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

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August 25, 2024

Job Market Paper

Latest Version

Abstract

Risk adjustment aims to equalize the profitability of diverse patient groups to prevent insurers from favoring inherently more profitable populations. However, evidence suggests that this system, widely implemented in Medicare Advantage (MA) markets, does not completely eliminate variations in profitability—a nature of the existing risk adjustment mechanisms. Low spenders remain more profitable than high spenders. Individuals possess private health perceptions, which influences heterogeneous preferences for plan generosity. MA firms strategically leverage this by designing plans that encourage self-selection to maximize profits. This framwork explains plan design trends and overpayment issue in MA. Counterfactual simulation shows that an additional generosity-specific capitation adjustment, designed to ensure equal profitability, would cost the government $1 billion (a 0.2% increase) but result in a $7 billion boost in social welfare.

Keywords: private information, self-selection, product design, risk adjustment
JEL Codes: L11, I13, I18, D22, D82

1 Introduction

This paper investigates the strategic insurance plan design under the risk adjustment mechanism empirically in the Medicare Advantage (MA) market.

The rest of the paper is structured as follows. Section 2 provides an overview of the institutional background, suggestive evidence of self-selection and strategic plan design in the MA market. Section 3 describes the data used in the analysis. Section 4 presents a structual model where consumers choose Medicare plan based on their health expectation and the plan attributes, and the MA firms design the plan to maximize their profit. Section 5 discusses the estimation strategy and results. Section 6 presents the counterfactual analysis where an addtional captiation is introduced to ensure equal-profit condition for MA firms. Sectoin 7 concludes the paper.

2 Institutional Background

2.1 The Medicare System

Medicare represents a fundamental component of the United States' social insurance system. It is administered by the Centers for Medicare & Medicaid Services (CMS), an agency within the Department of Health and Human Services (HHS). Established in 1965, Medicare's primary purpose is to provide health insurance coverage to individuals aged 65 and older, as well as to younger people with certain disabilities and diseases.

The funding for Medicare comes from three main sources: payroll taxes levied on workers and employers, premiums from beneficiaries, and contributions from the federal budget. This multifaceted funding structure ensures Medicare's operation and sustainability, supporting a wide range of healthcare services for its beneficiaries.

Medicare's financial significance is profound, accounting for a substantial portion of the federal budget with total expenditures reaching $905.1 billion in 2022. This reflects the program's broad impact, covering 65.0 million individuals, including both seniors and disabled persons (CMS, 2023). Notably, a significant number of beneficiaries, approximately 46 percent, choose Medicare Advantage (Part C) plans, indicating a strong preference for these private health plan options.

In the following section, we will delve into the specifics of Medicare Advantage, exploring its features and the role it plays in the broader Medicare ecosystem.

2.2 Medicare Advantage

Medicare is divided into several parts, with Traditional Medicare (TM) encompassing Part A (hospital insurance) and Part B (medical insurance), and Medicare Advantage (MA) offering an alternative way for beneficiaries to receive their Medicare benefits through private health plans. While TM is directly managed by the federal government, MA plans are offered by private insurers that contract with CMS to provide all Part A and Part B services.

Medicare Advantage was initiated in the Balanced Budget Act of 1997, MA's development, detailed by Mcguire et al. (2011), reflects a significant ideological and practical shift towards incorporating market mechanisms within Medicare. The introduction of Medicare Advantage was driven by a confluence of factors aiming to infuse the Medicare program with the efficiencies of market competition and the diversity of plan options.

The rationale behind MA's introduction centered on the belief that market competition could drive down costs, increase efficiency, and offer beneficiaries a wider array of health plan choices, each tailored to meet their unique healthcare needs. This strategy aimed to har-

ness the organizational efficiencies of Health Maintenance Organizations (HMOs) and other provider networks to streamline healthcare delivery and outcomes. It represents a notable policy transition towards incorporating private sector dynamics into Medicare, intending to secure better healthcare results for beneficiaries at lower costs.

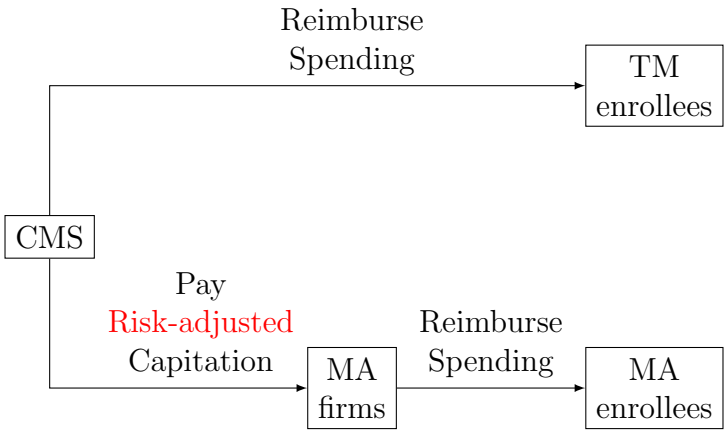


Figure 1: Medicare Market Structure

Note: CMS is the government agency, and MA firms are the private insurance companies. TM refers to Traditional Medicare (Original Medicare), and MA stands for Medicare Advantage.

As illustrated in Figure 1, the Medicare market structure delineates the choice for enrollees between Traditional Medicare (TM) and Medicare Advantage (MA), which are mutually exclusive options. MA firms generate revenue through a mix of capitation payments from the government (CMS) and premiums charged to enrollees. [1]

The relationship between TM enrollees and CMS is direct; CMS reimburses the cost of medical bills under the fee-for-service model for the basic Medicare coverage. In contrast, MA enrollees engage directly with private MA firms, where the firms are responsible for covering medical bills based on cost-sharing mechanisms. These cost-sharing requirements are mandated not to exceed the basic Medicare coverage standards, effectively shifting the Medicare benefits provider role from CMS to MA firms for enrollees opting for MA plans. Consequently, CMS compensates MA firms with capitation payments, transferring the requisite funds to support the enrollees' Medicare benefits under the MA scheme.

Notably, the capitation payments to MA firms are risk-adjusted to account for the varying health status of enrollees, underscoring the financial model that underpins MA plans.

[1] Compare to capitation payments, the revenue from premiums is much smaller. The main source of revenue for MA firms is the capitation payments from CMS.

2.3 Risk Adjustment

The introduction of risk adjustment mechanisms in Medicare Advantage (MA) plans aims to address a critical challenge: the mitigation of favorable selection, or "cream skimming." This issue arises as MA plans, under a uniform capitation payments for all enrollees, might pursue strategies to enroll predominantly healthier individuals. Such individuals represent lower healthcare costs, potentially enabling plans to maximize profits. This behavior not only undermines the equity and sustainability of the Medicare system but also contravenes the principle of social insurance by restricting access for high-cost patients and potentially leading to disproportionately high payments to MA plans relative to the actual cost of care provided.

Risk adjustment seeks to mitigate these incentives by adjusting capitations based on the health status of individual enrollees, [2] aiming to dissuade plans from engaging in cream skimming. Despite these efforts, challenges persist in fully neutralizing the financial incentives for selecting healthier individuals. The following discussion will explore the effectiveness of risk adjustment and the complexities involved in achieving its intended goals.

Risk adjustment utilizes the Hierarchical Condition Category (HCC) model to assign risk scores based on beneficiaries' health conditions. This process enables the adjustment of payments to Medicare Advantage (MA) plans, ensuring they reflect the health status of enrollees.

2.3.1 HCC Model Overview

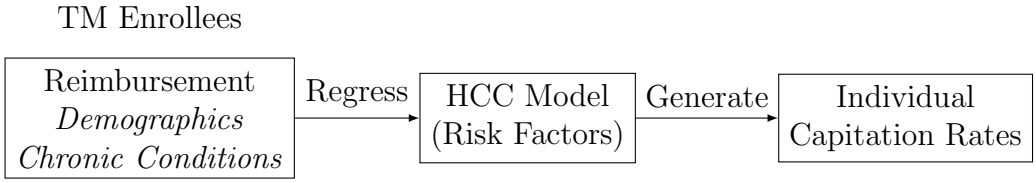


Figure 2: Process of HCC Coding

Figure 2 provides a simplified overview of the HCC risk adjustment system. Initially, the CMS gathers data on Fee-for-Service reimbursement records for Traditional Medicare enrollees, alongside information on their chronic conditions and demographics. Subsequently,

[2] Unlike many risk adjustment mechanisms that are typically applied at the group level, risk adjustment in Medicare Advantage is fundamentally an individual-based process. Given the wide variety of observable health condition combinations among individuals, this adjustment is highly personalized. It takes into account the unique health profile of each enrollee, rather than applying a one-size-fits-all approach at the pool level. This individualized approach to risk adjustment in MA is a deliberate effort to enhance the precision of fiscal allocations.

CMS constructs the HCC model by regressing FFS reimbursements against these chronic conditions and demographic factors. Finally, the model generates individual capitation rates for MA enrollees based on their health conditions and demographics.

While the actual HCC model encompasses more complexity than this simplified description, it essentially serves to estimate the expected reimbursement for each individual based on their observable health status. Detailed components and workings of the HCC model are elaborated in the Appendix.

2.3.2 Limitations of HCC

While the HCC model plays a crucial role in risk adjustment within Medicare Advantage plans, its predictive capabilities are subject to certain limitations. A notable constraint is the model's modest R-squared value. As recorded by CMS (2021), the Version 22 CMS-HCC model employed during the dataset period of 2016-2018 reports an R-squared of 0.1189. This statistic suggests that the HCC model explains merely 11.89% of the variance in individual reimbursement amounts, indicating a significant gap in its ability to forecast individual healthcare costs accurately.

The crux of the challenge lies in the inherent difficulty of precise individual-level cost prediction. The HCC model, by design, estimates the average cost for groups of individuals with similar health conditions, as categorized into 86 HCCs (varying by model version). However, this simplification may not adequately capture the complex health status spectrum of Medicare beneficiaries. The diversity in actual healthcare costs among individuals with ostensibly similar conditions underscores the model's limitations in granularity.

Furthermore, the rationale behind the limited number of HCC categories is rooted in practicality. An overly complex model featuring thousands of HCCs would be cumbersome to implement and manage, thus detracting from its utility. It's important to recognize that the HCC model's effectiveness is evaluated on a group level rather than at the individual level. While it provides a reasonable estimation of average care costs for people within the same health category, its precision diminishes significantly when applied to predict costs for individuals.

The key insight here is that within groups having the same observable health conditions (the same HCCs), there can be significant discrepancies in their actual health status, yet CMS allocates the similar capitation to these individuals. This aspect is crucial for understanding how MA firms might engage in selection practices.

Ideally, a flawless risk adjustment mechanism would eliminate the incentives for favorable selection. However, the reality may diverge from this ideal.

2.4 Cream Skimming and Overpayment

Cream skimming within Medicare Advantage (MA) refers to the strategic enrollment of healthier individuals by MA plans, a practice that can lead to overpayment when capitation payments exceed the actual cost of care provided. This section explores the evidence of cream skimming, previous explanations for its occurrence, and how MA plans navigate the highly regulated environment to possibly engage in favorable selection.

Xu et al. (2023) highlighted the significantly higher profit margins in Medicare Advantage (MA) compared to other insurance markets, despite similar contract pricing with healthcare providers as evidenced by Trish et al. (2017) between MA and Traditional Medicare (TM).

One potential driver of these higher margins is the practice of upcoding, where MA plans might encourage providers to report more severe diagnoses, inflating risk scores and subsequently, capitation payments. While Geruso and Layton (2020) noted that upcoding leads to excess public spending, it alone does not fully account for the observed overpayments, given the absence of systematic evidence that MA enrollees' risk scores are disproportionately higher than those in TM.

