional on Spending Deciles

Appendix: Benefit Structure