Subsidy Design and Effective Consumer Demand: Implications for Medicare Advantage*

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Abstract

Subsidy design in public-private partnerships is a key tool for aligning incentives between the public payer and the private entity. We study subsidy design in Medicare Advantage, a $400 billion health insurance program. We show that under the MA subsidy and regulatory design, a key parameter known as the rebate rate links plan bids to consumer demand. The last major reform to MA, the 2012 Quality Bonus Program, reduced the average rebate rate as part of a package of quality incentives. A lower rebate rate reduced the consumer demand penalty for higher plan markups, equivalent to making consumer demand less elastic. We find that while the 2012 reform's quality incentive succeeded in raising measured plan quality and consumer welfare, the rebate rate reduction resulted in more-than-offsetting consumer welfare declines due to higher markups and higher premiums.

Keywords: Public provision of health insurance, production of quality, Medicare

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1 Introduction

In recent decades, public services have increasingly been provided by private entities that contract with the government. Typically, in such public-private partnerships, private entities choose the price and quality of their services, consumers choose which service to use and pay a subsidized price, and the government pays the subsidy to the private entities. One concern is that such markets are typically imperfectly competitive, leading to inefficient outcomes (e.g., inefficiently low quality and high price). Therefore, policymakers typically design policies to align the incentives of private entities with the public interest in order to improve efficiency. An important policy tool that the government can use is the design of the subsidy scheme. In this paper, we study subsidy design in the context of Medicare Advantage (MA), a $400 billion public-private partnership that provides health insurance to Americans aged 65 and older or with work-limiting disabilities.

In this paper, we examine whether the most recent major reform to the MA subsidy design improves efficiency, paying particular attention to the role of a reduction in a key subsidy parameter. In 2012, Medicare implemented the Quality Bonus Program. As the name suggests, this program primarily targeted plan quality by tying the MA subsidy to plan scores on a set of quality measures. While tying the subsidy to plan quality incentivizes plans to improve quality, a concurrent reduction in a subsidy parameter effectively turns the demand curve counterclockwise, reducing the elasticity of demand and leading to a larger firm markup and lower consumer welfare.

This key subsidy parameter is the rebate rate, and it is tied to demand elasticity because of the MA subsidy design. In the MA market, plans choose a price, called a bid, and consumers pay a subsidized price. If a plan's bid is above a benchmark amount, the subsidy is the benchmark. When a plan's bid is below the benchmark, which is the case for most plans, the subsidy is the bid plus a rebate, which is a fraction of the difference between the benchmark and the bid.[1] Therefore, a $1 increase in the bid results in a premium increase of less than $1, with the ratio determined by the fraction called the rebate rate. As a result, a smaller rebate rate effectively means a lower sensitivity of consumer demand to plan bid. The 2012 reform reduced the rebate rate from 0.75 to a range averaging 0.62.

To address our research questions, we first use a simple model to explain how the MA market works and clarify how the subsidy design affects firms' incentives and market outcomes. The QBP program links rebates to plan quality, and we show that this change effectively increases demand sensitivity to quality and incentivizes firms to improve qual-

[1] This part of the subsidy is called a rebate because when a plan bids below the benchmark, it receives that fraction of the difference between the benchmark and the bid as a rebate from the government. By regulation, actual MA premiums are net of any rebates received.

ity. The QBP program also reduced the rebate rate. We show that such a change both shifts the demand curve to the left and rotates it counterclockwise, affecting both prices and qualities. In particular, the rotation reduces consumer sensitivity to firm decisions, is likely to increase the share of public funds going to firms, and reduces the consumer benefit from the subsidy.

To quantify the overall effect of the QBP, decompose it into the effect of each change in the QBP, and highlight the role of each aspect of the subsidy design, we develop a structural model of MA demand and supply that captures the key MA program rules and plan incentives. On the demand side, consumers choose a plan based on plan premium, quality, and generosity. We allow for heterogeneity in consumer tastes by demographics and estimate the model using both aggregate data on plan enrollment and individual data on consumer demographics and plan choice for the years 2010 to 2017. We address the endogeneity of premium and plan characteristics by exploiting the market feature that a plan is often offered in multiple counties. Therefore, the demographics of all counties covered by a plan except the focal county can be used to construct instrumental variables.

Our supply side captures the key strategic incentives facing MA plans and how they were changed in the 2012 reforms. MA plans in our model choose a quality input that stochastically generates the star rating rewarded by QBP. In addition, they choose the level of supplementary plan benefits (e.g., vision/hearing/dental benefits or cost-sharing reductions). Finally, the plans set a "gain/loss" profit margin that, in combination with the other variables and program rules, determines the plan premium. The cost parameters suggest MA plans incur about \$0.95 for each estimated \$1 in accounting expenditure on supplementary benefits. We also find that the fixed cost of providing quality is higher in earlier years of the program and higher when quality is already high (e.g., star rating is convex in the quality input). The estimated model implies an average of 18% markup for MA plans, similar to previous work such as Vatter (2021) and Curto et al. (2021).

Based on the estimated model, we simulate bidding and MA outcomes under various policy parameters. We first show that as expected, rebate rate reductions lead plans to choose higher gain/loss amounts, which lead to premium increases and decreases in consumer welfare. We then compare equivalent subsidy increases implemented via a higher rebate rate or a higher bonus rate. We find that increasing rebate rate always translates into a greater increase in consumer welfare per unit increase in government spending than an equivalent increases in the benchmark.

Next, we turn to the 2012 reforms. We find that the quality-dependent subsidy design implemented in 2012 was successful at increasing plan quality and increasing consumer welfare. However, the rebate rate reduction implemented at the same time resulted in premium increases and consumer welfare decreases. The net effect was negative, mean-

ing that the 2012 reforms reduced consumer welfare.

Our paper joins an established literature, dating to Town and Liu (2003), exploring the design and regulation of the MA market, which as of 2023 insures more than half of Medicare beneficiaries. Our paper is similar to Curto et al. (2021) and Miller et al. (2023) in highlighting MA plans' strategic choice of bids. Our paper is unique in demonstrating the role of the rebate rate in plan incentives. To our knowledge, the MA subsidy design is unique in its connection in implementing a partial feedback between the plan's profit margin and its premium. In Medicare Part D and the ACA marketplaces, a $1 increase in profit margin would raise premiums one-for-one. We are the first to highlight how this subsidy design choice – the partial feedback between profit margin and premium arising from a rebate rate less than one – affects bidding incentives in MA. In addition, we show that a recent quality incentive that was successful in incentivizing quality nonetheless resulted in welfare decreases due to the lower rebate rate.

In addition, this paper shows the key role of consumer price sensitivity in public-private partnerships. Insensitive consumers – i.e., consumers who are unresponsive to price or characteristics due to inertia, search costs, or inattention – can allow public funds to flow to inefficient or low-quality providers. Thus, many public-private partnerships such as publicly-subsidized health insurance or charter schools use policy interventions to encourage active choice and reduce the time and cognitive burden of search. Such interventions include consumer-friendly shopping websites (e.g., healthcare.gov, Medicare Plan Finder) and product standardization (ACA Exchange essential benefits and metal tiers, or standardized testing in the charter school example). Increasing the rebate rate, while seemingly dissimilar from these interventions, acts in the same way to increase the effective consumer demand elasticity. In MA, under the unique subsidy design and regulatory structure, policymakers have a parameter that increases plan penalty for higher profit margin, and our results show the welfare benefits of such increases.

Finally, our study belongs to the industrial organization literature on endogenous quality, including Fan (2013), and Crawford et al. (2019). We show that the quality incentive program implemented by CMS in 2012 was in fact successful at increasing the incentive to provide quality and that insurers responded by improving quality along the measured dimensions. This shows that subsidy designs that reward higher quality can in fact help align private firms' quality incentives with those of the public provider.

2 The Medicare Advantage Market

Medicare provides health insurance to US individuals aged 65+ or with work-limiting disabilities. At its founding in 1965, Medicare simply reimbursed medical services di-

rectly (Traditional Medicare or TM), but in the 1980s Medicare began contracting with private insurers to deliver a regulated insurance benefit in what became known in the MA program. We begin by explaining the market design and its key regulations.

2.1 Bidding, Rebates, and Premiums

Like in many public-private partnerships, CMS evaluates MA plans against a "benchmark" that is a function of what CMS might expect to pay for this individual if they were enrolled in TM. CMS sets a "benchmark" B_{ct} for county c and year t as a percent of average TM spending, adjusted for average health via diagnosis-based risk adjustment. The actual benchmark $\tilde{B}_{jt}$ for plan j depends on the county or counties it serves, the average risk of its projected enrollees, and potentially its quality. Specifically,

$$\tilde{B}_{jt} = B_{jt} \times rs_{jt} \times \lambda_{kt},$$

where B_{jt} is the average of county benchmarks weighted by projected enrollment in each county and rs_{jt} is the plan's "projected" risk score.[2] $\lambda_{kt} \geq 1$ is a so-called bonus rate that varies at the contract level, where a contract k is a set of plans offered by the same parent organization in the same state.

MA plans "bid" to offer a standardized benefit package (i.e., hospital and physician services, using the TM cost-sharing parameters) in that county. The bid describes the expected cost of covering these services for the plan's expected enrollment. When plans submit bids to CMS, they are comprised of three components: spending on medical services, non-benefit administrative costs, and a positive or negative amount referred to as "gain/loss". Specifically, plan j's bid in year t, denoted as b_{jt}, is calculated as follows:

$$b_{jt} \quad = \quad bb_{jt} - cs_{jt} + \psi_{jt}(C^O_{jt} + \rho_{jt}). \tag{1}$$

where bb_{jt} represents expenditure for the TM benefit package, cs_{jt} represents the expected cost-sharing for those services under the TM cost-sharing rules, ψ_{jt} is a fraction described below, C^O_{jt} are non-benefit administrative expenses, and ρ_{jt} is the gain/loss amount.

The bid b_{jt} is then compared to the benchmark $\tilde{B}_{jt}$. If the MA plan's bid is above its benchmark, CMS limits its payment to the benchmark, and the plan collects the difference through premiums.

However, most MA plans bid below their benchmark, meaning they propose to de-

[2]Plans submit actuarial evidence supporting enrollment and risk score projections, and differences between projected and realized risk score are reconciled after the contract year. We interpret "projections" as a true revelation of the plan's actual expectation, and treat the risk score as exogenous.

liver care more cheaply than the counterfactual TM spending for their enrollees.[3] In these cases, CMS pays the plan its bid, and a proportion η_{kt} of the difference between the benchmark and the bid as "rebate".

$$\text{rebate}_{jt} = \eta_{kt} \times (\lambda_{kt} rs_{jt} B_{jt} - b_{jt}) \quad \text{if } b_{jt} \leq \lambda_{kt} rs_{jt} B_{jt} \tag{2}$$

This expression reveals the key role of the rebate rate η_{kt} in the MA market. For the choice variable ρ_{jt} (the gain/loss amount), a \$1 increase in gain/loss reduces rebates by η_{kt}, and thus increases premiums by η_{kt}. Thus, a higher η_{kt} strengthens the premium penalty for a higher ρ_{jt}. The rebate rate η_{kt} was altered in the Quality Bonus Program we study; we describe it in Section 2.2.

In addition to the core medical benefits we have discussed, plans offer benefits beyond those covered by TM. These benefits take two forms: reductions to the TM-determined cost-sharing, and extra services such as vision, dental, and hearing coverage that are not included in the TM benefit package. The cost of these services is represented by a "supplemental premium":

$$\text{supp premium}_{jt} \quad = \quad sb_{jt} + (1 - \psi_{jt})(C^O_{jt} + \rho_{jt}). \tag{3}$$

where sb_{jt} is the plan's supplementary benefits including the reductions and extra benefits such as dental, vision, and hearing coverage. In addition, the supplemental premium includes a fraction $1 - \psi_{jt}$ of the administrative cost C^O_{jt} and the gain/loss amount ρ_{jt}. The fraction ψ_{jt} is given by $\frac{bb_{jt} - cs_{jt}}{bb_{jt} - cs_{jt} + sb_{jt}}$, meaning it is the proportion of the net medical spending for TM services ($bb_{jt} - cs_{jt}$) in total spending for net medical and supplementary benefits.[4]

We model the choice of a complete bundle of medical and prescription drug benefits. Most MA plans have a linked Part D plan in which their enrollees are automatically enrolled. Individuals who choose TM or who choose an MA plan without a linked Part D plan are assumed to buy coverage from the free-standing Part D market.

Premiums are not a choice variable in MA and instead are a function of bids, benchmarks, and benefits.[5] We conceptualize TM benefits as including Part D because MA

[3] MA plans could potentially deliver care more efficiently via lower service prices, improved care coordination, network exclusion of inefficient providers, advantageous selection of beneficiaries conditional on risk adjustment, or reduced coverage of services. Recent research rules out large differences in prices, but finds support for the other pathways (Landon et al., 2022, 2023; Curto et al., 2019; Baker et al., 2020; Ryan et al., 2023).

[4] In our sample, ψ_{jt} has a mean of 92% xx and a standard deviation of xx.

[5] All Medicare enrollees pay an overall premium, known as the Part B premium, for enrollment in either TM or MA in each year. We chose to exclude this from our premium concept because it is uniform across enrollees and premiums with two minor exceptions. First, a small share of MA plans (4%) choose to use

plans commonly use rebates to reduce Part D premiums, which means drug benefits are commonly cheaper in MA than in TM. Gross premiums for each MA plan are comprised of three elements: the basic premium, the Part D premium, and the supplemental premium. By regulation, actual MA premiums are net of any rebates received.[6]

$$p_{jt} = \begin{cases} b_{jt} - \lambda_{kt} rs_{jt} B_{jt} + \text{supp premium}_{jt} + \text{Part D premium}_{jt} & \text{if } b_{jt} > \lambda_{kt} rs_{jt} B_{jt}, \\ \text{supp premium}_{jt} + \text{Part D premium}_{jt} - \text{rebate}_{jt} & \text{if } b_{jt} \leq \lambda_{kt} rs_{jt} B_{jt}, \end{cases} \quad (4)$$

Medicare beneficiaries choose annually between TM and MA. They can enroll in any MA plan offering services in their county at premium p_{jt} for a combined package of MA and Part D.