Jacobson et al. (2019), among others, highlights a pivotal aspect of Medicare Advantage (MA) plans: enrollees in MA tend to be healthier compared to their counterparts in Traditional Medicare (TM), despite having *similar* risk scores. This discrepancy leads to a situation where MA plans receive overpayments, as the actual healthcare expenditures for these healthier individuals fall below the predicted costs.

Supporting evidence from Brown et al. (2014) and Lieberman and Ginsburg (2023) not only underscores the presence of significant overpayments attributed to this favorable selection but also clarifies that such selection refers to enrolling individuals who are healthier than their capitation predicted. Given that capitation is designed to reflect the average cost for individuals with similar observable health conditions, it inherently includes variability where some individuals' costs will exceed the average while others will fall below it. The insight from these studies suggests that, given a capitation rate, MA plans tend to select individuals whose expected costs are on the lower side of this average, thereby engaging in favorable selection.

Yet, a critical question arises: How do MA plans engage in favorable selection amidst stringent regulatory environments?

MA Market Regulations MA plans operate under tight regulations designed to ensure equitable access and treatment. These include mandates to offer identical premiums to all enrollees, prohibit discrimination based on health status, and enforce open enrollment periods during which any eligible individual can join an MA plan without the risk of being

denied due to health conditions.

Despite these regulatory constraints, MA plans may manage to selectively enroll profitable individuals though some means. Aizawa and Kim (2018) points to advertising as a strategic and scalable tool that MA plans employ to attract demographics (e.g., race[3]) associated with lower-than-average healthcare costs for individuals with comparable chronic conditions (similar risk socre). This approach, while effective in achieving favorable selection, also skirts the edge of legal risk since it targets specific demographics.

This direct approach to favorable selection, aiming to enroll individuals whose healthcare costs are anticipated to be lower than the assigned capitations, encounters significant practical challenges. The regulatory environment, coupled with the inherent unpredictability of individual health outcomes, renders such targeted selection difficult to implement on a practical level.

In conclusion, while evidence indicating that MA plans engage in favorable selection, the feasibility of implementing such selection at the individual level—especially under the stringent MA regulations and considering the unpredictable nature of health outcomes—appears to be constrained. A significant observation in this context is that a majority of MA enrollees incur actual healthcare costs that are lower than their assigned capitations. This pattern could be interpreted more as a consequence of the favorable selection mechanism rather than evidence of MA plans directly targeting individuals whose actual costs are anticipated to be below their capitation rates.

Such an interpretation suggests a shift in perspective, proposing that the prevalent lower-than-expected healthcare expenditures among MA enrollees might stem from broader, systemic strategies employed by MA plans rather than explicit individual-level selection. This nuanced understanding, viewing favorable selection as an emergent property of strategic plan design and operational tactics, will be delved into in the subsequent sections.

2.5 Revising Favorable Selection in MA

Diverging from the conventional understanding by(Brown et al., 2014; Aizawa and Kim, 2018; Lieberman and Ginsburg, 2023; MedPAC, 2023), this study seeks to enrich the discourse on favorable selection within Medicare Advantage (MA) plans. Traditional perspectives widely suggest or imply that the phenomenon of favorable selection observed in MA could be attributed to plans directly selecting individuals whose actual healthcare expenditures are lower than those predicted by risk adjustment models. However, considering the regulatory and practical challenges inherent to such direct individual-level selection, this approach seems

[3]Race is not included as a factor in the HCC model.

implausible.

This research introduces a fresh perspective on the implementation of favorable selection within MA plans: the widespread occurrence of MA enrollees incurring lower healthcare costs than predicted is not evidence of direct selection by MA plans. Instead, it may represent the outcome of a different form of favorable selection. This alternative strategy relies on attracting individuals with positive health perceptions—those who perceive themselves to be healthier. This selection criterion is both practical and implementable, especially if we consider that an individual's health perception linearly influences their preference for plan generosity.

Such a strategy would naturally result in the same observed pattern: a majority of MA plan enrollees having lower actual healthcare costs than those projected by risk adjustment models. The underlying reason for this pattern may stem from the imperfections of the current risk adjustment model. We can show the intuition of this by the following simplified demonstration.

2.6 Toy Model

This subsection introduces a simplified model to illustrate key aspects discussed in this paper, highlights how imperfect predictors of individual spending lead to compensation disparities at the group level, creating incentives for firms to strategically target low spenders. When personal spending cannot be perfectly predicted by observable indicators, conventional risk adjustment mechanisms may not align compensation with actual expenses. This encourages firms to attract low spenders, who, if aware of their spending type, influence plan features. Firms can then design products strategically to appeal selectively to these consumers.

Consider the following scenario: two age groups, 65-year-olds and 85-year-olds, of equal size. The population of 65-year-olds consists of 80% low spenders and 20% high spenders, whereas for 85-year-olds, the distribution is reversed with 20% low spenders and 80% high spenders. Let s^L represent the spending of low spenders and s^H that of high spenders, where $s^L < s^H$.

The government, observing only the age, compensates insurers based on the expected spending for each age group:

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

Although age-based capitation payments match the expected expenditures for each age

group, a re-evaluation based on spending type reveals disparities:

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

Insurers aiming to maximize profit seek to attract low spenders and deter high spenders. Although direct selection of consumers is prohibited, insurers can strategically design their plans, including elements such as cost-sharing generosity and premiums, to promote self-selection. This strategy operates in the context of a given outside option with fixed premium p_0 and generosity g_0, and consumers privately know their spending type, allowing them to choose the plan that maximizes their utility.

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

where $\beta^H > \beta^L > 0$ and $\alpha < 0$. This setup suggests that high spenders value plan generosity more than low spenders.

To ensure self-selection, insurers must offer plans that fulfill the following inequalities relative to the outside option (p_0, g_0):

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

ensuring that low spenders prefer the inside option, and high spenders prefer the outside option. This results in conditions $p < p_0$ and $g < g_0$, as shown in the Figure 3. This strategic design attracts low spenders while deterring high spenders, who opt for the outside option. Consequently, the plan predominantly enrolls low spenders, leading to an average overpayment of $c^L - s^L$, thereby improving insurer profitability.

2.6.1 Profitability Variation among Individuals

Figure 14 illustrates the concept of assured overpayment within the frameworks of both absent and imperfect risk adjustment mechanisms. Assured overpayment describes scenarios where individuals' actual healthcare costs consistently fall below their allocated capitation, independent of the specific capitation assigned. Imperfect risk adjustment is characterized by capitation adjustments based on observed health conditions that, nevertheless, fall short in precisely predicting individual healthcare costs.

1. **No Risk Adjustment**: In this scenario, all enrollees are allocated the same capitation, denoted as $\bar{C}$. Actual healthcare spending exhibits a distribution around $\bar{C}$, leading

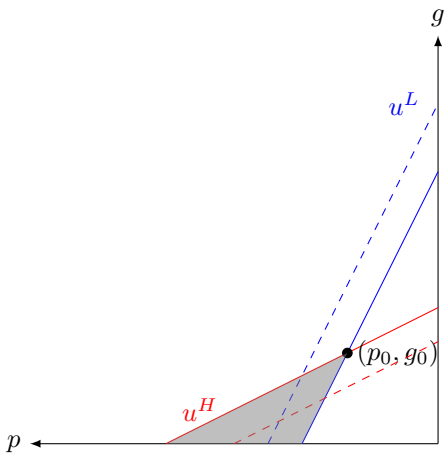
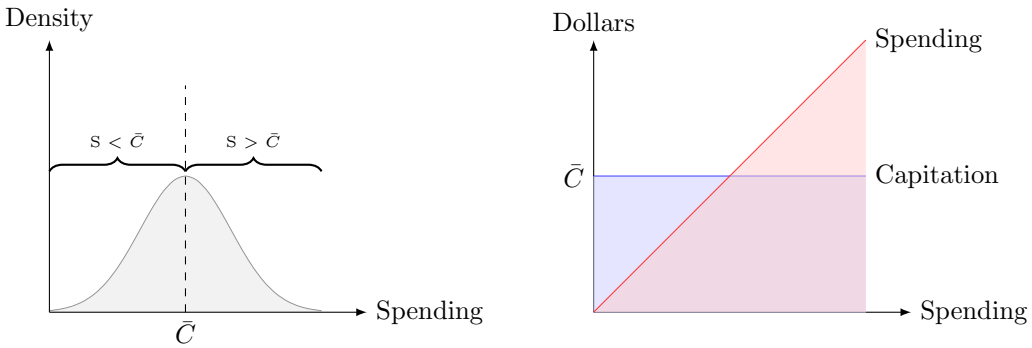


Figure 3: Indifference Curves with Reversed p axis

Note: The figure illustrates the indifference curves for high spenders (red) and low spenders (blue) in the space of premiums p and generosity g. The intersection point represents the outside option (p_0, g_0), with the shaded area indicating the region where low spenders prefer the inside option, while high spenders opt for the outside option.



(1) Distribution (2) Curves

Figure 4: No Risk Adjustment

Note: Graph (1) displays the distribution of medical spending across individuals without risk adjustment. Graph (2) shows the corresponding curves for capitation (blue line) and spending (red line) as a function of cost. In a scenario without risk adjustment, approximately half of the population incurs spending lower than the capitation amount (overpaid), while the other half incurs higher costs (underpaid). This leads to profitability variation among individuals. If the capitation curve and marginal cost curve are parallel, the profitability variation disappears.

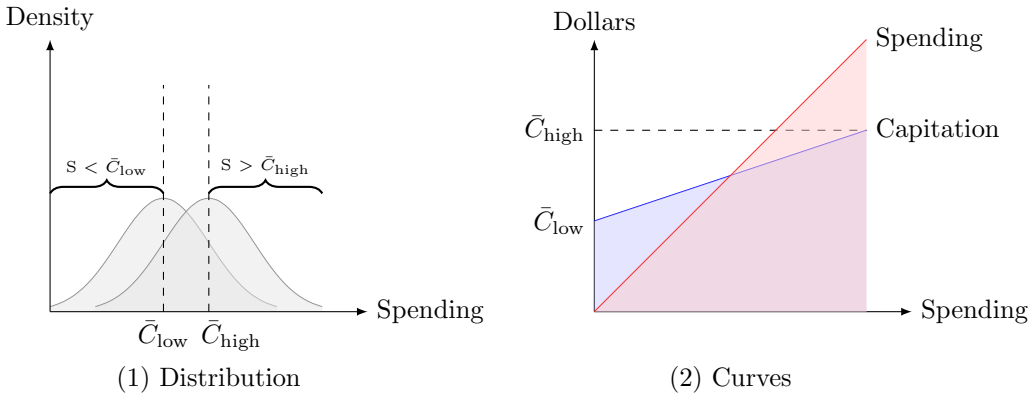


Figure 5: Conventional Risk Adjustment (Current)

Note: Graph (1) and (2) illustrate the case of an imperfect risk adjustment where individuals are assigned two different capitation rates based on their observed health conditions. Although the capitation curve becomes more tailored to spending, the pattern of the difference between spending and capitation remains similar as in the case of no risk adjustment in Figure 4. This pattern will also presist in the case of risk adjustment with more than two capitation rates (where $\bar{C}_{low}$ becomes the lowest capitation and $\bar{C}_{high}$ becomes the highest capitation). Therefore, profitability variation persists under imperfect risk adjustment.

