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

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December 27, 2024

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Medicare System

Medicare is a U.S. federal health insurance program mainly for individuals aged 65 and older, comprising two main components:

- **Traditional Medicare (TM)**: A fee-for-service (FFS) system, typically paired with Medigap plans.
- **Medicare Advantage (MA)**: A managed competition framework where private insurers, subsidized by the government, often offer plans with **lower premiums and reduced generosity** compared to Traditional Medicare (TM).

Medicare Advantage

- **Managed Competition**: The government provides fixed and predetermined subsidies to private insurance firms, which in turn offer insurance plans to beneficiaries.
- **Cream Skimming**: Firms strategically target healthier beneficiaries to maximize profits.
- **Risk Adjustment**: The government adjusts subsidy payments to insurers based on beneficiaries' observable characteristics.
- Can risk adjustment effectively neutralize insurers' incentives for cream skimming when beneficiaries have private information about their health status?

Simplified Risk Adjustment Scenario

- Equal size of younger and older seniors
  - **Younger**: 80% healthy, 20% sick
  - **Older**: 20% healthy, 80% sick
- Cost of care: $1,000 for healthy individuals, $5,000 for sick individuals
- Age is observable to the government; health status is private information

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- Cost of care: \$1,000 for healthy individuals, \$5,000 for sick individuals
- Age is observable to the government; health status is private information
- Subsidy risk-adjusted by age:
  - **Younger**: $\$1{,}000 \times 0.8 + \$5{,}000 \times 0.2 = \$1{,}800$
  - **Older**: $\$1{,}000 \times 0.2 + \$5{,}000 \times 0.8 = \$4{,}200$
- Average subsidy rate by health group:
  - **Healthy**: $\$1{,}800 \times 0.8 + \$4{,}200 \times 0.2 = \$2{,}240$ (**above** cost of \$1,000)
  - **Sick**: $\$1{,}800 \times 0.2 + \$4{,}200 \times 0.8 = \$3{,}960$ (**below** cost of \$5,000)
- **Firms still prefer healthy individuals even after risk adjustment**.

Motivation & Related Literature

- MA has gained popularity, enrolling 54% of beneficiaries by 2024.
- **Existing Studies**: Focus on competition (Curto et al., 2021; Miller et al., 2023) and selection (Aizawa and Kim, 2018; Brown et al., 2014).
- **New Perspective**: This paper focus on how private information and endogenous plan design jointly drive self-selection under risk adjustment in MA markets.

Research Questions

- How does self-selection influence plan design and market outcomes in MA market?
- What are the welfare implications of these interactions?

Methodology

- Develop a structural model of demand and supply that incorporates self-selection and endogenous plan design.
- Estimate the model using Medicare Advantage data.
- Conduct counterfactual simulation to analyze scenario where self-selection effects are neutralized.

Key Findings

If risk adjustment fully neutralizes cream-skimming incentives:

- Total consumer surplus rises by 11%
- Total firm profits increase by 34.6%
- No significant change in total government spending

Contributions

- **Theoretical**: Developed a managed competition model incorporating endogenous plan design and self-selection under private information.
- **Empirical**: Applied the model to Medicare Advantage data, evaluating the welfare implications of self-selection effects.
- **Policy**: Provided insights for enhancing risk adjustment payment policies to mitigate market distortions.

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Data

- **Individual Level**: Medicare Current Beneficiary Survey (MCBS)
  - Contains detailed information on individual beneficiaries, including demographics and plan choice.
- **Plan Level**: Centers for Medicare and Medicaid Services (CMS) datasets on MA plans
  - Includes data on plan generosity levels, premiums, and other attributes such as network and additional benefits.

Summary Statistics

Table: Consumer Summary Statistics by Plan Type

Category	Variable	TM	MA	Overall
Demographics	Age	73.887	74.283	73.997
	Female	0.524	0.557	0.533
	Income	70,203	50,484	64,697
	White Race	0.873	0.827	0.860
	Higher Education	0.607	0.469	0.568
Medicare	Medical Spending	8340	6012	7692

Note: TM refers to Traditional Medicare, and MA refers to Medicare Advantage. Values are means for continuous variables and proportions for binary variables.

Model: Timing

- **Government Sets Subsidy Rates:** Determines capitation payments using a risk adjustment formula.
- **Stage 1 - Firm Decisions:** Firms set the prices and generosity levels of their plans to maximize profit after accounting for subsidies.
- **Stage 2 - Consumer Choices:** Consumers choose plans (including the outside option) that best meet their needs, using their private information.