2.1.1 Unit Revenue

A plan's revenue consists of the CMS payment and the enrollee premium.

As explained above, the CMS payment depends on whether a plan's bid is above or below its benchmark:

$$\text{CMS subsidy}_{jt} = \begin{cases} \lambda_{kt} rs_{jt} B_{jt} & \text{if } b_{jt} > \lambda_{kt} rs_{jt} B_{jt}, \\ b_{jt} + \text{rebate}_{jt} & \text{if } b_{jt} \leq \lambda_{kt} rs_{jt} B_{jt}, \end{cases} \quad (5)$$

The per-enrollee revenue ("unit revenue") for plan j is the sum of the CMS payment in (5) and the enrollee premium payment (4), i.e.,

$$\begin{aligned} UR_{jt} &= b_{jt} + \text{supp premium}_{jt} + \text{Part D premium}_{jt} \\ &= bb_{jt} - cs_{jt} + sb_{jt} + C^O_{jt} + \rho_{jt} + \text{Part D premium}_{jt}, \end{aligned} \quad (6)$$

where the second line is obtained by plugging in (1).

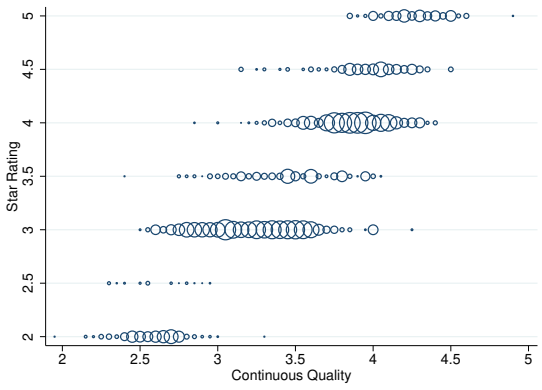
2.2 Star Ratings and the Quality Bonus Program

Since 2007, CMS has provided "star ratings" as a coarse summary of insurer quality. Contracts (plans offered by the same parent company in the same state) are evaluated on

rebates to offset Part B premiums; that use of rebates is reflected in p_{jt} for that plan because we difference the entire amount of rebates. Second, a small share of high-income Medicare beneficiaries pay somewhat larger Part B premiums (regardless of whether they are in TM or MA); we accommodate this difference in our demand model.

[6]This regulation is encoded in the Excel software that Medicare plans use to submit plans to CMS; in addition, it is explained in the instructions to plans for MA Worksheet 6 in the Bid Pricing Tool (CMS, 2022a).

Figure 1: Continuous Quality and Star Rating



This figure reports a scatter plot of star ratings (y-axis) with (binned) continuous quality input q_{kt}. The sample is the set of plan-years used in analysis, and the size of each marker represents the number of plan-years represented in that marker.

specific measures (e.g., share of enrollees with a flu shot), and the measures are aggregated to five categories (outcome, intermediate outcomes, access to care, patient experience, and process). Then, a (continuous) quality score q_{kt} is calculated for contract k in year t as a weighted average of the measures across the five categories. Both the measures and their weights change across years. Finally, a star rating is determined based on the quality score q_{kt} and an adjustment factor (denoted τ_{kt}), which is determined by how a plan's quality compared with the competitors'. Therefore, while q_{kt} is under the control of an insurer, the adjustment factor τ_{kt} is unknown. To make the star rating r_{kt} that is shown to consumers, the sum of q_{kt} and τ_{kt} is rounded to the nearest 0.5, with a floor of "< 2" and a top code of 5.

Figure 1 first reports on the mapping from continuous quality q_{kt} (x-axis) to the actual star rating r_{kt} (y-axis). The size of each marker represents the number of contract-year observations represented in that dot. Within each level of star rating, there are contracts with continuous quality ratings both above and below that eventual star rating; the horizontal distance is a measure of the adjustment factor τ_{kt}. Later in our model, we assume that τ_{kt} follows a normal distribution with mean zero and variance σ_τ^2.

Starting in 2012[7], the MA program introduced the Quality Bonus Program (QBP), which links CMS payments with star ratings. Specifically, QBP made two parameters, benchmark multiplier λ and rebate rate η, positive functions of star rating r. In addition,

[7] A payment-related quality incentive was legislated in the 2010 Affordable Care Act. CMS implemented the ACA-legislated quality program in 2015, but launched for the years 2012–2014 a "demonstration" project with similar parameters.

QBP lowered the rebate rate overall.

3 A Simplified Model of Medicare Advantage

In this section we use a simple model to illustrate how the MA market works and how QBP affects the market. We abstract away some of the details of the MA market introduced in Section 2, which return in our empirical model in Section 5.

3.1 A Simplified Model

In the simplified model, we make the following simplifications: We assume uniform risk so that the risk score rs_{jt} is 1 for all plans. We set administrative costs C_{jt}^{O} to zero and allocate all of the gain/loss amount to bid rather than supplementary premium (i.e., $\psi_{jt} = 1$). We also ignore prescription drug benefits. Finally, we suppress subscripts and focus on a single plan.

Under these simplifications, the plan premium is

$$p(b, x; \lambda, \eta) = \begin{cases} b - \lambda B + x & \text{if } b > \lambda B, \\ x - \eta(\lambda B - b) & \text{if } b \leq \lambda B, \end{cases}$$

and the revenue equation is $UR(b, x) = b + x$.

Let $s(p, x, r)$ be the demand function where $\frac{\partial s}{\partial p} < 0$, $\frac{\partial s}{\partial x} > 0$, and $\frac{\partial s}{\partial r} > 0$. Since a plan chooses (b, x, r), we can define an effective demand function that links consumer demand to firm decisions as

$$\tilde{s}(b, x, r; \lambda, \eta) = s(p(b, x; \lambda, \eta), x, r).$$

We have $\frac{\partial \tilde{s}}{\partial b} < 0$, $\frac{\partial \tilde{s}}{\partial r} > 0$, $\frac{\partial \tilde{s}}{\partial \lambda} > 0$, and $\frac{\partial \tilde{s}}{\partial \eta} \geq 0$.

A plan's profit function is

$$\pi(b, x, r) = [UR(b, x) - UC(x)]\tilde{s}(b, x, r; \lambda, \eta) - FC(r), \tag{7}$$

where $UC(x)$ is the unit cost and $FC(r)$ is the fixed cost.

3.2 Effects of QBP

Before QBP, both rebate parameters, i.e., the bonus rate η and the rebate rate λ, were constant. Let η^{pre} and λ^{pre} denote the pre-QBP rebate parameters. The QBP program led to three changes. First, both η and λ become increasing functions of quality rating r. Let

$\lambda^{\text{post}}(r)$ and $\eta^{\text{post}}(r)$ denote the post-QBP rebate parameters. Second, λ became weakly larger, i.e., $\lambda^{\text{post}}(r) \geq \lambda^{\text{pre}}$. Third, η becomes strictly smaller, i.e., $\eta^{\text{post}}(r) < \eta^{\text{pre}}$.

These three changes affect the plan's profit function and hence plan decisions and market outcomes. Specifically, the effective demand in (7) changes from $\tilde{s}(b, x, r; \lambda^{\text{pre}}, \eta^{\text{pre}})$ to $\tilde{s}(b, x, r; \lambda^{\text{post}}(r), \eta^{\text{post}}(r))$ while the profit margin $[UR(b, x) - UC(x)]$ and the fixed cost function $FC(r)$ remain unchanged. We now explain how each change in QBP affects the effective demand function and thus plan decisions and market outcomes.

Effects of Making Rebates Dependent on Ratings QBP was designed to incentivize plans to improve quality by making rebates dependent on quality ratings (i.e., $\lambda^{\text{post}}(r)$ and $\eta^{\text{post}}(r)$ are positive functions of r). Interestingly, this does not make the profit margin dependent on quality ratings because, as shown in Section 2.1.1, rebates are differenced out of net revenue. The only change to a plan's incentive is that the effective demand function becomes more sensitive to r. Formally, marginal demand from an increase in r is $\frac{\partial \tilde{s}}{\partial r}$ before QBP and becomes $\frac{\partial \tilde{s}}{\partial r} + \frac{\partial \tilde{s}}{\partial \lambda}\frac{\partial \lambda^{\text{post}}}{\partial r} + \frac{\partial \tilde{s}}{\partial \eta}\frac{\partial \eta^{\text{post}}}{\partial r}$ after QBP, where $\frac{\partial \tilde{s}}{\partial \lambda}\frac{\partial \lambda^{\text{post}}}{\partial r} > 0$ and $\frac{\partial \tilde{s}}{\partial \eta}\frac{\partial \eta^{\text{post}}}{\partial r} > 0$. Intuitively, when rebates depend on quality rating r, quality rating r affects demand not only directly but also indirectly through affecting p. Therefore, making rebates positive functions of r incentivizes insurers to improve r by increasing the slope of the effective demand with respect to r.

Effects of Increasing Bonus Rate λ Increasing the bonus rate λ shifts the effective demand to the right because it reduces premium p for any given bid b. Formally, because $\frac{\partial \tilde{s}}{\partial \lambda} > 0$, the effective demand is larger for any given b. Such a shift may increase a plan's incentive to improve quality. This is because a plan faces the tradeoff between increased demand and increased costs when deciding on whether to increase quality rating r. When demand is shifted to the right, the increased demand is likely to become larger while the increased cost $FC'(r)$ remains unchanged. Such a shift in demand may also lead to an increase in bid b, though premium p is still likely to decrease due to the increased bonus rate λ.

Effects of Reducing Rebate Rate η For plans that bid above the benchmark, reducing the rebate rate has no effect. However, for plans that bid below the benchmark, which count for majority of the plans, a change in η rotates the effective demand function as well as shifting it. Specifically, a decrease in η shifts the effective demand to the left because $\frac{\partial \tilde{s}}{\partial \eta} > 0$. A decrease in η also rotates the effective demand counterclockwise (i.e., reducing its slope with respect to the bid b) because the slope is $\frac{\partial \tilde{s}}{\partial b} = \frac{\partial s}{\partial p}\eta$ and a smaller η means a smaller slope.

Shifting demand to the left has the opposite effects as shifting demand to the right (see Effects of Increasing Bonus Rate λ). Specifically, it may reduce a plan's incentive to improve quality and lead to a reduction in bid b although premium is likely to increase due to the reduced rebate rate η.

However, rotating the effective demand counterclockwise generates a countervailing force that can increase b, further increasing the premium. This is because a plan faces the classic trade-off between a larger margin and a smaller quantity when choosing b. When consumers are less sensitive to an increase in b, it is optimal for a plan to increase b.

Correspondingly, the rotation increases the share of public funds goes to firms. As η decreases, the government rebate payment is likely to decrease. There seems to be a trade-off between reduced consumer surplus and reduced government spending. However, because demand becomes less elastic, the reduction in firm profit is likely to be smaller than the reduction in consumer surplus. As a result, the speed for the reduction in consumer surplus is likely to be faster than the speed for the saving in government spending as η decreases.

In summary, while making rebates dependent on quality incentivizes firms to improve quality to the benefit of consumers, the concurrent changes in the rebate rate may have a countervailing effect that reduces consumer welfare faster than reducing government spending.

3.3 Bid Relative to Benchmark and Role of Rebates Usage Restrictions

Though not the focus of the paper, it is worth noting that our model clarifies why some plans bid below the benchmark while others bid above it in the MA market.

The marginal profit of the bid $\frac{\partial \pi}{\partial b}$ is $s + (UR - UC)\frac{\partial s}{\partial p}$ if $b > \lambda B$ and $s + (UR - UC)\frac{\partial s}{\partial p}\eta$ if $b \leq \lambda B$. Thus, the marginal profit of the bid exhibits a discrete increase at $b = \lambda B$, since $\eta < 1$. However, despite this discrete increase at the benchmark, whether the optimal bid is below or above the benchmark depends on the price sensitivity of demand.

Figure * plots the profit of a plan as a function of b when it faces a low price sensitive demand in the left panel and a high price sensitive demand in the right panel. Specifically, the thick black line in figure * represents the actual profit function, i.e. $[UR(b,x) - UC(x)]s(p,x,r) - FC(r)$ with a fixed value of (x,r) and varying values of b, where p is given in (7). To illustrate the kink in the profit function (i.e, the discrete increase in the slope $\frac{\partial \pi}{\partial b}$), we also plot two auxiliary profit functions, namely $[UR(b,x) - UC(x)]s(p,x,r)$, where p is always $b - \lambda B + x$ (the below-benchmark premium) in the blue dashed line and p is always $x - \eta(\lambda B - b)$ (the above-benchmark premium) in the red solid line. Figure * shows that it is indeed possible for some plans to bid below the benchmark while

others bid above it.

The main driver of this result is the direct link between b and p even when a plan bids below the benchmark (i.e. when the base premium is 0), which is a consequence of the requirement that plans must use rebates to offset the premium. To see this point, note that under the current rebate usage rule, if a plan bids below the benchmark, the rebate is $\eta(\lambda B - b)$ and the total plan premium is $x - \eta(\lambda B - b)$. Without this constraint (i.e. plans are allowed to keep the rebates and can choose a total premium if they bid below the benchmark), the profit would be

$$[b + \eta(\lambda B - b) + p - UC(x)]s(p, x, r) \text{ if } b < \lambda B.$$

Since $\eta < 1$, this function increases with b. Therefore, a plan would never bid strictly below the benchmark.

In summary, even though a \$1 decrease in b leads to an increase in rebates of less than \$1 when a firm bids below the benchmark, it is possible that bidding below the benchmark is optimal. The CMS restriction on the use of rebates plays a key role in creating this possibility, thus incentivizing firms to bid below the benchmark.