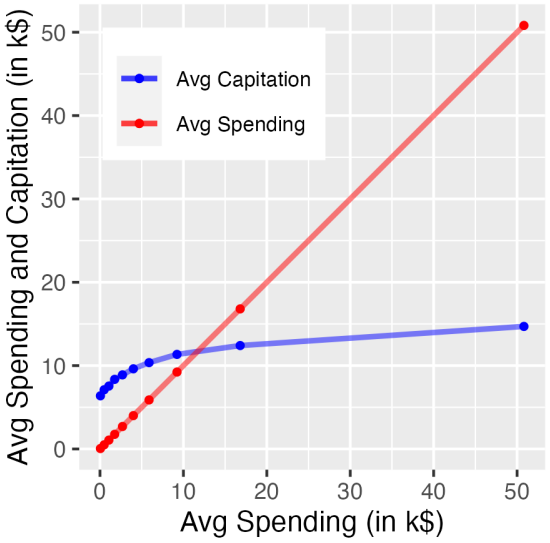


Figure 6: Avg Spending vs. Avg Capitation by Spending Deciles (from Data)

Note: This graph displays the average spending and capitation rates for each decile of spending, illustrating how capitation adjusts across different spending levels that derived from MCBS individual data (including TM and MA enrollees). This comfirms profit variation among individuals under the current risk adjustment suggested by Figure 5 (2).

to overpayment for individuals to the left of the distribution and underpayment for those to the right. This scenario uncovers the intrinsic selection incentive that risk adjustment seeks to mitigate.

2. **Imperfect Risk Adjustment**: In this scenario, capitations, $\bar{C}_{\text{low}}$ and $\bar{C}_{\text{high}}$, vary based on observed health conditions. Despite the variation, actual spending within each capitation group still centers around $\bar{C}_{\text{low}}$ and $\bar{C}_{\text{high}}$. Regardless of the capitation amount, individuals with actual spending lower than $\bar{C}_{\text{low}}$ are assuredly overpaid, and those with spending above $\bar{C}_{\text{high}}$ are assuredly underpaid,illustrating that assuredly overpaid enrollees remain prevalent under imperfect risk adjustment.

A critical insight from this analysis, viewed from an *ex post* perspective, is the enduring presence of assuredly overpaid enrollees regardless of any possible capitation rates. While imperfect risk adjustment aims to align capitations more closely with individual observable health conditions, it does not eliminate the selection incentives intrinsic to Medicare Advantage (MA) plans. Individuals significantly to the left of the spending distribution invariably receive overpayments, underscoring a persistent selection bias. Conversely, those significantly to the right face assured underpayments.

This *ex post* analysis underscores the limitations of imperfect risk adjustment models in fully mitigating selection biases within MA plans. However, the subsequent discussion will transition back to an *ex ante* perspective, exploring how prospective plan design adjustments and enrollee behaviors might influence, and potentially mitigate, these biases before they materialize.

Despite the complexities of reality, the underlying intuition of assured overpayment remains valid. In reality, the risk adjustment mechanism introduces more than just two levels of capitation rates, yet significant issues persist.

Firstly, a substantial variance in actual healthcare costs within the same risk score is observed, indicating a distribution of costs rather than uniform expenses across individuals (Brown et al., 2014). This variance suggests that the risk adjustment model, while sophisticated, cannot account for the full range of individual healthcare spending.

Secondly, the lowest possible capitation rate is significantly above zero, approximately around \$4,000—a figure set for individuals without any HCCs, according to CMS (2021). Given that a considerable portion of individuals incur healthcare costs below this threshold, there remains substantial room for MA plans to benefit from assured overpayment.

These facts underscore a persistent incentive for MA plans to engage in selection strategies, specifically aiming to attract individuals with lower actual healthcare costs and deter

those with higher costs. The analysis of this selection incentive, from an *ex post* perspective,acknowledges the outcomes of these strategies rather than merely their anticipation.

However, it is crucial to revisit this issue from an *ex ante* perspective as well. Before the actual healthcare costs materialize, MA plans face the challenge of not being able to precisely predict individual actual spending and would base their strategies on expected outcomes. The next section shifts back to an *ex ante* analysis, further exploring how MA plans might implement these strategies in anticipation.

2.6.2 Health Perception

Turning our focus back to an *ex ante* perspective, it's important to consider how beneficiaries' plan decisions are influenced by their perceptions of health prior to any engagement with healthcare services. Health perception, defined as an individual's subjective assessment of their health status, does not necessitate professional medical knowledge. Instead, it provides a personal insight into one's health that can significantly vary even among individuals categorized within the same observable health conditions (HCCs). Therefore, those with a positive health perception could often end up incurring very low healthcare spending across the entire Medicare population. As previously analyzed in Section 2.6.1, these individuals are more likely to be categorically overpaid *ex post*.

In practice, consumers are typically unaware of their specific capitation rates, a detail reserved for transactions between CMS and MA plans. Consequently, plan choices are predominantly influenced by individuals' own health perception rather than by capitation rates or risk scores.

When a substantial proportion of beneficiaries who hold positive health perceptions consistently experience overpayment, it establishes a trend of overpayment at the group level—where the average capitation exceeds the group's average expected healthcare expenditure. This suggests that the existing risk adjustment mechanisms might unintentionally promote overpayments among those beneficiaries with good feeling of their health status. Recognizing this, MA plans can adopt strategic approaches to target such groups on a macro level, capitalizing on the collective health perceptions to enhance their profitability. This strategy allows MA plans not just to navigate but also to exploit the nuances of risk adjustment to their advantage.

2.6.3 Group Level Selection

MA plans operate on a principle that transcends individual capitation rates, focusing instead on attracting groups characterized by positive health perceptions while dissuading those with

negative ones. This approach reflects a broader, more practical form of selection that aligns with how insurance firms inherently think—on a group level and from an *ex ante* perspective rather than individual level.

At the heart of this strategy lies the acknowledgment of inherent uncertainties at the individual level: a positive health perception does not invariably translate into low healthcare costs. In certain instances, individuals with a positive health outlook may incur unexpectedly high healthcare expenses. However, when considering the broader picture at the group level, these uncertainties tend to diminish. Collectively, a group with a predominantly positive health perception is likely to incur lower healthcare costs compared to a group with a negative health outlook. This predictability of group-level average profits underpins the MA firms' strategy, focusing on anticipated averages rather than individual discrepancies.

This strategic approach is corroborated by observations within MA plans mentioned earlier, where the bulk of beneficiaries exhibit healthcare expenditures significantly below the average for the broader Medicare population and below their respective capitations. This pattern predominantly arises because the majority of MA enrollees possess a positive health perception. Nonetheless, a minor segment within MA plans might have expenditures that exceed their capitation rates, underscoring that individual health perceptions are not infallible predictors of actual healthcare costs on a singular level. Despite these anomalies, the overarching trend in MA underscores that the average actual spending remains below the average capitation, enabling MA firms to secure substantial profit margins.

The feasibility of this group-level selection strategy hinges on specific conditions. These conditions, essential for the strategic alignment of MA plans with beneficiaries' health perceptions, will be elucidated in the subsequent section.

2.7 Plan Design Responsing to Self-Selection and Risk Adjustment

This section explores the strategic potential for Medicare Advantage (MA) plans to design offerings that systematically attract beneficiaries based on their health perceptions, independent of individual capitation rates. The successful implementation of this strategy hinges on meeting several critical conditions:

Influence of Health Perception on Plan Preferences The preferences of beneficiaries for certain plan attributes, particularly regarding the generosity of cost-sharing arrangements, are significantly influenced by their health perceptions. Here, "generosity" signifies the degree to which a plan mitigates out-of-pocket expenses for enrollees, a crucial factor for

individuals with bad health perceptions who anticipate high healthcare utilization, but less so for those with positive health perceptions.

Plan Design Flexibility MA plans enjoy considerable latitude in shaping their offerings, especially in terms of generosity. This flexibility enables them to tailor plans that resonate with individuals harboring positive health perceptions.

Availability of an Outside Option The effectiveness of MA plans' selective appeal is contingent upon the availability of alternative options for those who find a particular MA plan's design unattractive. This condition ensures that individuals seeking more comprehensive coverage due to negative health perceptions have viable alternatives, thereby reinforcing the strategy's effectiveness.

With these conditions as a backdrop, we anticipate the following outcomes from this selective strategy:

1. MA plans will be deliberately designed to attract beneficiaries with positive health perceptions and deter those with negative ones.

2. Consequently, individuals with positive health perceptions will gravitate towards MA plans, while those with negative perceptions will seek alternatives.

3. This alignment results in MA plans experiencing lower average actual healthcare expenditures than their average capitation rates, thereby augmenting MA firms' profit margins.

This strategy underscores the critical role of plan design in influencing MA enrollment patterns and underscores the economic dynamics of health insurance. In Section 2.8, we will delve into empirical evidence supporting the efficacy of this mechanism. This evidence includes factual verification of plan design flexibility and availability of an outside option, alongside data-driven analysis for the influence of health perception on plan preferences and the verification of expected outcomes, thereby demonstrating the practical implementation of revised favorable selection strategies within MA plans.

2.8 Empirical Evidence

This section delves into the empirical analysis of the strategy discussed earlier, centering on how health perceptions shape plan selection and influence the dynamics within Medicare Advantage (MA) plans. We investigate the foundational conditions for our selection mechanism through industry details and evaluate if the anticipated outcomes correspond with

observed data patterns. This analysis sets the stage for subsequent modeling and estimation efforts.

2.9 Market Conditions

This subsection examines the market framework within which MA plans operate, highlighting the flexibility in plan design and the significance of Medigap as an alternative for beneficiaries. These aspects form the strategic backdrop for the implementation of MA plans' selection strategies.

2.9.1 Plan Design Flexibility

MA plans operate under a distinctive framework that allows for considerable flexibility in annual plan offerings. As illustrated by the annual timeline for Medicare beneficiaries in Figure 7, MA firms have the opportunity each early summer to submit their forthcoming year's plan offerings to the CMS. These plans become available for beneficiaries to enroll in during the fall open enrollment period, effective for coverage in the subsequent year.

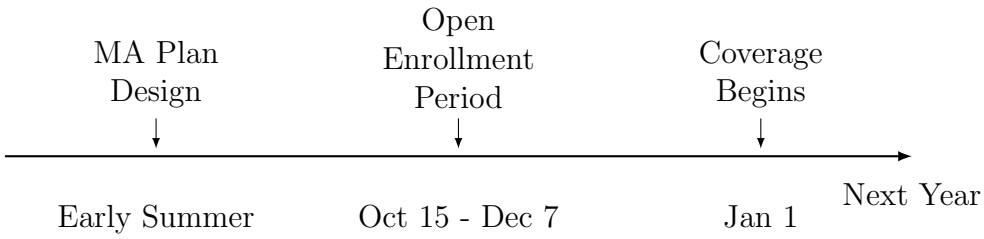


Figure 7: Annual Timeline

Central to the plan design process is the liberty MA firms have in selecting various plan attributes, with cost-sharing being notably influential. Cost-sharing not only determines a plan's overall generosity but also how expenses are split between the insurer and the beneficiaries. Unlike Traditional Medicare (TM), which offers partial coverage with beneficiaries responsible for a portion of their medical expenses (referred to as TM basic coverage), MA plans are required to at least match the essential services provided by TM. Regulations ensure that MA plans' cost-sharing does not exceed those set by TM basic coverage, hereby establishing a minimum baseline of coverage. However, beyond this baseline, MA firms can customize out-of-pocket (OOP) cost-sharing structures for additional coverage, providing a degree of autonomy in plan generosity.

Furthermore, the regulatory environment mandates uniform premium policies across all beneficiaries, alongside open enrollment periods that prohibit denying coverage based on health status or pre-existing conditions. For a comprehensive overview, see the appendix.

Despite constraints, MA firms maintain a level of flexibility in plan design, especially concerning plan generosity. This flexibility plays a pivotal role in how plans are tailored to attract specific beneficiary groups, a phenomenon we will explore in depth, demonstrating that MA plans often opt for lower generosity levels compared to the available outside option.