Demand: Private Information

Each consumer is characterized by two variables:

- An observable risk-adjusted capitation rate (k_i), which serves as a proxy for the average expected health expenditure within a cohort with similar observable characteristics.
- A private health perception (e_i), which directly influences their preference for plan generosity and, consequently, 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 [1] 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

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

[1] Generosity is measured by expected OOP under a specific health condition

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 Competition**: Firms compete on prices and plan generosity levels, considering plan offerings and other exogenous attributes, with each plan having specific cost functions.
- **Multi-Product, Multi-Market**: Firms operate as multi-product entities competing across multiple submarkets.
- **Short-Run Focus**: The model does not account for the entry and exit of plans.
- **Selection Effect**: The cost of plans is influenced not only by the plan's generosity level but also by the health status of the individuals who select the plan, which is itself affected by the plan's generosity.

Supply: Costs

The cost of a plan is influenced by its generosity level g_j and other observable exogenous attributes X_j. The marginal cost function is expressed as:

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

- ω_j represents the unobserved plan-specific cost shock.
- Each plan has a unique cost function due to the predetermined components.
- Higher generosity in plans increases costs both directly, through more generous coverage, and indirectly, by attracting more sick individuals, which adds further expenses to the plan (the **Selection Effect**).

Supply: Plan Design Problem

The firm's plan design problem is to maximize **state-level** profit by strategically setting bid and generosity levels for each plan:

$$\max_{b_f, g_f} \pi_f = \sum_{c \in \mathcal{C}_f} \sum_{j \in \mathcal{J}_{f,c}} (b_j - mc_j(g_j)) \cdot M_c \cdot s_{c,j}(g, b), \tag{12}$$

Where:

- $\mathcal{C}_f$: Set of counties in which firm f operates
- b_j: Bid price of plan j, determining the premium
- $mc_j(g_j)$: Marginal cost of plan j as a function of generosity level g_j
- M_c: Number of Medicare beneficiaries in county c
- $s_{c,j}$: Market share of plan j in county c

Supply: Necessary Optimality Conditions

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

$$\{b_j\}: \quad \sum_{c \in \mathcal{C}_f} M_c \left(s_{c,j} + \sum_{j \in \mathcal{J}_{f,c}} (b_j - mc_j) \cdot \frac{\partial s_{c,j}}{\partial b_j} \cdot \frac{\partial b_j}{\partial p_j} \right) = 0 \quad \forall j, \tag{13}$$

$$\{g_j\}: \quad \sum_{c \in \mathcal{C}_f} M_c \left(\frac{\partial mc_j}{\partial g_j} \cdot s_{c,j} - \sum_{j \in \mathcal{J}_{f,c}} (b_j - mc_j) \cdot \frac{\partial s_{c,j}}{\partial g_j} \right) = 0 \quad \forall j, \tag{14}$$

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).

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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.

Estimation: 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)

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Equal-Profit Risk Adjustment

- **Goal**: Align subsidies so firms earn the same profit from healthy and sick enrollees, removing cream-skimming incentives.
- **Approach**: Adjust plan subsidy payments so expected profits are uniform across all beneficiaries.
- **Impact**: Firms no longer have incentives to favor healthier individuals.

Welfare Comparison

Table: Welfare Comparison Between Current and Equal-Profit Risk Adjustment

Metrics	Current	Equal-Profit	% Change
Total MA share (%)	30.58	33.25	8.72%
Total Consumer Surplus	22.08	24.51	11.01%
Total Producer Surplus	14.45	19.45	34.60%
Gov Spending on TM	370.26	357.46	-3.46%
Gov Spending on MA	163.51	176.31	7.82%
Subsidy Adjustment	-	0.95	-
Total Gov Spending	533.77	534.72	0.18%

Note: The monetary values are in billion dollars. The subsidy adjustment is the change in the total capitation payment from the government to MA firms, compared to the current policy. The total government spending is the sum of government spending on TM and MA.

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- **Takeaway**: Conventional risk adjustment mechanisms are inadequate in completely eliminating cream-skimming incentives, resulting in market distortions and welfare losses.
- **Future Work**: Further investigate how different consumer and firm segments experience changes in surplus to provide more nuanced policy insights.

Thank You!