4 Data

To estimate demand, we collect plan characteristics such as premium, benefits, and star rating, and combine them with total enrollment from CMS and micro-level data on consumer choices and demographics from the Medicare Current Beneficiary Survey. Our analysis is focused on the 2010-2017 period, covering years both before and after the Quality Bonus Program.

4.1 Data Sources

Plan Data Our primary source of plan-level data are the detailed submissions that plans use to justify and support their bids to CMS (CMS, 2022a). This information is made available with a five-year lag. The plans submit bids in the summer preceding year t (after benchmarks are known, but before r_{jt} is known). The plans submit estimates of expected spending on Medicare-covered benefits bb_{jt}, the cost sharing cs_{jt} for Medicare-covered benefits under the TM benefit design (which we refer to throughout as TM-cost sharing), and the dollar value of the plans' cost-sharing reductions cs_{jt}^{red} and extra benefits eb_{jt}, non-medical (administrative) costs C_{jt}^{O}, and the gain/loss amount ρ_{jt}. Plans also project enrollment in each county to create an expected composite benchmark B_{jt}, and

project their risk score rs_{jt}. Combined with a projection of this year's star rating[8], these determine bid, rebate, basic premium, and supplementary premium. We also use these files to generate indicators for whether the plan's extra benefits are used to supply any vision, dental or hearing benefits. Certain bidding variables are censored in the bidding data for some plans due to CMS data disclosure rules; we impute these variables using a process described in Appendix Section A.

We collect enrollment data at the plan-county-year level (Centers for Medicare and Medicaid Services, 2021). Enrollment is censored if it is below 11, due to CMS data restrictions.

We develop two further characteristics that capture key metrics of differentiation among MA plans. First, we include a measure of plan networks, since MA networks vary greatly in their breadth. We replicate the measure of Feyman et al. (2024) which infers the breadth of an MA network from the prescription drug claims. We describe each MA plan-year as having a narrow, medium, or broad network. Secondly, we create an indicator that the plan is offered by one of the top two commercial insurers in the county. This indicator may reflect that this plan can take advantage of economies of scale (through co-management with its commercial insurance), or may have advantages in attracting enrollment (by specifically marketing to commercial enrollees who turn 65). We obtain this indicator from the American Medical Association's 20xx estimates of commercial market share's for each state and metro area. We crosswalk counties to urban areas using xxx, and use the state estimates for counties in non-metro areas.

County Data We collect county characteristics to use as instruments. These include county demographics (CMS, 2022b), risk-neutral benchmark (CMS, 2022b), primary care physicians per capita (AHRF, 2021), specialist physicians per capita (AHRF, 2021), and the Herfindahl–Hirschman Index for hospital systems (AHA, 2016). At the plan-county level, we generate an indicator that is 1 if the plan's parent company is among the top two insurers in this county in the employer market (Guardado and Kane, 2020).

Individual Data We obtain individual-level data from Medicare Current Beneficiary Survey (MCBS), which is a rolling-panel survey of a nationally representative sample of Medicare beneficiaries from 2010-2017 (except 2014 for which no data are available).

[8]Projected stars and actual stars (announced a few months later each fall) are similar. In particular, even when they differ, the fact that adjacent star values commonly map to the same rebate rate or bonus rate means that the rebate levels based on projected and actual star values are very similar. Rebates based on projected and actual stars are the same for 60% of the plan-county-years used in analysis, and within $80 (approximately 10% of average annual rebates) for 85% of plan-county-years. We use actual stars (i.e., what is reported to consumers in the fall before year t and is displayed when consumers shop for plans at Medicare.gov) as our star rating measure throughout the paper.

We observe detailed demographic information of the respondents, including county of residence, income, age, gender, race, education, and insurance arrangements. The respondents also self-report their heath status, which we dichotimize as "bad health" (fair or poor, as opposed to excellent, very good, or good). CMS merges on administrative records of MA plan enrollment for each respondent.

4.2 Data Descriptives

4.2.1 Bidding, Benefits, and Premiums

We begin by describing the observable data for a single plan in order to demonstrate the relationships described in Section 2. We take as our example a popular plan offered by UnitedHealthcare in 2017 in Wisconsin. This plan's annual benchmark was \$10391 based on its counties of operation and its 5-star rating in 2017. The plan bid \$9090, which was comprised primarily of medical benefits (e.g.,a basic benefit bb_{jt} of \$8287 less a TM-standard cost-sharing cs_{jt} of \$1352); the bid also reflected 92% (i.e., ψ_{jt}) of the plan's \$1112 of administrative costs (i.e., \$1025) and gain-loss amount of \$1226 (i.e.,\$1129). The plan bid under its benchmark; when combined with an $\eta(r) = 0.7$ resulted the plan was granted a rebate of \$911(=(10391-9090)*0.7). The plan's benefits included \$467 in cost-sharing reductions and \$125 in extra benefits. Following equation 3, these supplemental benefits were combined with $(1 - \psi_{jt})(C_{jt}^{O} + \rho_{jt})$ for a supplemental premium of \$778. In addition, the plan offered an integrated Part D plan with a premium of \$421. However, as implied by Equation 4, the actual premium paid by enrollees in the plan was \$288(=\$778+\$421-\$911).

The numbers for this plan are typical of MA as a whole. In Panel (a) of Figure 2, we describe the average values of benchmarks (including quality bonuses), bids, and bidding components in our sample. In Panel (b), we show how rebates are used as required by the MA program to offset total premiums. The use of the rebate to offset Part D premiums is quantitatively important; among plans that receive a rebate, the rebate exceeds supplemental benefits (e.g., exceeds the sum of cost-sharing reductions and extra benefits) for xx% of those plans, and is thus used to offset the gross Part D premium.

Table **??** describes the plan-level variables used in demand and supply estimation. Since MCBS micro-data covers only a subset of plans in our plan-level data and our estimation only uses those plans that fall within MCBS sample area, we report statistics for these xxx plans only. These plans represent more than 50% of MA enrollment overall.

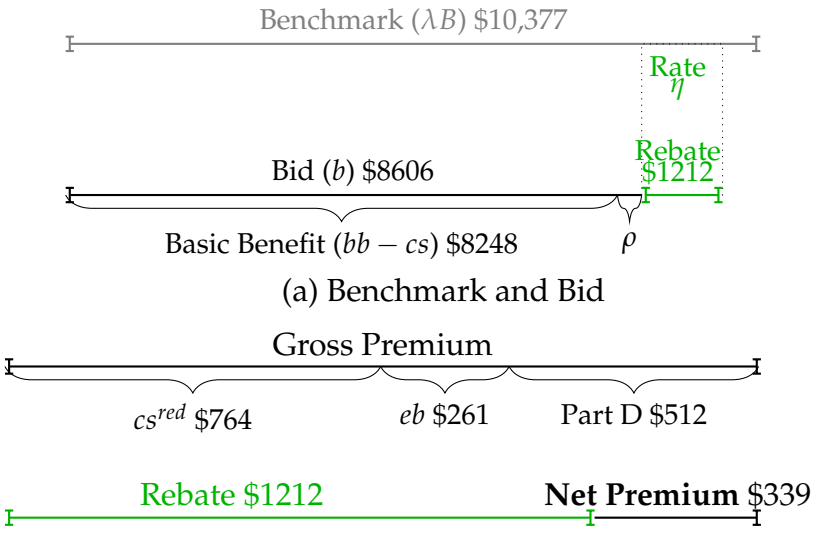
This table reports enrollment-weighted means and percentiles (the 10th, 50th, and 90th) for key variables both before and after QBP. In Panel A, we begin by reporting benchmarks. While benchmarks excluding bonuses were fairly similar before and after

Table 1: Data Descriptives: Bidding, Benefits, Premiums, and Enrollment

	Before QBP: 2010–2011				After QBP: 2012–2017			
	mean	p10	p50	p90	mean	p10	p50	p90
Panel A: Benchmarks and Bids ($)								
Benchmark Excluding Bonus	11024	8134	10610	14764	11039	8213	10392	14480
Benchmark Including Bonus	11024	8134	10610	14764	11365	8476	10661	14887
Bid	9430	7224	9073	12096	9545	7062	9022	12650
Benchmark (Incl. Bonus) – Bid	1594	316	1341	3223	1820	454	1564	3433
Rebate	1203	237	1006	2417	1215	307	1032	2329
Panel B: Medical and Supplemental Benefits ($, except risk score)								
Basic Benefits	9865	7201	9559	12766	9757	7197	9369	12609
Risk Score rs_{jt}	1.037	0.835	0.998	1.303	1.095	0.861	1.047	1.401
TM cost-sharing	1570	1158	1528	2004	1522	1139	1472	1931
Administrative Cost	884	527	836	1318	1043	569	1011	1513
Gain/Loss Amount	395	-101	439	1277	405	-325	389	1253
Cost-Sharing Reductions	749	247	704	1292	636	92	584	1182
Cost-Sharing Net of Reductions	821	366	693	1389	886	393	809	1495
Extra Benefits	234	83	188	437	225	76	165	425
Panel C: Premiums and Rebates ($)								
Basic MA Premium	11	0	0	0	12	0	0	0
Supplemental Premium	1127	477	1094	1776	1000	410	922	1650
Part D Premium (Integrated Plans only)	462	145	361	836	545	217	454	941
Part D Premium (All Plans)	453	157	386	785	529	227	447	900
Gross Premium	1591	768	1430	2450	1540	786	1403	2419
Net Premium	388	0	0	1392	325	0	0	1104
Panel D: Enrollment and Market Share								
Enrollment (Plan-Year Level)	19415	2038	13815	41097	24555	2761	15234	48600
Market Share (Plan-Year-County Level)	0.052	0.006	0.035	0.122	0.054	0.007	0.036	0.127
Panel E: Premiums, Cost-Sharing, and Premiums Relative to TM ($)								
Net Premium - TM Premium	-28	-485	-340	976	-111	-658	-266	690
Net Cost-Sharing - TM Cost-Sharing	-425	-910	-496	76	-503	-984	-513	-45
Total Benefits - TM Benefits	-941	-2653	-1181	666	-1882	-3708	-1974	-113
N	7,519 plan-years				21,410 plan-years			

xxx table notes

Figure 2: Benchmarks, Bids, and Rebates



(a) Benchmark and Bid

(b) Premium and Rebate

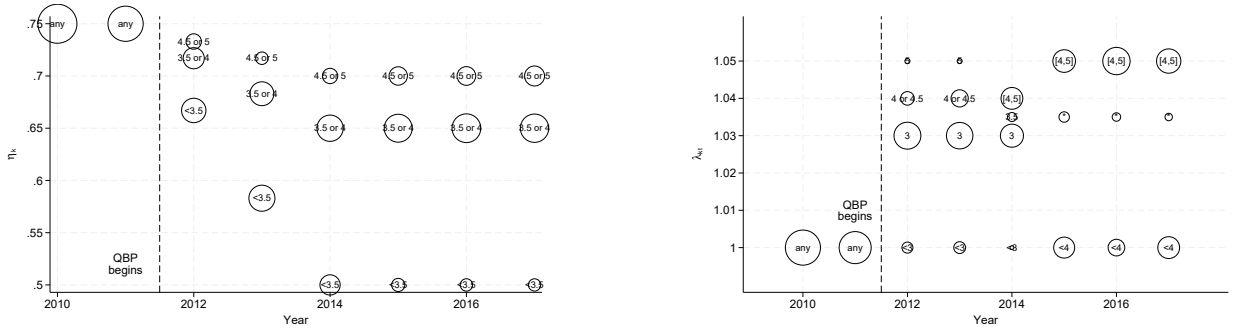
QBP, the QBP bonuses substantially increased bonuses. Bids increased slightly after QBP, although because benchmarks increased by even more, the benchmark-bid spread was larger after QBP. However, since rebate rates fell, overall rebates were fairly stable.

Panel B reports on plan benefits. The first row represents bb_{jt}; variation in what plans expect to spend on basic benefits are driven both by geography and by risk score (reported in the next row). The next three rows report on other inputs to bids. We note the large distribution in gain/loss amounts, with about 21% of plan-years choosing a negative gain/loss amount while 15% are choosing an amount in excess of a tenth of the plan's bid. We also note the important role of cost-sharing reductions, which are on average reducing beneficiary cost-sharing by approximately half relative to the TM standard.

Panel C reports on the components of premiums. Consistent with the vast majority of plans (92%) bidding below the benchmark, basic MA premiums are zero for most plans and low overall. Supplemental premiums, representing cost-sharing reductions and extra benefits, are the main determinant of gross premiums. Part D premium represents about a quarter of gross premiums, and are similar for MA plans with an integrated Part D plan or those for whom we impute the premium for the most popular free-standing Part D plan. 23% of MA plan-years are completely offsetting both supplemental and Part D premiums for a net premium of zero; however, these are the most popular plans, representing just over half of enrollment (e.g., the enrollment-weighted median net premium is zero).