2.9.2 Medigap as Outside Option

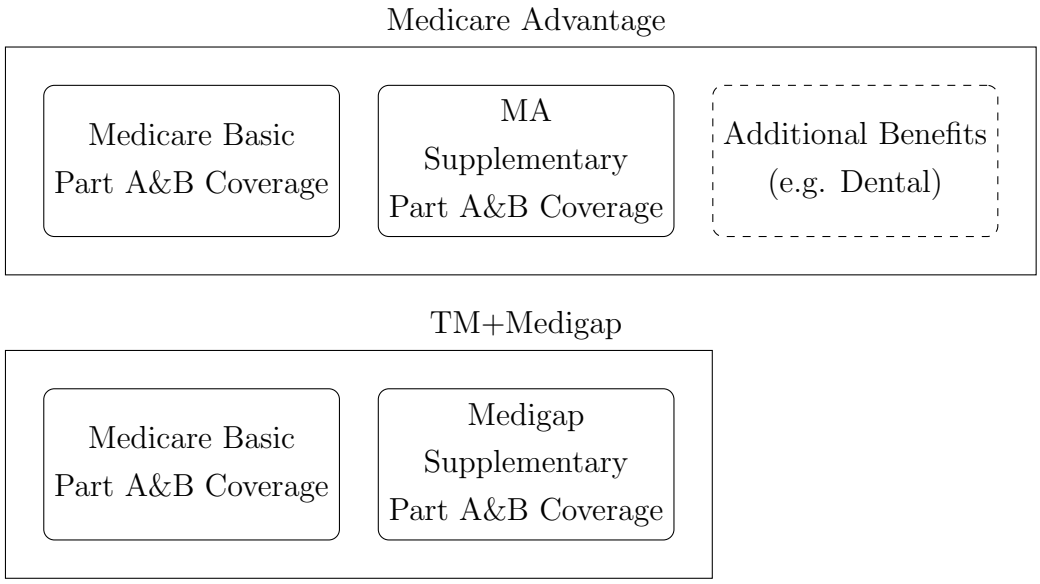


Figure 8: Benefits Structure of Medicare Options

The alternative to Medicare Advantage (MA) plans is remaining enrolled in Traditional Medicare (TM). As discussed earlier, TM's basic coverage inherently involves out-of-pocket (OOP) expenses, necessitating additional coverage for many beneficiaries. To mitigate these costs, over 90% of individuals in TM opt for supplemental insurance.

Among the supplemental insurance options, Medigap stands out as the most prevalent choice due to its universal availability. Medigap policies, standardized by the government and offered by private insurers, are designed specifically to cover the OOP costs associated with TM. Unlike MA plans, which are capitated by govenrment, Medigap policies employ age-based pricing, rendering them relatively costly.

For a detailed exploration of Medigap's structure and its role as a supplemental option, refer to the appendix.

Medigap's market presence is consistent across all regions and remains stable over the years, positioning it as a static alternative to MA plans. This stability establishes Medigap, combined with TM, as the benchmark against which MA plans are compared. As such, it serves as a crucial consideration for MA firms when designing their offerings, aware that

beneficiaries have the option to opt for the TM and Medigap combination should it better suit their needs.

Given its standardized coverage and lack of yearly changes, Medigap represents a known quantity to both beneficiaries and MA firms. This knowledge allows MA firms to tailor their plans with an understanding of the competitive landscape, including how their offerings stack up against the consistent alternatives provided by TM and Medigap.

2.9.3 Comparison of Medicare Options

Following our analysis of the market conditions conducive to the strategic behavior of MA plans, we now examine the key differences between MA and Medigap plans. This comparison is necessary for understanding the subsequent consumer behavior patterns within these frameworks.

A concise summary of the fundamental distinctions between MA and Medigap plans is presented in Table 1. For those interested in a more detailed evaluation, including specific examples from Suffolk County's popular plans, please consult the appendix, which offers an in-depth comparison.

Plan Type	**Premium**	**Generosity**	**Network Restriction**	**Additional Benefits**
TM+Medigap	High	Good	No	No
MA	Low	Bad	Yes	Yes

Table 1: General Comparison of Madicare Options

The primary distinction drawn from this comparison is that MA plans typically come with lower premiums but offer less generous coverage than Medigap plans, which, though more costly, provide more comprehensive coverage. For instance, a significant proportion of popular MA plans feature a $0 monthly premium, and even among those that do charge, premiums rarely exceed $50. In contrast, premiums for favored Medigap plans typically surpass $300 and often incorporate age-based pricing, leading to higher costs as beneficiaries age.

Moreover, while MA enrollees must navigate provider networks, these plans often include non-medical benefits like dental, vision, and hearing care, albeit at a basic level, and some plans also cover prescription drugs.

Conversely, Medigap enrollees, operating under the Traditional Medicare (TM) system, face no network restrictions but lack these additional benefits. This discrepancy in offerings can be traced back to each plan's design and funding mechanism: MA plans, which receive

capitated payments from the government and enjoy greater flexibility in plan design, versus Medigap plans, government-designed for higher generosity without capitation, necessitating higher premiums to cover costs.

These observed differences suggest that MA plans are typically more attractive to individuals with positive health perceptions, who expect lower healthcare needs and thus prioritize lower premiums over generous coverage. On the other hand, Medigap plans, with their higher premiums and more generous coverage, cater to those with more cautious health perceptions or those expecting greater healthcare expenses.

The consistent presence of Medigap as an alternative option provides a steady reference point for MA firms in their plan design efforts. As we delve into consumer behavior evidence, we will further investigate how private health perceptions distinctly influence the choice between these two Medicare options.

2.10 Consumer Behavior Evidence

This section leverages data from the Medicare Current Beneficiary Survey (MCBS) to delve into consumer behavior within the Medicare market, offering preliminary evidence to underpin our model.

2.10.1 MCBS Interview

The MCBS interviews, conducted in early fall as depicted in Figure 9, precede the annual Medicare open enrollment period. This sequencing furnishes an invaluable lens through which to view the impact of beneficiaries' prior health perceptions on their forthcoming plan selections.

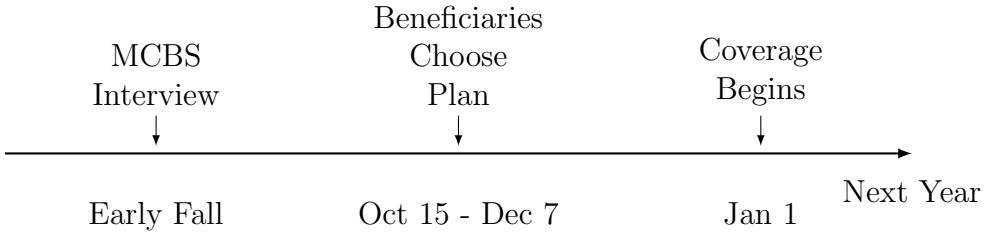


Figure 9: Interview and Plan Choice Timeline

During the interviews, articipants are asked to evaluate their health relative to others of the same age, allowing us to gauge their health perceptions. We classify these responses into two distinct groups: those who feel healthy and those who feel unhealthy. Although this binary classification might not capture the full nuance of participants' health statuses,

it serves as a basis for preliminary analyses rather than for detailed model estimation. Additionally, MCBS includes subsequent year data on plan choices and healthcare spending from administrative records, which is accorded high credibility. For more detailed information about the MCBS interview process, please refer to the appendix.

2.10.2 Health Perception on Plan Choice

The temporal sequence (Figure 9) of health perception assessment and plan choice offers a unique opportunity to study how beneficiaries' perceptions impact their decisions in the Medicare market. Given that health perceptions are evaluated prior to the open enrollment period, it's reasonable to infer a causal relationship between health perception and plan choice.

The analysis employs logistic regression, with MA enrollment of the next year as the dependent variable and health perception among other factors as independent variables. The regression results, summarized in Table 2, indicate a significant relationship between health perception and the likelihood of enrolling in MA plans.

Table 2: Logistic Regression Result

	Next-Year MA Enrollment	
Variable	**Estimate**	**Std. Error**
Feel Unhealthy	-0.601^{***}	(0.167)
Income	-0.373^{***}	(0.031)
White	-0.401^{***}	(0.069)
Female	-0.033	(0.046)
Age	-0.012^{***}	(0.003)
High Education	-0.367^{***}	(0.049)
Constant	4.675^{***}	(0.428)
Observations	9,751	

Note: $^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$. The dependent variable is a binary variable indicating whether the consumer will enroll in MA next year. "Feel Unhealthy" is a binary variable indicating whether the consumer feels unhealthy, which is self-reported.

Specifically, the negative and significant coefficient for "Feel Unhealthy" indicates that individuals with a positive perception of their health (coded as 0 for "Feel Unhealthy") are more likely to opt for MA plans, even after controlling for other demographic and socioeconomic factors. This finding underscores the influence of health perception on plan choice, aligning with our hypothesis that beneficiaries with better health perceptions are

more inclined towards selecting MA plans, which are typically less generous but offer lower premiums, likely due to their perceived lower need for extensive healthcare services.

2.10.3 Health Perception and Future Spending

This segment delves into the influence of health perception on future healthcare spending, emphasizing the role of beneficiaries' private health perception in forecasting healthcare expenses for the subsequent year. The analysis is stratified by both health perception (positive or negative) and plan choice (Medicare Advantage (MA) or Traditional Medicare (TM)), resulting in four distinct groups for comparison.

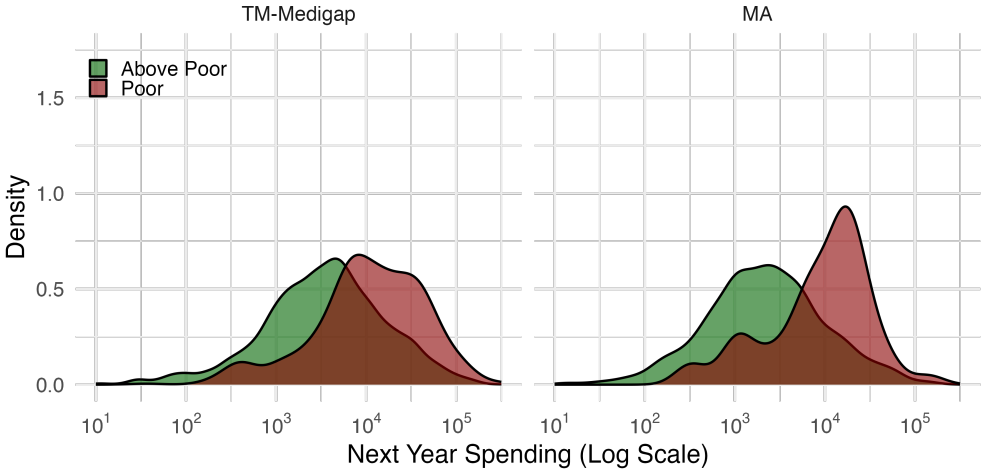


Figure 10: Next Year Spending Distribution by Health Perception and Plan Choice

Figure 10 presents the distribution of the following year's healthcare spending across these groups. Notably, individuals with positive health perceptions consistently incur lower healthcare expenses, irrespective of their enrollment in MA or TM plans. This pattern underscores the predictive value of health perceptions on future healthcare spending.

These findings suggest that positive health perceptions are associated with lower future healthcare spending, a trend holds ture for both MA and TM beneficiaries. The implication is clear: beneficiaries' private information is useful, their subjective health assessments effectively predict their future healthcare needs on the aggregate level.

2.10.4 Selection Effect in MA

Building on the insights from previous sections, this segment seeks to discern the extent to which the selection effect contributes to the observed lower average spending in Medicare Advantage (MA) plans. Based on the established premises that individuals with positive

health perceptions are more inclined towards MA plans and consistently demonstrate lower healthcare expenditures across both MA and Traditional Medicare (TM), we infer a significant selection effect at play.

1. Previous analyses have elucidated the role of health perceptions in guiding plan choices and influencing future healthcare expenditures. Specifically, beneficiaries with positive health perceptions not only prefer MA plans but also, on average, incur lower healthcare costs.

2. Consequently, the aggregated lower spending observed in MA plans can, at least partially, be attributed to this selection effect.