Appendix

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Appendix: Risk Adjustment Generation

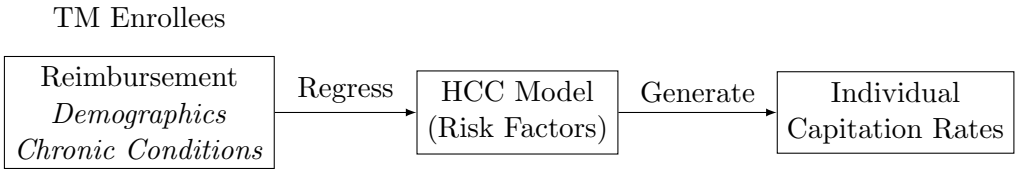


Figure: Capitation Rate Generation Process

Appendix: Risk Adjustment Outcomes

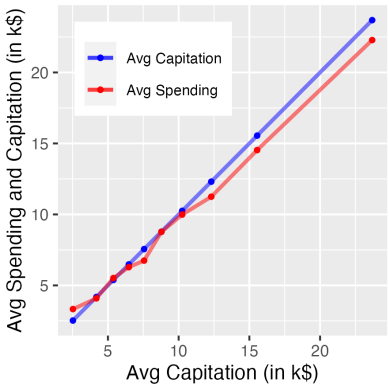


Figure: Conditional on Capitation Deciles

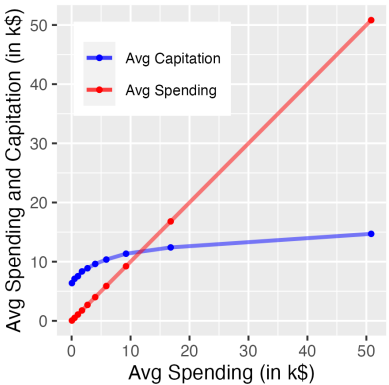
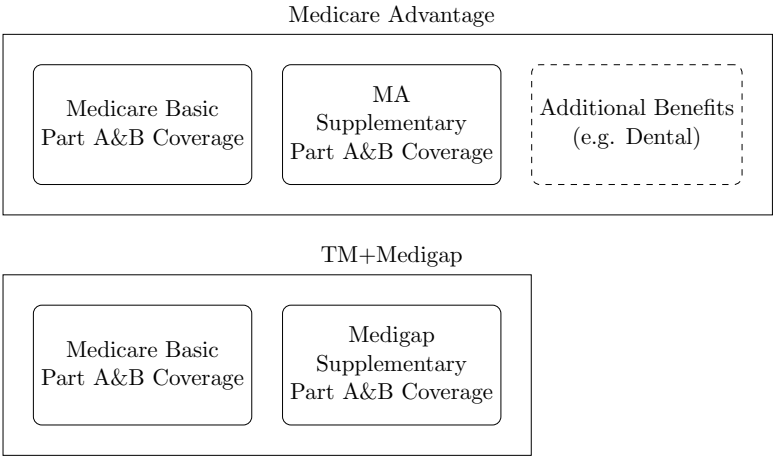
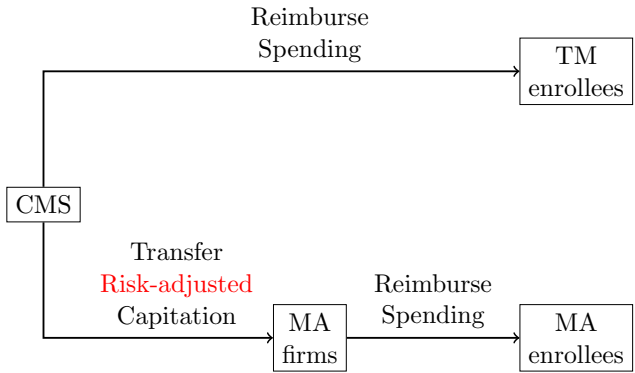


Figure: Conditional on Spending Deciles

Appendix: Benefit Structure



An Example: Medicare Advantage



- Traditional Medicare (TM) is FFS.
- Medicare Advantage (MA) is managed competition.
- Beneficiaries choose between TM and MA.

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 (set of parameters) that maximizes the likelihood of the observed individual choices, while ensuring that the implied market shares match the observed market shares.

$$\begin{aligned} &\max_{\vartheta} \underbrace{\sum_{c} \sum_{i} w_{ci} \cdot \sum_{j \in \mathcal{J}_c} y_{cij} \cdot \ln(s_{cij}(\vartheta))}_{\text{Weighted log-likelihood}} \\ &\text{s.t.} \quad \underbrace{s^*_{cj} = \sum_{i} w_{ci} \cdot s_{cij}(\vartheta)}_{\text{Market share matching condition}} \quad \forall j = 1, ...J, \quad \forall c, \end{aligned} \tag{15}$$

- 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.