The next panels report on variables used in demand estimation. Panel (D) reports on

Figure 3: Rebate Rates and Bonus Rates for MA Plans, 2010–2017



(a) Rebate Rates

(b) Bonus Rates

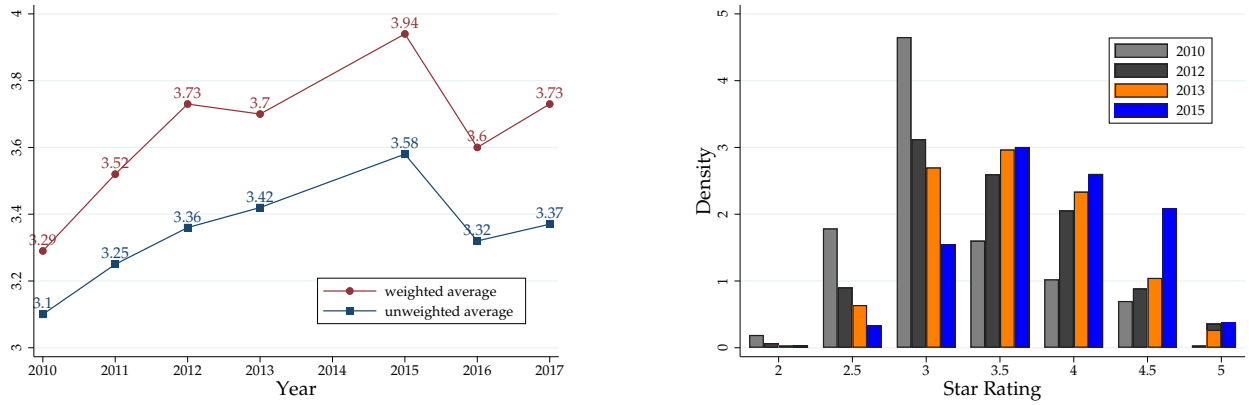
These figures represent rebate rates η_{kt} and bonus rates λ_{kt} over the years 2010–2017. The size of each marker represents the number of plans obtaining that rebate or bonus rate in that year, and the marker label represents the star rating that corresponds to that rebate or bonus rate in that year. Plans that lacked quality ratings are omitted from the figure; such plans were accorded the rebate and bonus rates of 3 or 3.5 star plans (depending on the year.)

plan enrollment and market shares for our sampled plan-years. In Panel (E), we report on key variables relative to their TM level, which is how we use them in estimation. The first row compares premiums, where the MA premium is net of rebates and the TM premium reflects simply the Part D premium for the most-popular free-standing plan. MA is generally less expensive than TM in our sample, particularly after QBP. Consistent with the important role of cost-sharing reductions, MA plans have much lower cost-sharing than TM. Finally, MA plans are offering a lower level of total benefits (medical benefits plus Part D benefits).

4.2.2 Quality Bonus Program

As discussed in Section 2.2 QBP affected CMS payments in three ways. First, the rebate rate for a particular contract η_{kt} became a positive function of its star rating r_{kt}. Second, it lowered rebate rates on average; rebate rates in 2011 were 0.75 for all contracts, but by 2014, only 18% of plans were receiving the highest rebate rate of 0.7, and 31% were receiving the lowest rebate rate of 0.5. Third, QBP established a quality-related "bonus" λ_{kt} that also increases with star ratings. Importantly, QBP left in place other regulations described previously, such as a requirement that rebates be used to offset the costs of supplemental benefits or Part D. Figure 3 show the number of plans at each rebate rate and bonus rate before and after QBP, while Appendix Table A1 shows how the rebate rate η_{kt} and the bonus rate λ_{kt} depend on a contract's star rating between 2009 and 2017.

Together with Table **??** we can perhaps reproduce CMS policymakers' reasoning when



(a) Average Star Rating

(b) Star Distribution

Figure 4: Star Ratings (2010-2017)

they reduced the rebate rate in the QBP. Over the two years preceding the reform, benchmarks were averaging $11024 and benchmark-bid spreads were averaging approximately $1600 with rebates at 75% of that, $1200. If CMS had simply set an average benchmark bonus of 1.03, that would have raised benchmark-bid spreads by $331 (3% of $11024) and would have raised rebates (and thus CMS subsidies) by $248. Thus, they paired an average 3% increases in benchmarks with a reduction in rebate rate to 0.62. Without accounting for any changes in bidding behavior, this would have implied that average rebates were now $1197($= 0.62(1600 + 331)$), very close to the rebates pre-reform rebates.

As shown in Section 3.2, QBP created upward pressure on quality investments and star ratings. Figure 4a displays how the average star rates of contracts, without and with weighted by contract enrollment, evolves over time from 2010 to 2017. The average star increases since 2010 and reaches around 4 in 2015, declining after that; note that CMS adjusted the rating system over this time period in an effort to encourage further quality improvements. The fact that the weighted average is above the unweighted average implies that contracts with higher stars have higher enrollment.

Figure 4b displays the distribution of rates before the implementation of QBP (2010 and 2012) and after that (2013 and 2015). Clearly, the distribution shifts towards the right after QBP, implying that insurers are motivated by the financial incentives to target higher rates.

However, these pre-post comparisons do not clarify the full impact of QBP on plan bidding and choice of plan characteristics; to fully do so, we now turn to our structural model.

Table 2: Summary Statistics of MCBS Individual-Level Data

	All		MA enrollees		TM enrollees	
	Mean	Std.dev	Mean	Std.dev	Mean	Std.dev
MA indicator	0.222	0.416	1	0	0	0
Income ($)	42,407	67,360	35,836	61,723	44,282	68,769
High income	0.497	0.500	0.438	0.496	0.514	0.500
Bad health	0.448	0.497	0.457	0.498	0.446	0.497
Age	71.87	14.77	73.64	12.31	71.36	15.35
Age $\in [75, 85)$	0.330	0.470	0.363	0.481	0.321	0.467
Age > 85	0.165	0.371	0.161	0.367	0.166	0.372
Female	0.542	0.498	0.564	0.496	0.536	0.499
Black	0.108	0.311	0.121	0.327	0.104	0.306
Hispanic	0.028	0.164	0.043	0.204	0.023	0.151
Attend college	0.495	0.500	0.447	0.497	0.509	0.500
Administrative indicators						
Employer provided insurance	0.263	0.441	0.049	0.215	0.324	0.468
Non-aged eligibility	0.175	0.380	0.131	0.337	0.188	0.391
Medicaid	0.197	0.398	0.197	0.398	0.197	0.398
Observations	63,326		14,059		49,267	

Note: An observation is a person-year. Income groups are defined by terciles of the income distribution for the entire MCBS sample. Low income is the omitted group.

4.2.3 Summary Statistics for Demand and Supply

Table 2 presents the summary statistics of our 62,899 individuals who covers 2,936 county-year markets. The first set of columns report means and standard deviations across all individuals. The mean income is $42,471 and 44.9% self-report either "Fair" or "Poor" health. The mean age is around 72, 33% are older than 75 but younger than 85, and 16.5% are older than 85. 54% are female, 10.9% are Black and 2.8% are Hispanic. Around half of them have attended college or above. 26.4% of individuals have employer-provided insurance, 17.5% are non-aged eligible, and 18.7% also have Medicaid.

The second set of columns report the statistics for MA enrollees and the third set of columns report the statistics for TM enrollees. On average, MA enrollees have lower income, are more likely to self-report bad health, are more likely to be female, Black, Hispanic, and have less educational attainment. Individuals with employer-provided insurance or Medicaid or non-aged eligible are less likely to choose MA plans.

5 An Oligopoly Model of Medicare Advantage

We now posit a model of Medicare Advantage that allows us to represent consumer choice and directly examine plans' strategic incentives both before and after the QBP policy change.

Each year t begins with the determination of parameters we treat as exogenous: each county's benchmark B_{ct} and the premium, benefits, and cost-sharing in TM in each county (p_{0ct}, bb_{0ct}, cs_{0ct}), as well as each plan's expected expenses $bb_{jt} - cs_{jt}$ for Medicare-covered services.

5.1 Demand

Medicare beneficiaries choose annually between TM and any MA plan operating in their county. Let $\mathcal{J}_{ct}$ denote the set of MA plans in county c in year t. Consumer i in county c gets utility u_{ijct} from MA plan j in year t and utility u_{i0ct} from TM. We assume that a consumer's utility from a plan depends on the plan's attributes and individual-specific tastes. Specifically, the utility that consumer i gets from a MA plan j in county c in year t is

$$u_{ijct} = \beta_i^p p_{jt} + \beta_i^{sb} sb_{jt} + \beta_i^{cb} cb_{jt} + + \beta_i^{sr} r_{jt} + \boldsymbol{x}_{jt}\boldsymbol{\beta}^x + \boldsymbol{z}_i\boldsymbol{\theta}^z + \xi_{jct} + \epsilon_{ijct}$$

where p_{jt} is the total premium that consumers need to pay for plan j in year t defined in (4). sb_{jt} is the supplementary benefits provided by the plan, including the cost-sharing reductions and the dollar value of vision, hearing, and dental coverage. cb_{jt} is the sum of Medicare-covered benefits and the drug benefits, measured in dollars. The star rating in year t for the contract that plan j belongs to is given by r_{jt}. The vector $\boldsymbol{x}_{jt}$ includes an indicator of whether plan j has its own linked Part D plan and year fixed effects. The term ξ_{jct} is the unobserved county-year-specific taste for plan j. ϵ_{ijct} is consumer i's idiosyncratic taste, following i.i.d. Type-I extreme value distribution.

Demographics affect consumer preferences in two ways. First, we allow consumer tastes for MA plan attributes to depend on whether consumer i has high income (above the highest tercile of the income distribution in the MCBS sample), whether her self-reported health status is either "fair" or "poor"; and whether she has attained at least a bachelor's degree. Therefore, consumer tastes for price, cost sharing, basic benefits, supplementary benefits, and star rating, i.e., β_i^p,β_i^{sb},β_i^{cb}, and β_i^{sr} are indexed by the subscript i. Second, we include the following demographics in the utility function: age, sex, race, ethnicity, educational attainment, access to an employer-sponsored health benefit,[9]

[9] An employer-sponsored health benefit could arise either because the beneficiary (or her spouse) is still

Medicare entitlement due to work-limiting disability, and dual enrollment in Medicaid. These demographics are likely to influence the choice of MA plans vs. TM. We denote them by z_i.

Finally, we include in x_{jt} an indicator for an integrated Part D benefit, an indicator that the plan is offered by one of the top two commercial insurers in the county, and the indicators for a network being medium or broad (relative to narrow).

The utility from choosing traditional Medicare is

$$u_{i0t} = \beta_i^p p_{0ct} + \beta_i^{cb} cb_{0ct} + \epsilon_{i0t},$$

The premium for TM in each county is given by p_{0ct}; this premium reflects the beneficiary's cost of enrolling both in TM as well as the most popular free-standing Part D plan in the county.[10] We measure spending on basic services in TM using publicly-available data using program rules and the category-specific components of spending on basic services (CMS, 2022b). To form cb_{0ct}, we add to it the expected spending for the most popular Part D plan in the county.

Following Berry, Levinsohn, and Pakes (1995), we define the "relative" mean utility, δ_{jct}, as the difference between the mean utility from plan j in county c in year t and the mean utility of TM in that county and that year:

$$\delta_{jct} = \bar{\beta}^p(p_{jt} - p_{0ct}) + \bar{\beta}^{sb} sb_{jt} + \bar{\beta}^{cb}(cb_{jt} - cb_{0ct}) + \bar{\beta}^{sr} r_{jt} + \boldsymbol{x}_{jt}\boldsymbol{\beta}^x + \xi_{jct}. \quad (8)$$

We let μ_{ijct} denote individual-specific utility, which is

$$\mu_{ijct} = \boldsymbol{d}_i\theta^p \cdot (p_{jt} - p_{0ct}) + \boldsymbol{d}_i\theta^{sb} \cdot sb_{jt} + \boldsymbol{d}_i\theta^{cb} \cdot (cb_{jt} - cb_{0ct}) + \boldsymbol{d}_i\theta^{sr} \cdot r_{jt} + \boldsymbol{z}_i\boldsymbol{\theta}^z. \quad (9)$$

Under the type-I extreme value distribution assumption for ϵ_{ijct}, the probability that consumer i in county c chooses plan j in year t has a Logit form:

$$s_{ijct} = \frac{exp(\delta_{jct} + \mu_{ijct})}{1 + \sum_{j' \in \mathcal{J}_{ct}} exp(\delta_{j'ct} + \mu_{ij'ct})}. \quad (10)$$

Let $\mathcal{I}_{ct}$ be the set of consumers in county c in year t in the MCBS data. Then, the market

working or because a former employer offers health benefits as part of a retiree package.

[10] Over our time period, approximately three-fourths of Medicare enrollees purchase prescription drug coverage through Part D. The remainder generally obtain coverage as part of an employee or retiree benefit package for themselves or their spouse; the presence of such benefits is accounted for in our demand model by the indicator for employer-provided insurance.

share of plan j in county c in year t is:

$$s_{jct} = \sum_{i \in \mathcal{I}_{ct}} w_{it} s_{ijct} = \sum_{i \in \mathcal{I}_{ct}} w_{it} \times \frac{exp(\delta_{jct} + \mu_{ijct})}{1 + \sum_{j' \in \mathcal{J}_{ct}} exp(\delta_{j'ct} + \mu_{ij'ct})}, \tag{11}$$

where w_{it} is the MCBS sample weights.

5.2 Supply

MA insurers simultaneously choose the gain loss ρ_{jt}, supplementary benefits sb_{jt}, and quality input q_{kt} for their MA plans. These choices in turn generate each plan's premium p_{jt} and star rating r_{jt}.

On the supply side, we assume each state-year is a market. After CMS publishes the benchmarks at the beginning of each contract period, MA insurers in a market simultaneously choose the quality inputs for their contracts as well as the gain/loss amount and supplementary benefits for their plans. Specifically, let $\mathcal{K}_{fst}$ denote the set of contracts that insurer f offers in state s in year t, $\mathcal{J}_{kt}$ denote the set of plans that included in contract k in year t, and $\mathcal{C}_{jt}$ denote the set of counties that plan j covers in year t. The profit-maximization problem for MA insurer f is:

$$\max_{\{\rho_{jt},\, sb_{jt}, j \in \mathcal{J}_{kt};\, q_{kt}, k \in \mathcal{K}_{fst}\}} \sum_{k \in \mathcal{K}_{fst}} \Big\{ [\sum_{j \in \mathcal{J}_{kt}} \sum_{c \in \mathcal{C}_{jt}} (UR_{jt} - UC_{jt}) M_{ct} E(s_{jct})] - C^q_{kt}(q_{kt}) \Big\}, \tag{12}$$

where UR_j and UC_j are, respectively, the unit revenue and unit cost associated with one enrollee of plan j (of plan j's expected risk score). We have explained UR_j in Section 2.1.1 and will define UC_j in what follows.