While acknowledging the limitations of this analysis, the preliminary evidence presented herein suffices to underscore the selection effect as a plausible explanation for the lower average spending observed in MA plans. This preliminary evidence lays a solid foundation for further empirical modeling and estimation.

2.11 Vaildaing the Anticipate Outcomes

The preceding empirical evidence segment has systematically validated the outcomes anticipated by our selection strategy theory. These validations can be summarized as follows:

1. MA plans have been empirically shown to be designed with attributes that are attractive to beneficiaries with positive health perceptions,thereby deterring those with negative health perceptions, as discussed in Subsection 2.9.3.

2. This design strategy effectively influences plan choices, leading individuals with positive health perceptions to preferentially enroll in MA plans, a pattern confirmed in Subsection 2.10.2.

3. Moreover, these individuals, by virtue of their health perceptions, incur lower average healthcare expenditures, substantiating the selection effect and contributing to the profitability of MA firms. This finding is detailed in Subsection 2.10.3.

In conclusion, the congruence between theoretical predictions and observed empirical patterns provides a foundation for the subsequent model construction.

3 Data

3.1 Data Source and Description

This study leverages data from two principal sources to investigate the mechanisms at play within the Medicare Advantage (MA) program. The first dataset, the Medicare Current Beneficiary Survey (MCBS), furnishes comprehensive individual-level information, encompassing demographics, health-related attributes, and beneficiaries' choices regarding their insurance plans. These choices include the decision between Traditional Medicare (TM) and Medicare Advantage (MA), and, in cases where MA is selected, the specific MA plan chosen by the beneficiary. [4]

The second dataset originates from the Centers for Medicare & Medicaid Services (CMS) public datasets, offering rich plan-level information. These include detailed plan attributes, premiums, and market shares. For further details on the datasets employed in this analysis, including specific variables and the methodology for data cleaning, refer to Appendix C

3.2 Data Cleaning

In this study, we implemented several steps to refine the dataset for a more precise examination of the MA market. First, we identified and removed individuals and plans that do not meet the criteria for being considered standard. For individuals, the standard beneficiaries are those enrolled based on age, living in the community, possibly having dual eligibility for Medicaid. These criteria encompass the most common type of Medicare beneficiaries. Consequently, individuals enrolled due to disability, End-Stage Renal Disease (ESRD), or other special conditions were excluded due to their potentially different plan choice sets.

Regarding MA plans, the standardization criteria excluded employee-group, cost, or special needs plans (SNP). Only plans with a network type of Health Maintenance Organization (HMO) or Preferred Provider Organization (PPO) were included, as these are open to all beneficiaries and represent the core of the MA plan market.

The availability of MA plans varies by county, defining the MA market for this study. It is notable that not all U.S. counties offer MA plans. The Medicare Current Beneficiary Survey (MCBS) data is collected from a subset of these markets. An appendix Table 10 provides a table shows the offering of MA plans by state in 2016, and the sapled markets in

[4]MA plans offering defined at the county level, generally characterized by a hierarchical structure of firm-contract-plan. Within this framework, the contract ID specifies the provider network, while the plan ID delineates the distinctions among plans under the same network, primarily in terms of premiums, cost-sharing (generosity), and additional benefits, yet sharing a common network. Therefore, we define the product at the plan level for this analysis. Our dataset enables the identification of the exact MA plan chosen by an individual, with specificity to the plan level.

the MCBS dataset, which, according to the Centers for CMS, is representative of the entire MA market.

An essential component of our data cleaning process involved calculating the Hierarchical Condition Categories (HCC) risk scores for each individual. While CMS does not provide these scores directly, the available administrative data on chronic conditions, demographics, and Fee-For-Service (FFS) reimbursement amounts include sufficient information for this calculation. By following a process similar to the official HCC model, we calculated the risk scores. Our calculation of the HCC risk scores yielded an R squared of 11.07%, closely approximating the official HCC model's R squared of 11.89%. This similarity indicates that our simulation serves as a good approximation of the real HCC model. Detailed information on the simulation process can be found in Appendix D.2.

3.3 Data Summary

The summary statistics for beneficiaries, detailed in Table 3, provide a comparative insight between Traditional Medicare (TM) and Medicare Advantage (MA) enrollees.

Table 3: Summary Statistics of Consumers by Choices

	TM enrollee	**MA enrollee**	**Overall**
MA Enrollment	-	-	0.279
Age	73.887	74.283	73.997
Female	0.524	0.557	0.533
Income	70.203	50.484	64.697
Race:			
White	0.873	0.827	0.860
Black	0.062	0.098	0.072
Hispanic	0.008	0.020	0.011
Education:			
High	0.607	0.469	0.568
Medicare:			
Capitation	8.913	8.847	8.894
Spending	8.340	6.012	7.692

The data indicate negligible disparities in both age and gender distributions among the groups. However, income levels diverge significantly, with MA participants generally reporting lower incomes than those in TM. This trend is complemented by a marginally higher enrollment rate among minority groups in MA plans, suggesting a nuanced demographic appeal of MA offerings. Educational attainment further distinguishes the cohorts, revealing

that MA participants typically possess lower levels of educational qualifications compared to their TM counterparts. This observation underscores a socio-economic gradient in plan preference, with MA plans attracting individuals from lower socio-economic backgrounds who may be more sensitive to plan premiums, which enrollees must cover irrespective of their actual health service utilization.

Regarding Medicare's financial implications, although capitation rates for MA enrollees mirror those of TM participants, indicating similar observable health conditions, MA enrollees exhibit lower overall healthcare expenditure. This phenomenon,as previously discussed in Section 2.10.4, is partly influenced by selection effects.

Table 4: Summary Statistics of MA Plans

Variable	**Mean**	**Std.Dev**
Part A&B Coverage		
Annual Premium	0.240	0.327
Expected OOP	2.166	0.347
Network		
Rating (per star)	3.884	0.502
HMO	0.502	—
Additional Benefit		
Dental Comprehensive	0.519	—
Dental Preventive	0.794	—
Vision Exam	0.968	—
Vision Wear	0.639	—
Hearing Exam	0.698	—
Hearing Aid	0.594	—

Notes: Statistics are weighted by the plan county market share. Dollars are in thousands.

The plan-level summary statistics, weighted by enrollment and detailed in Table 4, underscore significant financial and structural differences between MA plans. A notable observation is the substantially lower premiums associated with MA plans. The expected OOP cost, an official measure of plan generosity defined by CMS, indicates that most MA plans enrollees will face high OOP costs when they encounter significant medical expenses.

Furthermore, the majority of MA plans operate as Health Maintenance Organizations (HMOs), characterized by their stringent restrictions on provider choice. This is indicative of the managed care approach adopted by MA plans to control costs and manage patient care. Additionally, MA plans frequently offer additional benefits not typically covered by TM, such as dental, vision, and hearing services, highlighting the value-added services that

distinguish MA offerings in the competitive health insurance market.

4 Model

This section introduces a model that captures the interactions between consumers and private insurance firms within the Medicare Advantage (MA) market. Consumers choose plans that maximize their utility, informed by their private information, considering TM-Medigap as an available outside option. Conversely, firms strategically design their offerings—setting price and generosity levels—to optimize profits while anticipating consumer self-selection behaviors.

The subsequent subsections elaborate on the structure of the model. Subsection 4.1 delineates the sequence of decisions involving the government, firms, and consumers. Subsection 4.2 describes the demand side, highlighting consumer variations in health perceptions and preferences. Subsection 4.3 explores the supply side, focusing on the Bertrand-Nash competition in price and generosity among MA plans.

4.1 Timing

The market operates on an annual cycle. Each year, firms design their plan offerings, which are subsequently made available to consumers during the open enrollment period. Consumers choose their plans during this period, with the selected plans becoming effective from the beginning to the end of the subsequent year.

Government Sets Capitation CMS generates individual-level risk-adjusted capitation rates for each consumer based on observable health conditions. If a consumer enrolls in a MA plan, the corresponding capitation rate, intended to cover the costs of Traditional Medicare (TM) basic coverage, is transferred to the MA firm. The capitation rate is predetermined of subsequent decisions made by firms and consumers.

Stage 1: Firm Decision Given the plan offerings from all MA firms and the availability of the outside option, each firm strategically determines the pricing and generosity levels of its plans to maximize profits.

Stage 2: Consumer Decision Consumers assess the plan offerings and attributes from all available MA plans and outside options within their local market. Armed with their private information, they select the plan that best aligns with their preferences.

4.2 Demand

We model the demand for MA plans in the Medicare Advantage market, focusing on the influence of consumer private information on plan choice.

4.2.1 Consumer Private Information

This section introduces the critical role of consumer private information in determining preferences of plans. An essential aspect of this information is the consumers' health perception, which significantly influences their choice behavior, particularly in terms of plan generosity.

Consumers with a self-perception of poor health tend to value plan generosity more highly, leading to heterogeneity in preferences across the consumer base. This perception, however, remains private and unobservable.

Given that capitation rates are risk-adjusted to reflect the average medical expenses of individuals with similar observable health conditions, we can model an individual's true subjective health perception as a distribution centered around their capitation. This assumption allows us to later estimate the parameters of this distribution.

Thus, in the model, each consumer is characterized by two variables:

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

The relationship between the capitation k_i and the self-assessed health perception e_i is formalized as follows:

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

Here, τ_i signifies the discrepancy between the observable capitation and the unobservable self-assessed health perception. By employing the logarithmic transformation of e_i and k_i, we ensure that health perception is represented as a positive value, facilitating the interpretation of higher values as indicative of poorer health perceptions.

4.2.2 Utility Specification

This subsection outlines the utility function for consumers with heterogeneous preferences, taking into account the influence of private health perceptions on plan choice.

Consumer i in a specific county faces a choice set that includes various MA plans and an outside option. Each MA plan j is characterized by a premium p_j, a generosity measure g_j

[5], an MA indicator A_j, and other attributes X_j (including additional benefits and healthcare network attributes). The expected utility of consumer i from selecting plan j is expressed as:

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

Here, ξ_{ij} reflects the unobserved quality of plan j, influencing consumer preferences beyond observable attributes. ε_{ij} captures the idiosyncratic preferences of consumer i towards plan j, assumed to follow an independent and identically distributed Type 1 Extreme Value (T1EV) distribution, as established in Berry et al. (1995).

The utility from the outside option[6] is defined as:

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

Consumers exhibit heterogeneity in their preferences for plan generosity, premiums, and the type of plan (MA or outside option). These preferences are modeled as follows:

Preferences for plan generosity (β_i) are influenced by the consumer's health perception e_i:

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

Preferences for plan premiums (α_i) are associated with the consumer's income level:

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

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

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

Among these heterogeneities, only health perception e_i is an unobservable continuous variable. Other characteristics, including income level inc_i, education level edu_i, racial background white_i, Medicaid coverage Mcd_i, and employer-sponsored insurance coverage ESI_i, are observable and modeled as dummy variables.

[5]The generosity measure, expected Out-of-Pocket (OOP) cost, is directly obtained from CMS, which is the official measure used to comprehensively assess plan generosity.

[6]Medigap, as a TM supplemental insurance, is government-designed and available in every market, making it the most popular supplemental insurance. For this analysis, we focus on the most popular Medigap Plan during the data period and TM combination as the outside option.

4.2.3 Plan Choice Probability

Accordingly, the mean utility difference for an MA plan j, relative to the outside option, can be expressed as:

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

Here, δ_j captures the differential in mean utility between plan j and the outside option, anchored at zero for the latter. This differential reflects variations in plan generosity, premiums, exogenous characteristics, and unobserved quality, delineating the comparative appeal of MA plans.