The market share s_{jct} in Equation 12 is an expectation; this is because the share depends on star ratings, which itself depends on the insurer's choice of the quality input q_{kt} and a shock, i.e., the adjustment factor τ_{kt}. In practice, we use the empirical mapping from quality input q_{kt} – i.e., the average star ratings across the five domains – to overall star rating r_{kt} for the functional form $r_{kt} = \text{round}_{0.5}(q_{kt} + \tau_{kt})$, where $\text{round}_{0.5}$ indicates rounding to the nearest half. We assume a mean of zero for τ_{kt} and estimate a variance of 0.587. Finally, $C^q_{kt}(q_{kt})$ is the cost of providing quality input q_{kt}.

The unit cost of an enrollee, UC_{jt}, is assumed to be

$$UC_{jt} = (\gamma^{sb} + \omega^{sb}_{jt}) sb_{jt} + \tilde{C}^o_{jt}. \tag{13}$$

In equation (13), γ^{sb} is the average cost of providing the \$1 in estimated supplementary

benefits[11], and ω_{jt}^{sb} is plan j's deviation from the average in year t. $\tilde{C}_{jt}^{o}$ is the remaining part of plan j's cost in year t, including the cost of providing medical and prescription drug benefits as well as other observed and unobserved factors.

As for the quality-related cost, we assume that the marginal cost of quality for contract k is

$$\frac{\partial C_k^q(q_{kt})}{\partial q_{kt}} = \gamma_{1t}^q + \gamma_2^q q_{kt} + \omega_{kt}^q, \tag{14}$$

This equation allows the marginal cost of the quality input to be a function of the level of quality (which allows it to be more costly to increase quality when it's already at a high level), and a cost shock ω_{kt}^q. Moreover, we allow this cost function to be year specific to capture the fact that the inputs into the quality measure and the weights of those inputs vary over years, as pointed out in Vatter (2021).

5.3 First Order Conditions

In our model, Medicare insurers choose the quality (q_{kt}) at the contract level as well as the gain-loss amount (ρ_{jt}), and supplemental benefits (sb_{jt}) at the plan level. In what follows, we derive the first-order conditions with respect to each of these endogenous variables. These first-order conditions are used for estimating the cost parameters.

Gain-Loss Amount (ρ_{jt}) The insurer's first-order conditions with respect to the gain-loss amount ρ_{jt} is

$$0 = \frac{\partial UR_{jt}}{\partial \rho_{jt}} \Big(\sum_{c \in \mathcal{C}_{jt}} M_{ct} E[s_{jct}] \Big) + \sum_{j' \in \mathcal{J}_{ft}} (UR_{j't} - UC_{j't}) \Big(\sum_{c \in \mathcal{C}_{j't}} M_{ct} \frac{\partial E[s_{j'ct}]}{\partial p_{jt}} \frac{\partial p_{jt}}{\partial \rho_{jt}} \Big) \tag{15}$$

where, according to (6),

$$\frac{\partial UR_{jt}}{\partial \rho_{jt}} = 1$$

and, according to equations (1)–(3) and (4),

$$\frac{\partial p_{jt}}{\partial \rho_{jt}} = \begin{cases} 1 & if\ b_{jt} > \lambda_{kt} rs_{jt} B_{jt}, \\ \psi_{jt}\eta_{kt} + (1 - \psi_{jt}) & if\ b_{jt} \leq \lambda_{kt} rs_{jt} B_{jt}. \end{cases} \tag{16}$$

[11] That is to say, sb_{jt} is the plan's reported accounting cost of supplying supplementary benefits; we include this dollar value in demand to capture the generosity of these benefits. γ^{sb} captures the true average cost incurred by the firm for reporting \$1 in supplementary benefits.

Though seemingly complicated, this first-order condition reflects the familiar tradeoff between profit margin and demand quantity in choosing its gain/loss amount ρ_{jt}. Specifically, a one dollar increase in ρ_{jt} leads to a one dollar increase in the unit revenue and thus in the profit margin. At the same time, an increase in ρ_{jt} leads to an increase in premium ($\frac{\partial p_{jt}}{\partial \rho_{jt}} > 0$) and thus a decrease in market share ($\frac{\partial E(s_{jct})}{\partial p_{jt}} < 0$). Specifically, when a plan bids above the benchmark and thus receives no rebate, a higher gain/loss increases premium one for one. When a plan bids below its benchmark, an increase in ρ_{jt} by one dollar reduces rebates by $\eta_{kt}\psi_{jt}$ and supplemental premium by $(1 - \psi_{jt})$, both leading to a higher premium and thus a smaller market share.[12]

However, this first order condition highlights the key role of the rebate rate η_{kt} in the tradeoff between unit revenue and demand. Before QBP, rebate rates were a uniform 75% for all plans; after QBP, Figure 3 showed that rebates fell on average to range of 50% to 70%. A lower rebate rate lowers $\frac{\partial p_{jt}}{\partial \rho_{jt}}$ for the majority of plans that bid below their benchmark. Thus, after QBP a higher ρ results in a weaker premium increase and thus a weaker demand penalty. In our counterfactuals, we will independently model the role of the overall rebate rate reductions in QBP in order to isolate this channel.

Supplementary Benefits (sb_{jt}) The insurer's first-order condition with respect to supplementary benefits (the sum of cost-sharing reductions and extra benefits) is

$$\begin{aligned} 0 \;=\; & \Big(\frac{\partial UR_{jt}}{\partial sb_{jt}} - \frac{\partial UC_{jt}}{\partial sb_{jt}}\Big)\Big(\sum_{c\in\mathcal{C}_{jt}} M_{ct}E[s_{jct}]\Big) \\ & + \sum_{j'\in\mathcal{J}_{ft}} (UR_{j't} - UC_{j't})\Big(\sum_{c\in\mathcal{C}_{j't}} M_{ct}\big[\frac{\partial E[s_{j'ct}]}{\partial sb_{jt}} + \frac{\partial E[s_{j'ct}]}{\partial p_{jt}}\frac{\partial p_{jt}}{\partial sb_{jt}}\big]\Big), \end{aligned} \tag{17}$$

where

$$\frac{\partial UR_{jt}}{\partial sb_{jt}} = 1,$$

and

$$\frac{\partial p_{jt}}{\partial sb_{jt}} \;=\; \begin{cases} 1 & if\ b_{jt} > \lambda_{kt} r s_{jt} B_{jt}, \\ 1 + \frac{(1-\eta_{kt})\psi_{jt}(C^O_{jt}+\rho_{jt})}{bb_{jt}+sb_{jt}} & if\ b_{jt} \le \lambda_{kt} r s_{jt} B_{jt}. \end{cases} \tag{18}$$

A plan's supplementary benefits sb_{jt} affect its profit through three channels. First, increasing sb_{jt} leads to a one-to-one increase in the unit revenue UR_{jt} since any increase

[12]While the ratio ψ_{jt}) appears throughout these FOCs for completeness, ψ is generally close to one, with a mean and median of 0.92 for our sample.

is added to gross premium. Second, they increase costs. Specifically, $\frac{\partial UC_{jt}}{\partial sb_{jt}} = \gamma^{sb} + \omega_{jt}^{sb}$. Three, they affect market share through both a shift of the demand curve and a move along the demand curve. Specifically, they shift demand because consumers value supplementary benefits. At the same time, according to the MA regulation, they mechanically increase premium with the marginal effect given by $\frac{\partial p_{jt}}{\partial sb_{jt}}$ in (18).

QBP changes the incentives for supplemental benefits sb_{jt} in two ways. First, QBP lowers n_{kt} on average; since η_{kt} enters negatively into $\frac{\partial p_{jt}}{\partial sb_{jt}}$, this will mean that the premium impact of higher supplemental benefits is higher after QBP than before. In addition, this first order condition demonstrates that these supplemental benefits sb_{jt} become production complements with quality. To see why, look at $\frac{\partial p_{jt}}{\partial sb_{jt}}$ and note that η_{kt} enters negatively. Thus, as a higher quality level increases rebate rate η_{kt}, the premium impact of higher supplemental benefits is lessened. Thus, relative to before QBP, plans will be incentivized to produce quality and supplemental benefits together after QBP.

Quality (q_{kt}) The insurer's first-order condition with respect to its contract's quality q_{kt} is

$$0 = \sum_{j \in \mathcal{J}_{ft}} (UR_{jt} - UC_{jt}) \Big(\sum_{c \in \mathcal{C}_{jt}} M_{ct} \Big[\frac{\partial E[s_{jct}]}{\partial q_{kt}} + \sum_{j' \in \mathcal{J}_{kt}} \sum_{c \in \mathcal{C}_{j't}} M_{ct} \frac{\partial E[s_{jct}]}{\partial p_{j't}} \frac{\partial p_{j't}}{\partial q_{kt}} \Big] \Big) - \frac{\partial C_k^q(q_{kt})}{\partial q_{kt}} \quad (19)$$

This is a standard optimality condition of equal marginal revenue and marginal cost. Increasing a contract's quality input q_{kt} would shift the distribution of the contract's star rating to the right. A higher star rating affects the market share through two channels. On the one hand, a higher star rating of a contract would increase the demand for all its plans because consumers like star rating. On the other hand, a higher star rating would increase the rebate rate and the bonus rate after 2012, which lower the premium according to equation (5).

5.4 Discussion of the Model

Our model makes several simplifications. First, we ignore the timing issue that a contract's rebate and bonus rates depend on its star rating in the previous year. Essentially, we assume that when an insurer makes its quality decision, the decision is based on the market structure and the demand and cost conditions in the current year instead of a forecast about them in the next year. Therefore, if consumer preference, firm costs, and market structure do not vary greatly over time, our simplification assumption is somewhat innocuous. Despite the simplification assumption, our model captures the three effects

of quality on profit: (1) demand increases with quality; (2) it is costly to provide quality; (3) quality affects star rating of a contract, and thus increases the rebate and bonus rates of any plan within the contract as long as the plan bids below its benchmark. Second, the model is static in the sense that consumers do not learn from their past experience and firms' decisions in one period do not depend on their decisions in the previous periods. Capturing these dynamic sources requires a dynamic model of consumers' plan choice and firms' dynamic investment. As mentioned, we believe our model nonetheless capture the key economic forces in the MA market.

6 Estimation

6.1 Demand Estimation

We carry out the demand estimation in two steps, as in Goolsbee and Petrin (2004).[13] In the first step, we leverage the individual-level data and use maximum likelihood to estimate the parameters that capture heterogeneity in consumer tastes: $\theta = (\theta^p, \theta^{sb}, \theta^{cb}, \theta^{sr}, \boldsymbol{\theta}^z)$, where the $\theta^{(\cdot)}$ parameters govern how consumer tastes for various plan characteristics vary with demographics, and $\boldsymbol{\beta}^z$ governs how consumer taste for MA plans in general varies with demographics. We also obtain the mean utility δ_{jct} for each plan in a county. In the second step, we use an instrumental-variables approach to regress mean utility δ_{jct} on product characteristics to obtain an estimate of $\beta = (\bar{\beta}^p, \bar{\beta}^{sb}, \bar{\beta}^{cb}, \bar{\beta}^{sr}, \boldsymbol{\beta}^x)$.

To conduct the first step, we form the likelihood function based on each individual's choice probability. With a slight abuse of notation, we rewrite the choice probability in (10) as $s_{ijct}(\boldsymbol{\delta}_{ct}, \theta)$ to make its dependence on the parameters θ and the mean utilities of all plans in county c (denoted by $\boldsymbol{\delta}_{ct} = (\delta_{jct}, j \in \mathcal{J}_{ct})$) explicit.[14] Let j_i denote the observed choice of individual i. Then the likelihood of observing individual i choosing j_i is $s_{ij_ict}(\boldsymbol{\delta}_{ct}, \theta)$.

Instead of maximizing the likelihood over the entire parameter space of $(\theta, \boldsymbol{\delta})$, where $\boldsymbol{\delta}$ is the collection of δ_{jct} across for all plans, all counties, and all years, we invert out the vector of mean utilities $\boldsymbol{\delta}(\theta)$ and search over the parameter space θ. Specifically, we invert out the vector of mean utilities $\boldsymbol{\delta}$ by matching the observed market shares in the data and the market shares predicted by the demand model (in (11)) for each county/year combination, in the spirit Berry (1994) and Berry, Levinsohn, and Pakes (1995). Let $\boldsymbol{\delta}_{ct}(\theta)$ be the solution to $\sum_{i \in \mathcal{I}_{ct}} w_{it} s_{ijct}(\boldsymbol{\delta}_{ct}, \theta) = s_{jct}$ for all $j \in \mathcal{J}_{ct}$, where the right-hand side is the

[13] Other examples following such a two-step estimation procedure includes Train and Winston (2007), Murry and Zhou (2020), and Bachmann, Ehrlich, Fan, Ruzic, and Leard (2023).

[14] Its depends on plan attributes and demographics is absorbed in the subscript of $s_{ijct}(\boldsymbol{\delta}_{ct}, \theta)$.

observed market share based on the enrollment data. Plugging $\delta_{ct}(\theta)$ into the likelihood $s_{ij_ict}(\delta_{ct}, \theta)$ yields the log-likelihood function for estimation:

$$L(\theta) = \sum_t \sum_c \sum_{i \in \mathcal{I}_{ct}} w_{it} s_{ij_ict}(\delta_{ct}(\theta), \theta). \tag{20}$$

This step produces the estimates of θ and the mean utilities δ_{jct}.

To conduct the second step, we regress the estimated mean utility of each plan in each county and year δ_{jct} on its premium and characteristics using equation (8) and thereby estimate β, the parameters capturing the average taste. Different from many papers in demand estimation, here, both plan premiums and other plan attributes such as supplementary benefits and star ratings may be correlated with the unobservable demand shocks.