Let μ_{ij} indicate the deviation of consumer i's utility from the mean utility difference δ_j due to individual preferences:

$$\mu_{ij} = \gamma \ln e_i(g_j - g_0) - \rho^{\text{inc}}\text{inc}_i(p_j - p_0) + (\rho^{\text{edu}}\text{edu}_i + \rho^{\text{white}}\text{white}_i + \rho^{\text{Mcd}}\text{Mcd}_i + \rho^{\text{ESI}}\text{ESI}_i)A_j \tag{8}$$

This can simplify the utility function as:

$$u_{ij} = \delta_j + \mu_{ij} + \varepsilon_{ij} \tag{9}$$

The probability that consumer i, with health perception e_i, will choose plan j is derived from the utility function, considering the Type 1 Extreme Value (T1EV) distribution of the error term ε_{ij}:

$$s_{ij}(e_i) = \frac{\exp\left(\delta_j + \mu_{ij}(e_i)\right)}{\sum_{j'=0}^{J} \exp\left(\delta_{j'} + \mu_{ij'}(e_i)\right)} \tag{10}$$

The overall demand for plan j, denoted by q_j, is calculated as the sum of individual choice probabilities, weighted by the sampling weights w_i, the individual sampling weight of consumer i:

$$q_j = \sum_i w_i \cdot s_{ij}(e_i) = \sum_i w_i \cdot \int_\tau s_{ij}(k_i) dF_\tau(\tau_i) \tag{11}$$

This segment introduces a demand model that accounts for the influence of private health perception on consumer choices among Medicare options. The following subsection will shift focus to the supply side of the model, where MA firms anticipate consumer behavior to optimize their plan designs in terms of price and generosity, within a Bertrand-Nash competition framework.

4.3 Supply

This section explores the strategic interactions among Medicare Advantage (MA) firms, with a focus on optimizing price and generosity levels to maximize profits. Mirroring the approach of multi-product firm competition in existing literature (e.g., Berry et al. (1995), Petrin (2002)), our model conceptualizes the competition among MA firms as a Bertrand-Nash scenario. Here, firms strategically determine not only the price but also endogenous product attributes—specifically, generosity—which influence marginal costs (as discussed in Miller et al. (2023) and Fan (2013)).

In this model, all MA firms make decisions simultaneously, considering the strategic responses of their competitors. We specifically focus on short-run competition, where networks and plan offerings are assumed to be predetermined. Consequently, only price and generosity levels are endogenously determined, without modeling the entry and exit of products. This approach allows for a focused analysis of firm behavior in response to the impact of risk adjustment and consumer self-selection.

4.3.1 Costs

Our analysis concentrates on the marginal costs in the short term, treating fixed costs as sunk. We assume that marginal costs remain constant regardless of the number of enrollees. Let mc_j denote the subsidized marginal cost[7] of offering plan j. 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:

$$mc_j = mc_j^g(g_j) + w^X \cdot X_j + \omega_j \tag{12}$$

where ω_j represents the product-level shock on marginal cost. This function includes a generosity-dependent component, $mc_j^g(g_j)$, and a linear term for other attributes, $w^X \cdot X_j$. The linear treatment of $w^X \cdot X_j$ is justified because these variables are either dummies or discrete variables, such as star ratings, simplifying our analysis by focusing mainly on price and generosity rather than the broader plan attributes.

4.3.2 Plan Design Problem

This subsection models the strategic decision-making of MA firms as they seek to maximize profits. Firms are faced with optimizing state-level profits by strategically setting bid and

[7]The marginal cost incorporates the capitation payment, and the risk adjustment may not perfectly compensate for medical spending due to self-selection effects.

generosity levels, given their plan offerings across various counties within a state.

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

$$\pi_j = (b_j - mc_j(g_j)) \cdot M_c \cdot s_{c,j}(g, b) \tag{13}$$

Here, $s_{c,j}(g, b)$ represents the market share of plan j in county c, derived from the demand model's plan choice probabilities. This market share reflects the strategic responses to bid and generosity levels set by all competing MA firms within the market.

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

$$\pi_{f,c} = \sum_{j \in \mathcal{J}_{f,c}} \pi_j \tag{14}$$

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

$$\pi_f = \sum_{c \in \mathcal{C}_f} \pi_{f,c} \tag{15}$$

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:

$$\max_{b_f, g_f} \pi_f = \sum_{c \in \mathcal{C}_f} \sum_{j \in \mathcal{J}_{f,c}} (b_j - mc_j(g_j)) \cdot \frac{M_c}{M} M \cdot s_{c,j}(g, b) \tag{16}$$

where M is the total market size of the state.

The solution to the profit maximization problem defined in Equation 16 is obtained by deriving the first-order conditions with respect to the bid b_j and generosity g_j levels:

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

$$\{g_j\}: \quad \sum_{c \in \mathcal{C}_f} \frac{M_c}{M} \left(\frac{\partial mc_j}{\partial g_j} \cdot s_{c,j} - \sum_{j \in \mathcal{J}_{f,c}} (b_j - mc_j) \cdot \frac{\partial s_{c,j}}{\partial g_j} \right) = 0 \quad \forall j \tag{18}$$

Following the methodology of Berry et al. (1995), we define the $J \times J$ matrix Δ, which

accounts for the interaction between the product choice probabilities within the same firm:

$$\Delta^p_{i,jk} = \begin{cases} -\alpha_i s_j(1-s_j), & \text{if } j = k \\ \alpha_i s_j s_k, & \text{if } j \neq k \text{ and both are produced by the same firm} \\ 0, & \text{otherwise} \end{cases} \tag{19}$$

where $\alpha_i = \bar{\alpha} + \rho^{\text{inc}} \text{inc}_i$ denotes the consumer i's sensitivity to plan premiums.

$$\Delta^g_{i,jk} = \begin{cases} \beta_i s_j(1-s_j), & \text{if } j = k \\ -\beta_i s_j s_k, & \text{if } j \neq k \text{ and both are produced by the same firm} \\ 0, & \text{otherwise} \end{cases} \tag{20}$$

where $\beta_i = \bar{\beta} + \gamma \ln e_i$ represents the consumer i's preference for plan generosity.

These first-order conditions simplify to the matrix forms:

$$mc = b - (\Delta^p)^{-1} \cdot s \tag{21}$$

$$\frac{\partial mc}{\partial g} = \frac{\Delta^g \cdot (b - mc)}{s} \tag{22}$$

We utilize these matrix-derived first-order conditions to recover marginal costs of MA plans.

5 Estimation

5.1 Demand Estimation

Following the two-step estimation approach outlined by Goolsbee and Petrin (2004), our methodology first involves performing a weighted maximum likelihood estimation (MLE) to recover parameters capturing preference heterogeneity and mean utility among consumers. This step is followed by a two-stage least squares (2SLS) regression using instrumental variables (IVs) to estimate the remaining parameters that affect mean utility δ.

In our demand model, initially tailored for single-market analysis, we expand our approach to encompass multiple markets. In the demand estimation, we will use all markets within the sampling scope of the MCBS that offer Medicare Advantage plans. Our dataset encompasses thousands of county-year observations, each providing a rich blend of individual-level data and product-specific information necessary for calculating the probabilities of plan selection.

5.1.1 Consumer Heterogeneity

The first step estimation is formalized as search paramter set ϑ to maximize the weighted log-likelihood function with constriants:

$$\begin{aligned} &\max_{\vartheta} \underbrace{\sum_{m}\sum_{i} w_{mi} \cdot \sum_{j\in\mathcal{J}_m} y_{mij} \times \ln(\Pr_{mi}(j|k_{mi};\vartheta))}_{\text{Weighted log-likelihood}} \\ &\text{s.t.} \quad \underbrace{s_{mj} = \sum_{i} w_{mi} \times \Pr_{mi}(j|k_{mi};\vartheta)}_{\text{Market share matching condition}} \quad \forall j = 1, ...J, \quad \forall m \end{aligned} \tag{23}$$

- w_{mi}: sampling weight for consumer i in market m.
- y_{mij}: indicator for consumer i choosing plan j in market m.
- s_{mj}: observed market share for MA plan j in market m.

The estimation process aims to identify a set of parameters that maximize the likelihood of observed individual plan selections across multiple markets, subject to specific constraints. These constraints require that, for each Medicare Advantage (MA) plan within every market, the model-predicted market shares align with the observed market shares.

The parameter set ϑ encompasses elements that reflect consumer heterogeneity, as detailed in the demand model section, alongside the mean utilities δ_j associated with each

Table 5: Estimation Results of Consumer Heterogeneity

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

Note: Health Perception is measured in thousand dollars. A higher value indicates poorer health perception (which indicates a higher expectation of healthcare needs).

plan. This approach acknowledges the multifaceted nature of consumer preferences and the varying appeal of MA plans.

Addressing the challenge posed by unobservable private information, we employs simulations of individual-specific discrepancies, τ_i, which are presumed to follow a standard normal distribution. This methodology allows for the indirect capture and incorporation of private information into the model, through the estimation of the standard deviation, σ_τ, among other parameters.

Following the estimation results presented in Table 5, we can interpret the parameters within the context of consumer preferences and their heterogeneity in Medicare plan choices.

Firstly, the parameter γ, associated with health perception, is positive and statistically significant, indicating a clear preference trend. A higher value of health perception, which in this context represents a poorer self-assessed health status, is associated with a greater value placed on plan generosity. This result aligns with the intuitive expectation that consumers who perceive their health as poorer are more likely to value plans offering more generous benefits, as they anticipate higher healthcare needs.

The estimation results pertaining to premium preferences and Medicare Advantage (MA) plan types preference reveal distinct influences of demographic and socio-economic factors on plan choice. The parameter ρ^{inc} specifically sheds light on the sensitivity to premium levels among different income groups. The negative estimate associated with high income individuals indicates that wealthier consumers exhibit less sensitivity to plan generosity, attributed to their greater financial capacity to cover higher premiums. This insight underscores the im-

portance of considering income levels in designing insurance products that cater to consumer affordability and value perception.

Among the socio-economic status indicators, the preference for Medicare Advantage (MA) plans is most significantly influenced by access to Employer-Sponsored Insurance (ESI). The parameter associated with ESI, ρ^{ESI}, shows a notably negative estimate, suggesting that individuals with ESI are significantly less likely to opt for MA plans. This finding aligns with the expectation that ESI, typically a benefit linked to employment and often serving as the primary payer, offers more generous coverage compared to MA plans. Consequently, individuals with ESI have little incentive to enroll in MA, validating our model's prediction through the substantial negative value of ρ^{ESI}.

In this section, out analysis utilizing weighted maximum likelihood estimation and simulation of private information, provides a clear picture of consumer heterogeneity in the Medicare market. The results highlight key trends and preferences among beneficiaries, affirming the importance of accounting for consumer heterogeneity in studying health insurance plan selection.

5.1.2 Plan Mean Utility

Following the examination of consumer heterogeneity and its impact on plan preferences, we now turn our attention to the second component of our demand estimation: the influence of observable plan attributes on plan mean utilities. This part of our analysis seeks to understand how observable plan attributes affect the overall attractiveness of Medicare Advantage plans to beneficiaries.

In our demand model, the expression for mean utility is captured by Equation 7, which encompasses the effects of observable plan characteristics, adjusted for the baseline of outside option (g_0, p_0, ξ_0), and includes the unobserved plan quality ($\xi_j - \xi_0$), leading to potential endogeneity issues.

This endogeneity arises because plan generosity and premiums are endogenous choices made by firms, determined in response to market conditions, strategic considerations, and other unobserved factors. Firms design these attributes with an understanding of consumer preferences and competitive landscapes, which could correlate observable plan features with unobserved plan quality, thereby introducing endogeneity issues into the model.

To address the endogeneity stemming from unobserved plan quality, we introduce an instrumental variable (IV) approach, drawing inspration from the methodology proposed by Fan (2013). This approach constructs instruments from market-level demographic characteristics to isolate the impact of observable attributes from the confounding effects of unobserved quality.

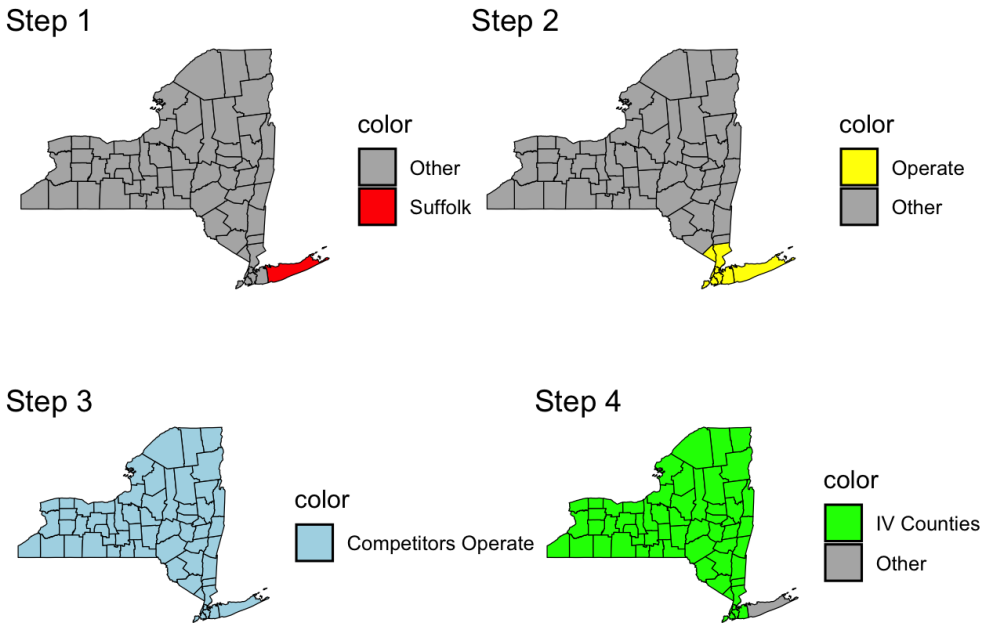


Figure 11: Instrumental Variable Construction

The detailed exposition of the IV methodology follows.

Table 6: Estimation Results of Plan Mean Utility

Variable	Parameter	Estimate	Std Error
Part A&B Coverage			
MA indicator	$\bar{\lambda}^A$	-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)

5.2 Supply Estimation

My supply side estimation reports an average of $1,022 for the markup of the MA plans, which is 10.3% of the marginal cost before the capitation. This result is close to 11.2 % of Vatter (2023). The average gross marginal cost is $10,409 per enrollee per year, which is higher than the average capitation payment of $10,538. Notice that the capitation is design to cover the cost of basic Medicare Part A&B coverage only, while the gross marginal cost includes all the cost of the plan, including the supplementary benefits.

Table 7 reports the estimation results of the supply side of the model, with and without firm fixed effects. The results show that the esitmation is rubust to the inclusion of firm fixed effects. The quadratic term of plan generosity is positive and significant, indicating that the marginal cost of the plan increases with the generosity of the plan. This comfirms the selection effect of the MA plans.

Table 8 presents a summary of plan costs ranked by generosity, providing insights into the relationship between plan generosity and costs.

Our model implies that the MA plan generosity get higher, people with bad health perception are more likely to choose the plan, and therefore the plan average cost will increase. Although the risk adjustment mechanism will capture the risk changes, currnet risk adjustment mechanism will not fully compensate the cost rise. As a result, when plan generosity increases, the growth rate of plan cost will surpass the growth rate of risk adjustment.

This phenomenon is consistent with the cost result of Table 8, where the gross marginal cost is less than the capitation payment for the first three quartiles of generosity, but exceeds the capitation payment for the highest quartile of generosity.

Table 7: Estimation of Plan Marginal Cost

	I		II	
Variable	**Estimate**	**Std Error**	**Estimate**	**Std Error**
Coverage Generosity				
Expected OOP	-0.168	(0.056)	-0.208	(0.057)
Expected OOP Squared	-0.104	(0.013)	-0.091	(0.014)
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)
BCBS	-	-	0.104	(0.053)
Cigna	-	-	0.130	(0.063)
Humana	-	-	0.013	(0.027)
UHG	-	-	-0.079	(0.030)

Note: Regression I is estimated without firm fixed effects. Regression II is estimated with firm fixed effects. Unit are thousand dollars. Expected Out-Of-Pocket (OOP) is the expected out-of-pocket cost for a typical enrollee with poor health status in the plan. It ranges from 0 to around $3.2k.

Table 9 offers a summary of plan costs by firm, the firm-level estimation of gross marginal cost (MC) are consistant with Miller et al. (2023).

5.2.1 Explanation of Overpayment in MA Plans

The results from our study provide empirical support for the notion of overpayment within Medicare Advantage (MA) plans. By design, the capitation payment from CMS is intended to cover the costs associated with basic Medicare Part A&B coverage. MA plans charge a supplemental bid intended to cover additional Part A&B coverage, as well as other supplementary benefits such as dental, vision, and hearing aids.

However, our findings indicate that for plans with lower generosity (lower generosity implying fewer supplementary coverage), the capitation payment often exceeds the necessary expenditure to cover these basic and supplemental services. This excess in capitation not only covers the intended costs but also contributes to significant profits for these MA plans.

Table 8: Summary of Plan Costs Ranked by Generosity

Generosity Quartile	**MC**	**Capitation**	**Capitation – MC**	**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 supplementary bid that supposed to cover the cost of additional benefits. The difference between capitation and marginal cost is the profit margin of the plan without premium revenue.

This scenario suggests that the supplemental bid, in such cases, effectively becomes a source of pure profit rather than a necessary charge to cover additional costs.

Therefore, by simply designing the plan with lower generosity, the MA plans can generate substantial profits from the excess capitation payment, without asking for additional premiums from the beneficiaries. This practice results in a situation where the MA plans set their MA premium to zero, attracting enrollees with good health perception and therefore do not pay attention to low generosity of the plan.

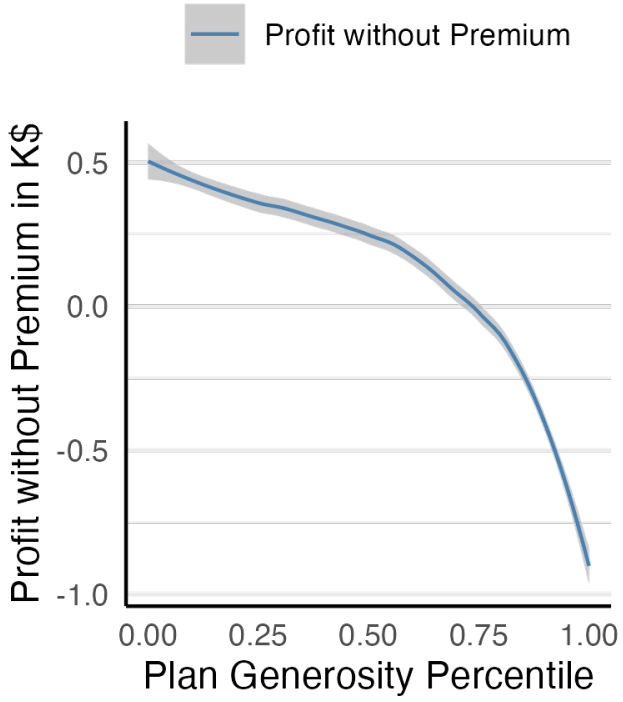


Figure 12: Plan Cost by Plan Generosity Percentile

Note: 95% confidence interval is shown in the plot

6 Counterfactual Simulation

7 Conclusion

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Appendix

A Additional Figures

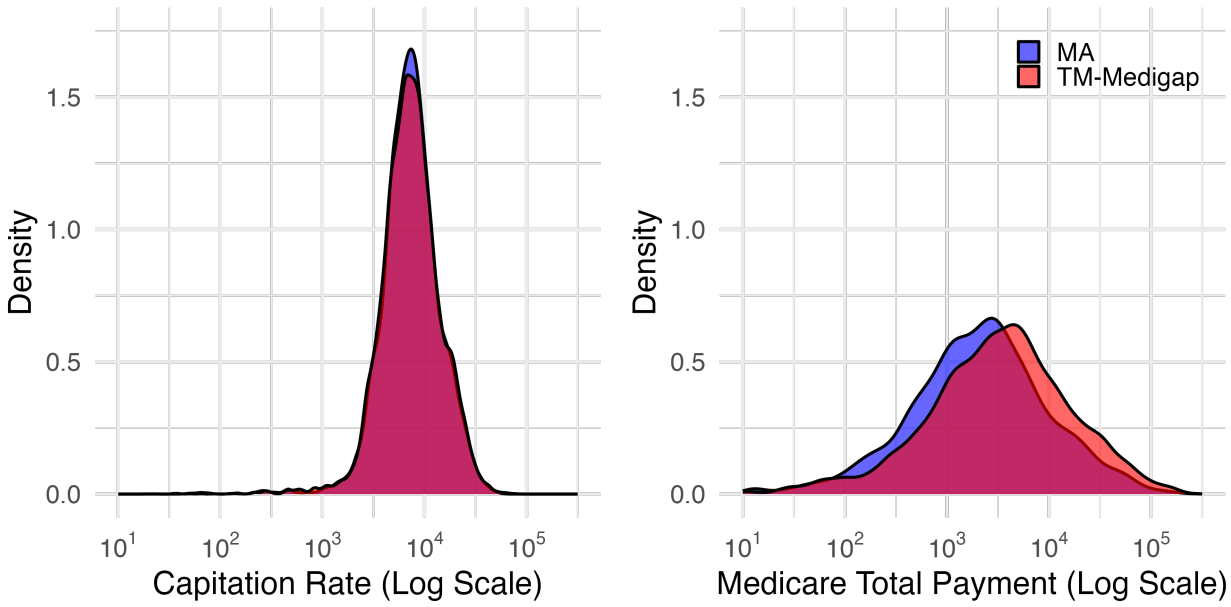
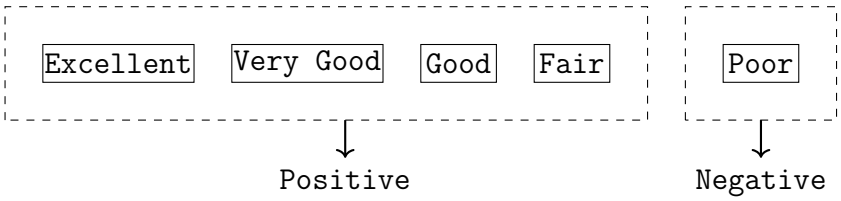
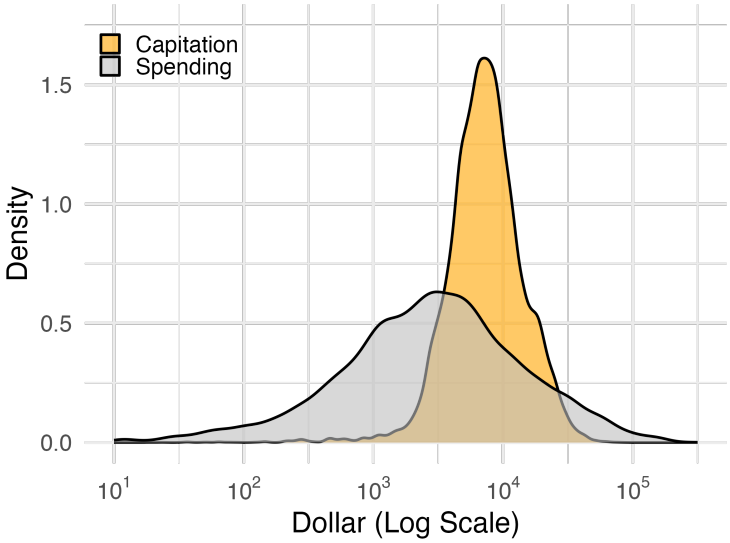