To deal with such endogeneity concerns, following Fan (2013), we construct instrumental variables based on demographic characteristics of the counties served by plan j excepting the county in question. Intuitively, the demographic characteristics of a plan's service market affects both demand and cost for the plan and thus the insurer's decision on plan characteristics.

Specifically, let D_{ct} represent a vector of county demographics. It includes the benchmark, the average age, and the percentages of female, white, black, and Hispanic shares of Medicare beneficiaries in a county. It also includes cost shifters such as per-capita number of primary doctors, per-capita number of specialists, and the Herfindahl-Hirschman Index of hospital systems.

Our instrumental variables are the weighted demographics of plan j's service counties in year t, weighted by the share of a county's market size over the total market size of all service counties:

$$IV_{jt} = \frac{\sum_{c \in \mathcal{C}_{jt}} M_{ct} D_{ct}}{\sum_{c \in \mathcal{C}_{jt}} M_{ct}},$$

where $\mathcal{C}_{jt}$ is the set of counties where plan j is active in year t and M_{ct} is the market size of county c in year t.

Demand Estimation Results Table 3 reports the estimates of the parameters in the utility equation (8). First, we find that consumer utility decreases with a plan's premium and high-income consumers are less sensitive to premium than low-income consumers. Second, consumers value supplementary benefits on average. High-income consumers value it less than low-income consumers. In particular, an increase in supplementary benefits by \$1 is equivalent to an increase in premium by \$0.847 (= 0.641/0.757) for low-

income consumers and \$1.121 (= (0.641-0.122)/(0.757-0.294)) for high-income consumers. We also find that consumers in bad health value the supplementary benefits more than those in better health, perhaps because they use the plan more.

Consumer utility increases with the Medicare-covered services (with a slightly higher increase for individuals in bad health), but the coefficient suggests higher expenditure on these services is only valued at approximately \$0.05 on the dollar. However, this variable represents MA plans' expected spending on a uniform set of services at a uniform benefit design, suggesting that variation in this variable arises due to differences in the prices MA plans pay to providers (e.g., hospitals or physicians). High service prices plausibly have little innate value to MA enrollees, particularly if any increase in provider quality afforded by these higher prices is unobservable to the consumer at the time of plan enrollment.

Our estimates also imply that consumers highly value plans' star rating. The estimated coefficient for the star rating is 0.680, implying that one point increase in a plan's star rating is equivalent to a decrease in the premium by \$898 ($= 0.680/0.757 \times 1000$) for low-income consumers and $\$1,469 = (0.680/(0.757 - 0.294) \times 1000)$ for high-income consumers. Consumers with bad health and higher education value plan quality even more. This suggests that policies that aim at improving plan qualities may have substantial welfare effects.

Finally, coefficients on other plan characteristics and consumer demographics largely accord with intuition. Consumers value MA plans that integrate Part D benefits; integrated plans tend to cover some drugs more generously than free-standing plans, and enrollees can benefit from rebate-funded reductions in Part D premia (Starc and Town, 2019; Lavetti and Simon, 2018). MA plans offered by one of the county's top 2 commercial insurers tend to be more popular, potentially because the parent firm can market the MA plan directly to commercial enrollees prior to the Medicare transition, o. The very oldest individuals (age 85+) have a higher utility from TM relative to MA, as do males, whites, individuals with a college degree or employer-provided insurance, individuals entitled to Medicare due to disability, and individuals dually enrolled in Medicare and Medicaid.[15]

6.2 Supply Estimation

To solve for our supply-side parameters, we back out UC_{jt}, $\frac{\partial UC_{jt}}{\partial sb_{jt}}$, and $\frac{\partial C_k^q(q_{kt})}{\partial q_{kt}}$ from the first-order conditions with respect to, respectively, the gain-loss amount (equation (15)), supplementary benefits (equation (17)), and quality (equation (19)). We use $\frac{\partial UC_{jt}}{\partial sb_{jt}}$ to

[15]Individuals dually enrolled in Medicare and Medicaid do not pay Medicare cost-sharing, which means they do not value the cost-sharing reductions offered by MA plans.

Table 3: Demand Estimates

	Est.	SE
Premium ($1,000)	-0.757	0.042
× High income	0.294	0.001
Supplementary benefits ($1,000)	0.641	0.069
×High income	-0.122	0.001
×Bad health	0.085	0.001
Medicare-covered benefits ($1,000)	0.047	0.005
×Bad health	0.017	0.000
Star rating	0.680	0.027
× Bad health	0.017	0.000
× College or higher	0.025	0.001
Other plan characteristics (β^x)		
Part D Indicator	0.624	0.020
$\mathbb{1}$(Top-2 commercial insurer)	0.073	0.020
$\mathbb{1}$(Medium network)	0.300	0.021
$\mathbb{1}$(Large network)	0.689	0.018
Demographics (θ^z)		
Age $\in [75, 85)$	0.047	0.001
Age > 85	-0.155	0.001
Female	0.043	0.001
Black	0.063	0.001
Hispanic	0.031	0.002
College degree or higher	-0.349	0.002
Employer provided insurance	-2.233	0.001
Non-aged eligibility	-0.481	0.001
Medicaid	-0.375	0.001
N individual-years for Eq. 20	62,899	
Weighted log-likelihood in Eq. 20	-2,224	
N plan-years for Eq. 8	28,929	
First-stage F stat for Eq. 8	164.72	

determine γ^{sb} in Equation (13). And we use $\frac{\partial C_k^q(q_{kt})}{\partial q_{kt}}$ to determine the parameters γ_1^q and γ_2^q in the quality equation.

We estimate the supply-side parameters using the Generalized Method of Moments. Similarly to the endogenous concern in demand estimation, plan attributes such as supplementary benefits and quality may also be correlated with the unobservable cost shocks. We again use the demographic characteristics of plan j's service counties as instrumental variables to address such an endogeneity concern.

6.2.1 Supply Estimation Results

Table 4 reports the estimates of cost parameters. The coefficient before the supplementary benefit is 0.946, suggesting that increasing one dollar value of supplementary benefit would increase insurers' cost per enrollee by around 0.946 dollars. In the lower panel, we present the annual cost of producing a given level of quality in each year of the program. The cost of producing quality is convex in the quality input, and roughly stable during our sample period.

We define plan j's markups in year t as the difference between the plan's revenue per enrollee, including the premium and CMS payment, and the plan's cost per enrollee. It can be measured in dollars or the share of this difference over the total revenue:

$$\text{markup}_{jt} = \frac{\text{premium}_{jt} + \text{CMS payment}_{jt} - \text{implied UC}_{jt}}{\text{premium}_{jt} + \text{CMS payment}_{jt}}$$

Our estimates imply that the average implied cost per enrollee is \$9,115. The average markup per enrollee is \$2,260 in dollars and 17.75% in percentage. Our estimate of markup of MA insurers is comparable with the estimates of previous studies. For example, Vatter (2021) reports an average markup of 11.2% and Curto et al. (2021) reports the average being 19%.

Table 4: Estimates of Cost Parameters

	Unit Cost			
	Estimate			SE
Supp. benefit (γ^{sb})	0.947			(0.002)
Fixed cost of producing a given star level in each year				
	3	4	5	SE
2010	0.747	1.770	2.793	(0.379)
2011	0.696	1.719	2.742	(0.384)
2012	0.853	1.876	2.899	(0.382)
2013	0.886	1.909	2.932	(0.404)
2015	0.854	1.877	2.900	(0.429)
2016	0.573	1.596	2.619	(0.445)
2017	0.652	1.675	2.698	(0.438)

Note: The top panel reports on our estimate of Equation 13. The lower panel reports on our estimate of Equation 14, where we report the annual cost of producing a given level of quality using the estimated γ_1^q and γ_2^q.

7 Subsidy Policies

The main goal of this section is to understand how insurer incentives and consumer demand interact with the subsidy policies to determine market outcomes when competition is imperfect. In particular, we are interested in two subsidy policy instruments: rebate rate and bonus rate. We first consider a set of counterfactual subsidy policies where we adjust one instrument while keeping the other instrument unchanged. This conceptual exercise allows us to cleanly illustrate how the policy instruments of interest affect consumer demand, insurer incentives, and market outcomes. Then we turn to quantify the impact of the Quality Bonus Program that has lowered the rebate rate, increased the bonus rate, and positively tied both to star ratings. To further quantify the impact of each change, we consider a set of counterfactuals where we consider those changes one by one.

Before we conduct the counterfactual analysis, we provide our definitions of consumer surplus, insurer surplus, and the government spending on the Medicare program. Following the literature, we measure consumer surplus in either the true scenario or the counterfactual as the consumer surplus of participating in the market for MA & TM. Based on our demand model, the total consumer surplus in a year t is:

$$\begin{aligned} \textit{consumer surplus}_t &= \sum_c \sum_{i \in \mathcal{I}_{ct}} E\Big[\max_{j \in \mathcal{J}_{ct} \cup \{0\}} u_{ijct}\Big] / \beta_i^p \\ &= \sum_c \sum_{i \in \mathcal{I}_{ct}} ln\Big[1 + \sum_{j \in \mathcal{J}_{ct}} exp(\delta_{jct} + \mu_{jct})\Big] / \beta_i^p. \end{aligned} \tag{21}$$

We define the MA plans' surplus in year t as their total profit in that year:

$$\textit{insurer surplus}_t = \sum_{f \in \mathcal{F}_t} \Big[\sum_{j \in \mathcal{J}_{ft}} \sum_{c \in \mathcal{C}_{jt}} (UR_{jt} - UC_{jt}) M_{ct} s_{jct} - \sum_{k \in \mathcal{K}_{ft}} C_k^q(q_{kt}) \Big], \tag{22}$$

where plan j's revenue per enrollee in year t includes the CMS payment and premium, that is, $UR_{jt} = \textit{CMS payment}_{jt} + \textit{total premium}_{jt}$.

The total government expenditure on the Medicare program in a year t is the sum of the total CMS payments to MA plans and the total spending on TM enrollees in that year, which is

$$\begin{aligned} \textit{government spending}_t &= \textit{CMS payments to MA plans}_t + \textit{government spending on TM}_t \\ &= \sum_c \sum_{j \in \mathcal{J}_{ct}} \textit{CMS payment}_{jt} \times \Big[M_{ct} s_{jct}\Big] \\ &\quad + \sum_c \textit{Average TM spending}_{ct} \times \Big[M_{ct}(1 - \sum_{j \in \mathcal{J}_{ct}} s_{jct})\Big]), \end{aligned} \tag{23}$$

where $\textit{CMS payment}_{jt}$ is the risk-adjusted CMS payment to MA plan j per enrollee given by equation (5), M_{ct} is the total Medicare beneficiaries in county c, and $\textit{average TM spending}_{ct}$ is the average risk-adjusted spending on TM enrollees in county c and year t.

As consumers move between MA and TM in a county, our calculation of government spending includes the spending on both MA and TM. However, we treat $\textit{Average TM spending}_{ct}$ as exogenous as in Miller et al. (2023). In other words, we assume that as consumers switch into or out of MAs, the average risk-adjusted TM spending in that county does not change.

7.1 Subsidy Policy Instruments: Rebate Rate and Bonus Rate

To tease apart the complex economic forces, we first consider a set of counterfactuals where we scale the current QBP rebate rate while keeping the bonus rate the same as in the QBP, and then consider another set of counterfactuals where we scale the current QBP bonus rate while keeping the rebate rate the same as in the QBP.

Figure 5 clearly shows that the average star ratings increases when we scale up the rebate rate or when we scale up the bonus rate. This is consistent with the intuition that have been explained by our simplified model. A higher rebate rate or bonus rate amplifies the negative impact of star rating on price and hence makes demand more sensitive to star rating. As a result, insurers have stronger incentive to invest on star rating related quality.

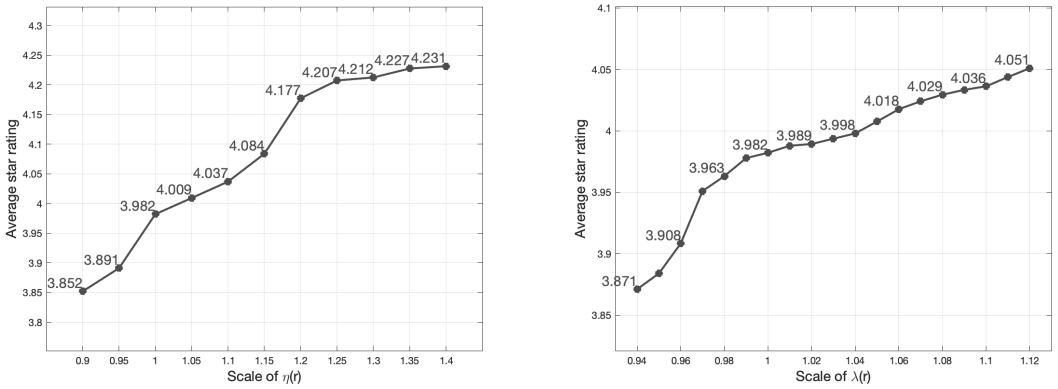
Figure 6 shows the opposite impact of rebate rate and bonus rate on the average gain/loss amount. A higher rebate rate would not only shift the demand outward but also make the demand more sensitive to gain/loss. As a result, insurers would lower their gain/loss when the rebate rate becomes higher. In contrast, a higher bonus rate would make the demand less sensitive to gain/loss and hence insurers would increase their gain/loss when the bonus rate becomes higher.

Figure 7 shows the opposite impact of rebate rate and bonus rate on the supplementary benefits. The demand become more sensitive to the supplementary benefits when the rebate rate increases, whereas it becomes less sensitive when the bonus rate increases. As a result, the impacts of the two policy instruments are opposite.

A plan's premium depends on the insurer's choice of gain/loss, supplementary benefits, and the rebates amount it receives. Figure 8 shows that the average premium becomes lower when we scale up the rebate rate or the bonus rate.