Figure 13: Distribution of Capitation and Payment by Plan Type





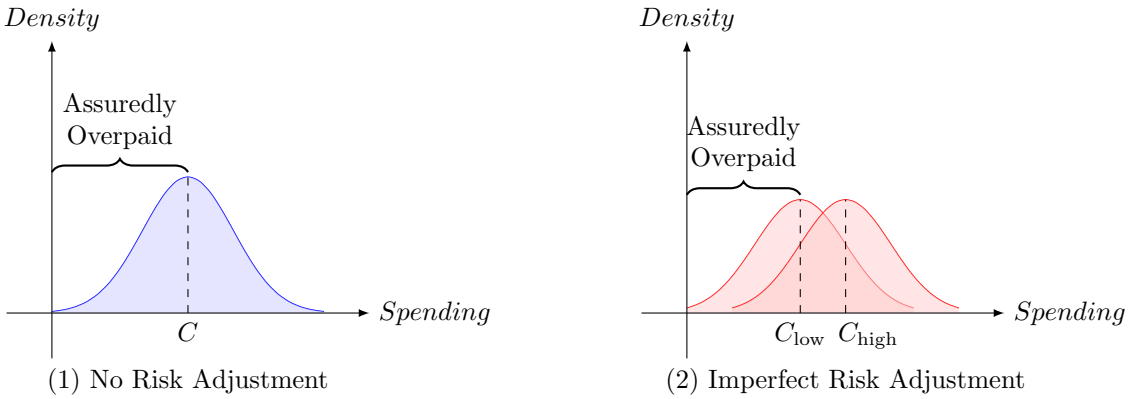


Figure 14: Intuition of Selection Incentive

Table 9: Summary of Plan Costs by Firm

Firm	MC	Capitation	MC – Capitation	Bid	# of Plans
Humana	10.637	10.790	-0.153	0.848	481
UHG	10.725	10.904	-0.180	0.861	337
Aetna	10.175	10.362	-0.187	0.778	237
Anthem	10.220	10.479	-0.259	0.720	94
BCBS	9.341	9.484	-0.143	0.828	85
Cigna	11.528	11.495	0.032	0.971	51

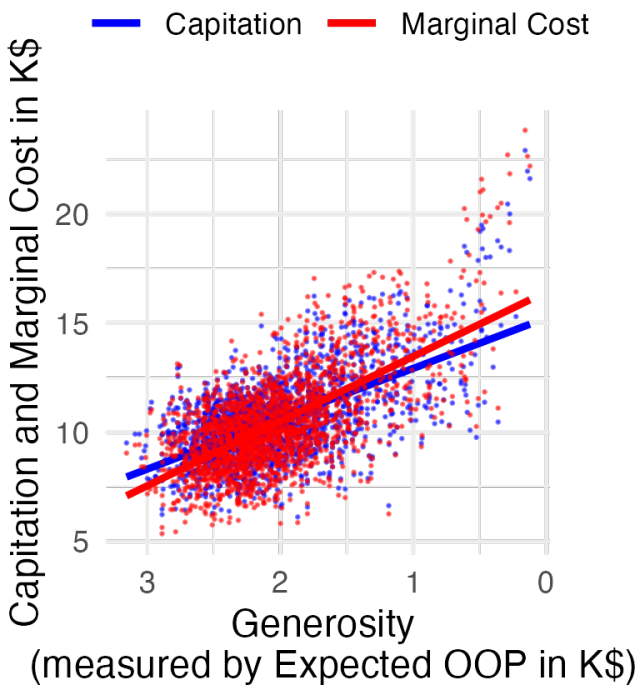


Figure 15: Capitation and Marginal Cost by Plan Generosity

Note: Points represent captiation and marginal cost of each plan, while the line represents the fitted values of these two variables given the plan generosity. The herizonal axis is reversed because a higher expected Out-of-Pocket cost indicates a lower plan generosity.

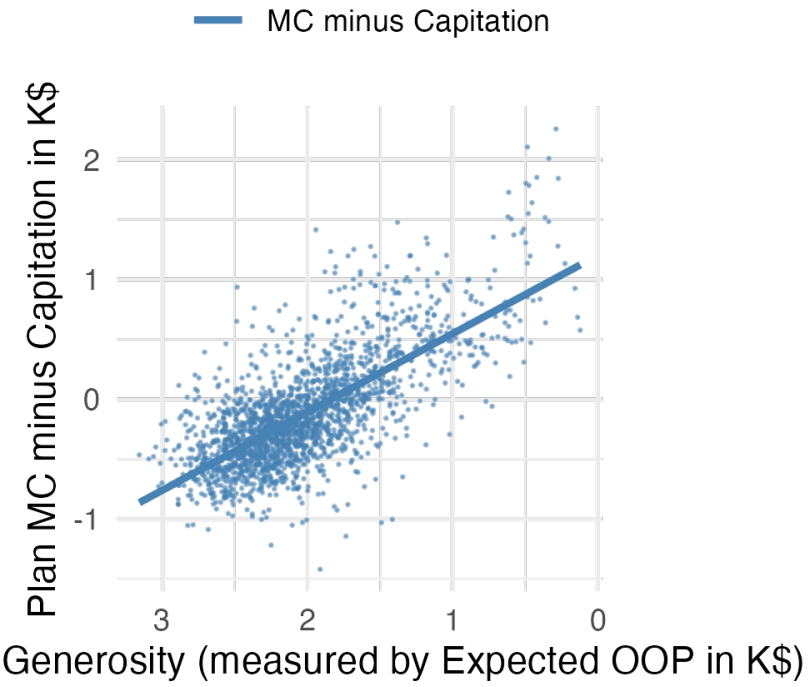


Figure 16: Difference between Marginal Cost and Capitation by Plan Generosity

Note: The difference between marginal cost and capitation is calculated by subtracting the capitation from the marginal cost. The herizonal axis is reversed because a higher expected Out-of-Pocket cost indicates a lower plan generosity.

B Industry Details

C Data Details

C.1 Data Sources

C.1.1 MCBS Data Source

The Medicare Current Beneficiary Survey (MCBS) is a continuous survey of a national sample of Medicare beneficiaries. Our study uses data from 2016 to 2018. The MCBS captures individual-level information about self-reported health status, medical service use, insurance plans, payments, and demographics. More about MCBS can be found on the MCBS website.

The MCBS data from 2016 to 2018 consists of two parts: the Survey File and the Cost Supplement. The Survey File provides demographic characteristics, health status, and healthcare use. The Cost Supplement, on the other hand, focuses on the healthcare expenses of the Medicare population.

C.1.2 Public Data Source

The public datasets used in this study are sourced from various official CMS (Centers for Medicare & Medicaid Services) databases. Most of the data can be directly downloaded via the provided links.

`benefit` MA plan additional benefits. Benefits Data

`contract` Contract and firm information. Monthly Enrollment by CPSC

`enrollment` MA enrollment. Monthly Enrollment by CPSC

`special_plan_enrollment` Enrollment of special plans. Monthly Enrollment by CPSC

`landscape` MA Plan star-ratings. MA Landscape Files

`penetration` Medicare-eligible population. MA State/County Penetration

`ratebook` County benchmark rates. Ratebooks & Supporting Data

`plan_OOP` Official MA Plan generosity measure. OOPC Resources

`Medigap_state_level` Medigap state level data. Medigap State Level

C.2 Data Cleaning

Table 10: Sample Markets Summary for 2016

State	All	MA	in Sample	State	All	MA	in Sample
Alaska	23	0	0	Montana	56	39	0
Alabama	67	66	12	North Carolina	100	99	22
Arkansas	75	75	3	North Dakota	53	8	0
Arizona	15	15	6	Nebraska	93	18	0
California	58	39	17	New Hampshire	10	8	0
Colorado	64	33	7	New Jersey	21	21	14
Connecticut	8	8	5	New Mexico	33	29	5
D.C.	1	0	0	Nevada	17	10	2
Delaware	3	3	0	New York	62	62	26
Florida	67	66	20	Ohio	88	88	29
Georgia	159	156	18	Oklahoma	77	61	1
Hawaii	5	4	0	Oregon	36	36	1
Iowa	99	91	4	Pennsylvania	67	66	23
Idaho	44	39	0	Rhode Island	5	5	0
Illinois	102	88	10	South Carolina	46	45	6
Indiana	92	92	3	South Dakota	65	29	0
Kansas	105	39	3	Tennessee	95	92	13
Kentucky	120	117	11	Texas	254	229	33
Louisiana	64	63	6	Utah	29	19	1
Massachusetts	14	13	6	Virginia	134	132	9
Maryland	24	24	8	Vermont	14	14	1
Maine	16	16	0	Washington	39	29	8
Michigan	83	83	28	Wisconsin	72	71	14
Minnesota	87	84	13	West Virginia	55	54	7
Missouri	115	110	12	Wyoming	23	1	1
Mississippi	82	80	1	**Total**	**3136**	**2669**	**409**

Note: "All" refers to the total number of counties in the state, "MA" denotes the number of counties offering MA options, and "Sample" represents the number of counties covered in the MCBS sample that offer MA options. These counties are included in the estimation sample.

D Risk Adjustment

[This section is currently under development and will be updated with content in due course.]

D.1 HCC Details

D.2 Derivation of Individual Risk Scores

This section details the methodology employed to simulate HCC risk scores for individuals in the MCBS dataset, mimicking the actual process based on regression of FFS reimbursements against chronic conditions and demographic information.

Table 11: Chronic Conditions Employed in Deriving HCC Risk Scores

Condition	**Code**	**Condition**	**Code**
Physical - Cancer		***Physical - Others***	
Skin Cancer	OCCSKIN	Hysterectomy	HYSTEREC
Lung Cancer	OCCLUNG	Arteriosclerosis	OCARTERY
Colon Cancer	OCCCOLON	Hypertension	OCHBP
Breast Cancer	OCCBREST	Myocardial Infarction	OCMYOCAR
Uterine Cancer	OCCUTER	Angina Pectoris/CHD	OCCHD
Prostate Cancer	OCCPROST	Congestive Heart Failure	OCCFAIL
Bladder Cancer	OCCBLAD	Other Heart Conditions	OCHRTCND
Ovarian Cancer	OCCOVARY	Stroke	OCSTROKE
Stomach Cancer	OCCSTOM	High Cholesterol	OCCHOLES
Cervical Cancer	OCCCERVX	Emphysema/Asthma/COPD	OCEMPHYS
Brain Cancer	OCCBRAIN	Complete/Partial Paralysis	OCPPARAL
Kidney Cancer	OCCKIDNY	Amputation	OCAMPUTE
Throat Cancer	OCCTHROA	Enlarged Prostate/BPH	HAVEPROS
Blood Cancer	OCCBLOOD	Diabetes	OCBETES
Bone Cancer	OCCBONE	Overweight	BMI_CAT
Esophageal Cancer	OCCESOPH	Cataracts	ECATARAC
Gallbladder Cancer	OCCGALLB	Glaucoma	ECGLAUC
Laryngeal Cancer	OCCLARNX	Macular Degeneration	EMACULAR
Leukemia	OCCLEUK		
Liver Cancer	OCCLIVER	***Mental/Psychological***	
Lymphoma	OCCLYMPH	Intellectual Disability	OCMENTAL
Oral Cancer	OCCMOUTH	Alzheimer's Disease	OCALZMER
Pancreatic Cancer	OCCPANCR	Dementia	OCDEMENT
Rectal Cancer	OCCRECT	Depression	OCDEPRSS
Soft Tissue Cancer	OCCTISS	Non-depressive Mental Disorders	OCPSYCHO
Testicular Cancer	OCCTESTS	Parkinson's Disease	OCPARKIN
Thyroid Cancer	OCCTHYR	Tobacco Dependence	CIGNOW
Other Cancer Types	OCCOTHER	Alcohol Dependence	ALCNDAYU

Note: Code refers to the chronic condition code used in the MCBS datasets.