Figure 9, Figure 10, and Figure 11 show that the total consumer surplus, MA insurers' profit, and government spending on the Medicare program increase when we scale up the rebate rate or the bonus rate. However, the consumer welfare net the government spending is increasing in rebate rate but a hump-shaped in the bonus rate (see Figure 12),

Figure 5: Policy Instruments: Star Rating



(a) Rebate Rates

(b) Bonus Rates

although the total surplus is increasing in both rebate rate and bonus rate (see Figure 13).

In addition, we can compare the performance of the two subsidy instruments. Consider a policy that increases the current QBP rebate rate by 10%. According to our simulation results, this rebate rate policy would increase the government spending by 1.295 (=313.050-311.755) billion dollars, increase total consumer welfare by 2.575 (=27.317-24.742) billion dollars, and increase MA insurers' profit to by 1.055 (=19.635-18.580) billion dollars.

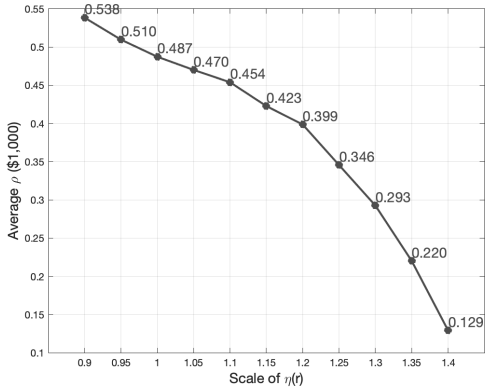
We consider an alternative policy that increases the current QBP bonus rate and increases government spending by a similar amount. According to our simulation results, a 2% increase of the bonus rate is such an alternative policy. This bonus rate policy would increase total consumer welfare by 1.573 (=26.315-24.742) billion dollars, and increase MA insurers' profit to by 1.608 (=20.188-18.580) billion dollars.

Comparing the 10% increase of rebate rate policy with the 2% increase of bonus rate policy that would increase the government spending similarly, the former would increase the total consumer welfare more while the latter would increase the MA insurer profit more.

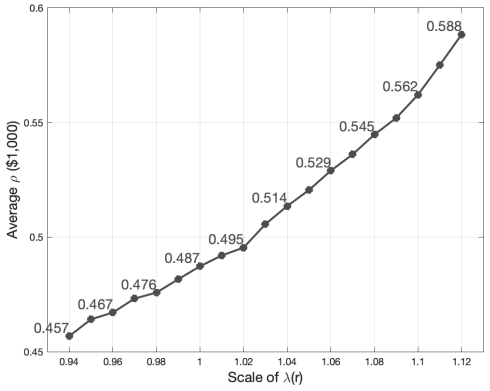
7.2 Quality Bonus Program

Before the Quality Bonus Program (QBP) introduced in 2012, the rebate rate was 0.75 and the bonus rate was 1 for all contracts. The QBP program introduced three changes. First, it introduced a positive dependence between the rebate rate and a contract's star rating. Second, in addition to the slope change, there was also a level change. The rebate

Figure 6: Policy Instruments: Gain/Loss Amount

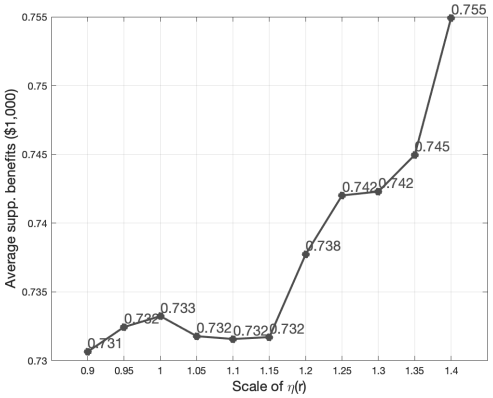


(a) Rebate Rates

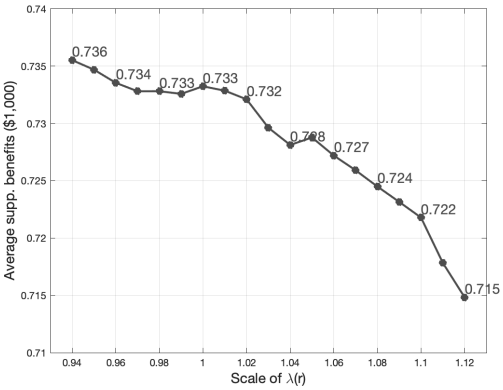


(b) Bonus Rates

Figure 7: Policy Instruments: Supplementary Benefits

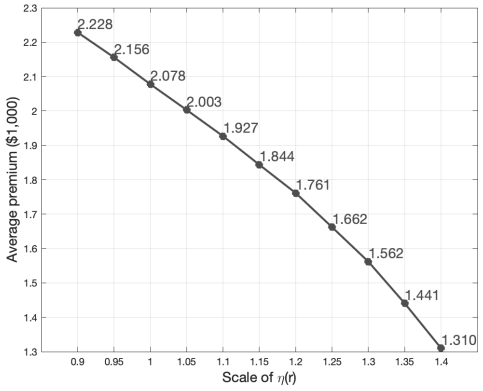


(a) Rebate Rates

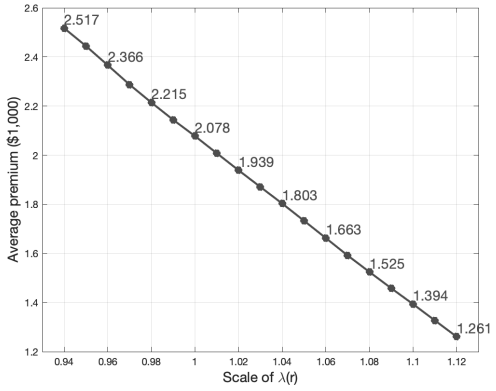


(b) Bonus Rates

Figure 8: Policy Instruments: Premium

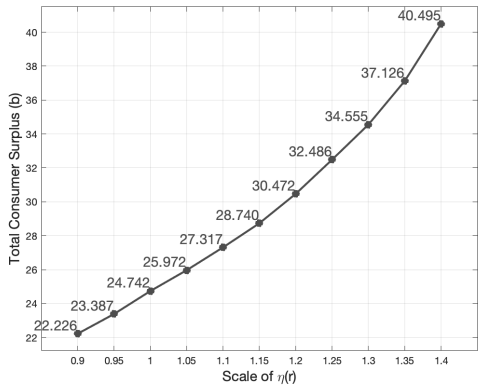


(a) Rebate Rates

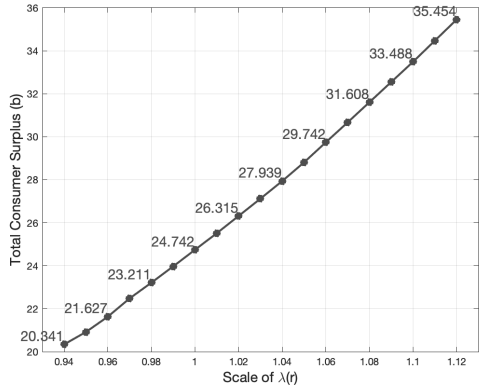


(b) Bonus Rates

Figure 9: Policy Instruments: Consumer Surplus

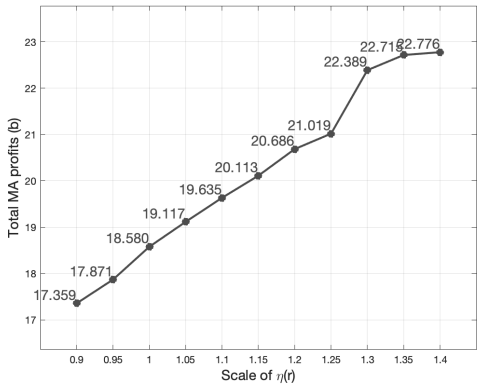


(a) Rebate Rates

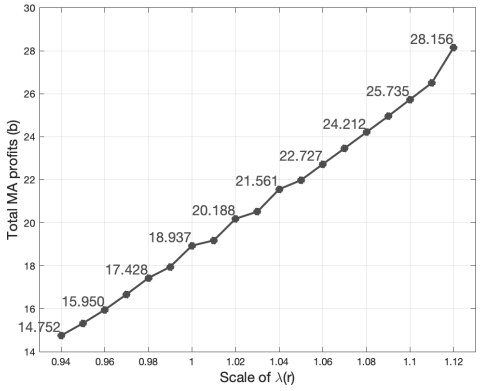


(b) Bonus Rates

Figure 10: Policy Instruments: MA Insurer Profit

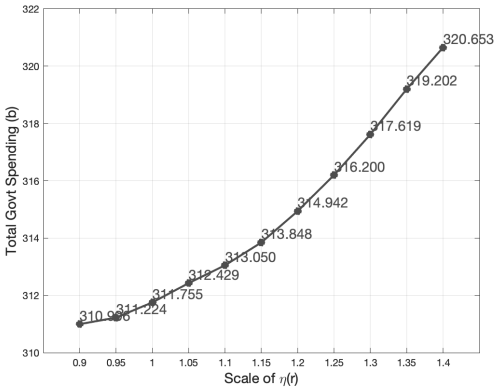


(a) Rebate Rates

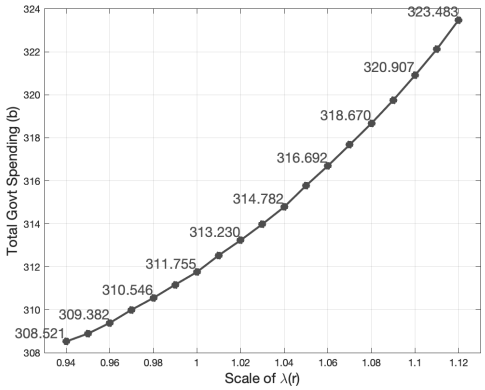


(b) Bonus Rates

Figure 11: Policy Instruments: Govt Spending on Medicare

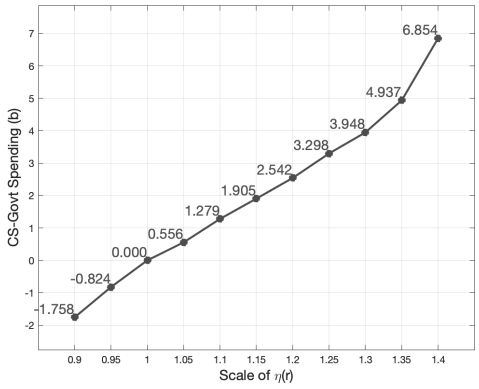


(a) Rebate Rates

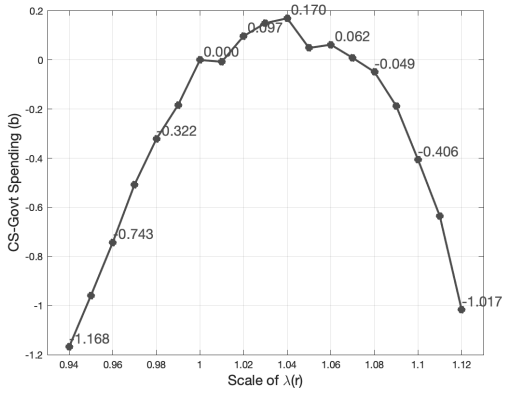


(b) Bonus Rates

Figure 12: Policy Instruments: Consumer Surplus - Govt Spending

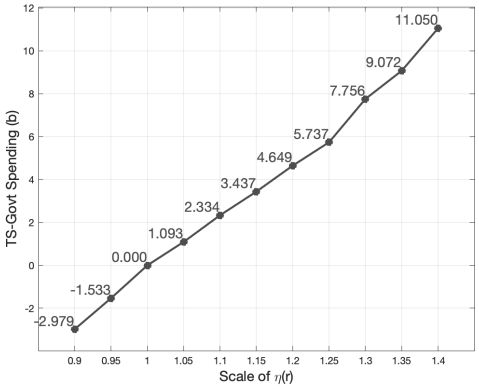


(a) Rebate Rates

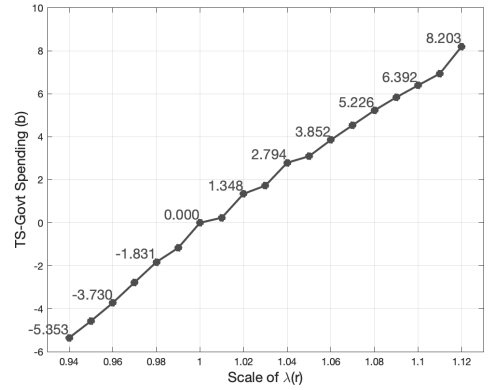


(b) Bonus Rates

Figure 13: Policy Instruments: Total Surplus



(a) Rebate Rates



(b) Bonus Rates

rates became smaller: the rebate became only 0.7 even for the highest star rating. Third, the bonus rate now also increases with the contract's star rating.

The first order condition with respect to star-rated quality (equation 19) clearly shows how a plan's star rating affects that plan's profit. Besides the standard cost channel that a higher star rating requires a higher investment on star-rated quality, a higher star rating affects the market share directly and indirectly through affecting premium after QBP that positively ties a plan's rebate and bonus rates to its star rating. On the one hand, increasing a plan's star rating would directly increase its market share and hence profit because consumers like higher star rating. On the other hand, increasing a plan's star rating would increase that plan's rebate and bonus rates after QBP. A higher bonus rate implies a higher benchmark. It becomes easier for that plan to be in the range of being lower its benchmark. Moreover, even when that plan bids above its benchmark, its premium becomes lower given that the premium is the difference between the bid and the benchmark. When that plan bids below its benchmark, its premium becomes lower as well because a higher rebate rate leads to higher rebate and hence lower premium. In contrast, this effect of star rating on premium is zero when these two rates are independent of star rating. Therefore, due to this premium effect, plans have a stronger incentive to improve their star rating after QBP when the rebates are positively tied to their star rating.

To see how QBP would affect plans' choice of plan attributes, we can revisit the first order condition with respect to gain-loss amount (equation 15) and the first order conditions with respect to cost-sharing reduction and extra benefits (equations **??** and **??**).

A plan's gain/loss ρ affects its profit through two channels. On the one hand, increasing a plan's ρ would increase its revenue per enrollee and hence its profit, which is always one dollar to one dollar mapping with or without QBP. On the other hand, increasing a plan's ρ would increase its premium. When a plan's bid is above its benchmark, increasing one dollar of ρ always increases its premium by one dollar (regardless of QBP). After QBP, however, rebate rate η_t becomes smaller no matter what a plan's star rating is. As a result, the premium impact of higher ρ is weaker for plans bidding is below its benchmark (equation (16)). A higher premium would lower the market share and lower the profit. Hence, under QBP with lower rebate rates, firms have stronger incentive to increase their gain/loss.

A plan's supplementary benefits, including cost sharing reduction and extra benefits, affect its profits through two channels as well. On the one hand, increasing a plan's supplementary benefits would directly increase its market share and hence profit because consumers like them. On the other hand, increasing a plan's supplementary benefits would increase its premium. When a plan's bid is above its benchmark, one dollar higher

supplementary benefits would transfer into one dollar higher premium, and this relationship does not depend on rebate or bonus rates. However, when a plan's bid is below its benchmark, the impact of supplementary benefits on premium is more positive for plans with lower rebate rates, see equation (18). Since rebate rates are lower with QBP than without QBP, the premium impact is stronger with QBP. Therefore, firms have less incentive to increase their supplementary benefits.

The impact on premium is unclear, depending on whether the impact on gain/loss or the impact on supplementary benefits dominates. With our estimates, we predict the impact on gain/loss dominates.

With the model estimates, we solve the equilibrium for the sample of 2017 by fixing the rebate rate to be 0.75 and the bonus rate to be 1 as the situation without QBP. Table 5 reports the impact of QBP on plan attributes, consumer welfare, insurer surplus, and government spending on the Medicare program. First, it improves insurers' incentives to invest on star-related quality. If fixing the rebate and bonus rates, the average star-related quality is 3.538, lower than 3.934 which is the average value under QBP. Figure 14 presents the distributions of star ratings observed in the data and the star ratings in the counterfactual scenario. Plans' star ratings are more concentrated at 4 with QBP whereas they are quite spread without QBP.

Plans' supplementary benefits are lower with QBP. In specific, the average cost sharing reduction is \$128 lower and the average extra benefits is \$35 lower. In addition, plans' premium is \$122 higher on average with QBP. Taking all together, consumer welfare per Medicare beneficiary is lowered by \$175 on average with QBP.

Table 5 also reports the impact of QBP on the aggregate outcomes. In the absence of QBP, there would have been higher enrollment in MA and thus higher spending on MA enrollees and lower spending on TM enrollees. On net, government spending is expected to be 22.254 billion less without QBP. MA insurers had earned 7.861 billion more profit and consumers had enjoyed 7.101 billion more surplus.

To isolate the impact of each of the three major changes of QBP, next we conduct three different counterfactual exercises. The first one aims to quantify the impact of positively tying a contract's rebate rate to its star rating by assuming a positive slope for how a contract's rebate rate relates to its star rating while keeping the average rebate rate approximately equals to the rebate rate before the policy change and fixing the bonus rate at one. The second counterfactual aims to quantify the impact of lower levels of rebate rate by assuming that the rebate rate equals to the average level after the policy change while fixing the bonus rate at one. The third counterfactual aims to quantify the impact of tying a contract's bonus rate to its star rating by assuming post-policy bonus rate scheme while keeping the pre-policy rebate rate that is fixed at 0.75.

Figure 14: Impact of QBP on Star Ratings

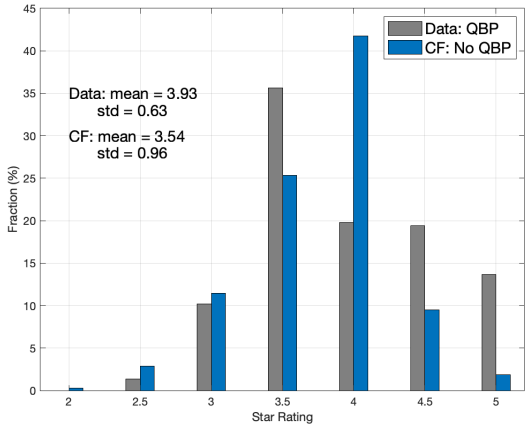


Table 5: Impact of QBP

Variables	QBP (Data)		No QBP (CF)		Change (Data-CF)	
	Mean	SD	Mean	SD	Mean	SD
Gain loss	0.488	0.806	0.315	1.016	0.173	0.712
Bid	9.906	3.083	9.720	3.138	0.188	0.627
Rebates	0.998	0.754	1.103	0.902	-0.105	0.501
Total premium	2.084	0.650	1.945	1.228	0.122	0.945
Cost sharing reduction	0.531	0.355	0.659	0.615	-0.128	0.542
Extra benefits	0.202	0.159	0.238	0.277	-0.035	0.240
Star-related quality	3.934	0.635	3.538	0.955	0.396	(1.024)
Consumer surplus	0.523	0.513	0.698	0.647	-0.175	(0.420)
Total MA share (%)	27.430		31.663		-4.232	
Govt payments to MA plans ($ billion)	89.716		96.342		-6.626	
Govt spending on TM ($ billion)	221.220		192.340		28.880	
Aggregate insurer surplus ($ billion)	10.910		18.771		-7.861	
Aggregate consumer surplus ($ billion)	22.276		29.377		-7.101	

Note: Gain loss, bid, rebates, cost sharing reduction, extra benefits, and consumer surplus are measured in thousand dollars. The aggregate consumer surplus is calculated at the individual level using equation (21) and then aggregated using the MCBS sample weights. Aggregate insurer surpplus is caculated using equation (22). Government payments to MA plans and Government spending on TM are calculated using equation (23).

7.2.1 Star-Dependent Rebate Rates

To isolate the impact of tying the rebate rate to the star rating, in this counterfactual scenario, we set a contract's rebate rate to be 0.8 if its star rating is 4.5 or 5, 0.75 if its star

rating is 4 or 3.5, and 0.6 if its star rating is 3 or lower, while keeping the bonus rate to be one. This rebate rate scheme leads to an average rebate rate being around 0.75, which is the value before the QBP. We solve the equilibrium model for the sample of 2017 and report the results in the middle panel of Table 6. We use the outcomes when the rebate rate equals to 0.75 and the bonus rate equals to 1 regardless of the star rating as the benchmark and report the impact of star-dependent rebate rate in the last panel of Table 6.

As we have discussed above, tying a contract's rebate rate to its star rating would increase insurers' incentive to improve their star rating not only because consumers like higher star rating but also because a higher star rating would result in more rebates and lower premium. Our simulation results suggest that the average star-related quality would become 4.127 on average in the counterfactual scenario.

Since most plans would have a star rating higher than 4, the equilibrium adjusted rebate rate would be higher than 0.75 in the counterfactual scenario. A higher rebate rate would encourage insurers to lower their choice of gain-loss because the impact of gain-loss on premium is increasing in the rebate rate. As a result, their bids tend to be lower in the counterfactual scenario. Moreover, a higher rebate rate would encourage insurers to improve their supplementary benefits because the impact of supplementary benefits on premium is decreasing in the rebate rate. Our simulation results imply that in 2017, MA plans' bid would be \$25 higher, their cost-sharing reduction would be \$46 lower, and their extra benefits would be \$15 higher on average. Plans' premium would be \$88 higher. An average consumer's surplus would be \$40 higher and the aggregate consumer surplus would increase by 1.958 billion. MA enrollment share would increase by 2.795% and insurer surplus would increase by 1.373 billion. Meanwhile, more consumers choosing MAs would increase CMS payments to MA plans by 9.366 billion and reduce government spending on TM enrolless by 10.755 billion. Hence, the government spending on the Medicare program would be 1.389 billions lower.

7.2.2 Lower Flat Rebate Rates

In this counterfactual scenario, we set the rebate rate to be 0.6, approximately the average of the rebate rate after the policy change, while keeping the bonus rate to be one. By doing that, we can quantify the impact of lowering the level of rebate rate. Table 7 reports the counterfactual results in the middle panel and the impact by using the rebate rate before QBP as the benchmark in the third panel.

A lower rebate rate would weaken the impact of gain-loss on premium and hence plans' market share and profit. As a result, insurers would have a stronger incentive to choose a high gain-loss amount and a high bid. We find that the average gain-loss would be \$111 higher and the average bid would be \$102 higher. A lower rebate rate directly

Table 6: Average Impact of Star-Dependent Rebate Rates

Variables	$\eta = 0.75$ (Baseline)	Star-Dependent η (CF)	Impact (CF-Baseline)
Gain loss	0.315	0.340	0.025
Bid	9.720	9.744	0.025
Rebates	1.103	1.085	-0.017
Total premium	1.945	2.033	0.088
Cost sharing reduction	0.659	0.613	-0.046
Extra benefits	0.238	0.253	0.015
Star-related quality	3.538	4.127	0.590
Consumer surplus	0.698	0.738	0.040
Total MA share (%)	31.663	34.457	2.795
CMS payments to MA plans ($ billion)	96.342	105.710	9.366
Government spending on TM ($ billion)	192.340	181.590	-10.755
Aggregate insurer surplus ($ billion)	18.771	20.144	1.373
Aggregate consumer surplus ($ billion)	29.377	31.335	1.958

Note: Gain loss, bid, rebates, cost sharing reduction, extra benefits, and consumer surplus are measured in thousand dollars. The aggregate consumer surplus is calculated at the individual level using equation (21) and then aggregated using the MCBS sample weights. Aggregate insurer surpplus is caculated using equation (22). Government payments to MA plans and Government spending on TM are calculated using equation (23).

implies a lower rebate. Their rebate tends to be even more lower given that they bid higher. We find that the average rebate would be $63 lower when the rebate rate equals to 0.6. Meanwhile, a lower rebate rate would exaggerate the impact of supplementary benefits on premium when a plan's bid is below its benchmark. Meanwhile, plans' cost-sharing reduction would be $10 higher and their extra benefit would be $50 lower on average. As a result, their premium would be $151 higher on average.

Higher premium and worse supplementary benefits would lower consumer surplus and lead to few consumers to choose MA. Our results show that an average consumer's surplus would be $233 lower and the aggregate consumer surplus would be 8.587 billion lower. The share of MA enrollment would be 7.076% lower and the aggregate insurer surplus would be 10.487 billion lower. CMA payments to MA plans would be 16.522 billion lower while the government spending on TM enrollees would be 42.730 billion higher. Taking these two programs together, the government spending the Medicare program would be $26.208 billion higher when setting rebate rebate to be 0.6 instead of 0.75.

Table 7: Average Impact of Lower Flat Rebate Rate

Variables	$\eta = 0.75$ (Baseline)	$\eta = 0.6$ (CF)	Impact (CF-Baseline)
Gain loss	0.315	0.425	0.111
Bid	9.720	9.822	0.102
Rebates	1.103	1.039	-0.063
Total premium	1.945	2.096	0.151
Cost sharing reduction	0.659	0.669	0.010
Extra benefits	0.238	0.188	-0.050
Star-related quality	3.538	3.446	-0.092
Consumer surplus	0.698	0.465	-0.233
Total MA share (%)	31.663	24.587	-7.076
CMS payments to MA plans ($ billion)	96.342	79.820	-16.522
Government spending on TM ($ billion)	192.340	235.070	42.730
Aggregate insurer surplus ($ billion)	18.771	8.284	-10.487
Aggregate consumer surplus ($ billion)	29.377	20.790	8.587

Note: Gain loss, bid, rebates, cost sharing reduction, extra benefits, and consumer surplus are measured in thousand dollars. The aggregate consumer surplus is calculated at the individual level using equation (21) and then aggregated using the MCBS sample weights. Aggregate insurer surpplus is caculated using equation (22). Government payments to MA plans and Government spending on TM are calculated using equation (23).

7.2.3 Star-Dependent Bonus Rate

To isolate the impact of tying a contract's bonus rate to its star rating, we set the rebate rate to be 0.75 as before QBP and keep the bonus rate scheme as after QBP. Table 8 reports the counterfactual results and the impact of star-dependent bonus rate.

Intuitively, allowing the bonus rate to positively depend on the star rating would increase insurers' incentive to improve their star ratings. Moreover, it would increase the benchmark of plans with high star ratings. Higher benchmark would lead to lower premium and hence higher market share. As a result, insurers have stronger incentive to increase their bid. Meanwhile, they have stronger incentive to improve their cheaper benefits but weaker incentive to improve their costly benefits. However, our results suggest all of those impact are not substantial.

7.2.4 Discussion of the Decomposition of the QBP Impact

When examining QBP's policies one by one, we can see that the key driver of the overall impact of QBP is the lowering of the rebate rate. As predicted by our model, lowering the rebate rate encourages plans to choose higher gain/loss amounts, resulting in higher premiums and lower consumer surplus. The star-dependence of the payment parameters

Table 8: Average Impact of Star-Dependent Bonus Rate

Variables	$\lambda = 1$ (Baseline)	Star-Dependent λ (CF)	Impact (CF-Baseline)
Gain loss	0.315	0.333	0.018
Bid	9.720	9.737	0.017
Rebates	1.103	1.092	-0.011
Total premium	1.945	1.974	0.029
Cost sharing reduction	0.659	0.653	-0.006
Extra benefits	0.238	0.248	0.010
Star-related quality	3.538	3.627	0.589
Consumer surplus	0.698	0.707	0.008
Total MA share (%)	31.663	31.799	0.136
CMS payments to MA plans ($ billion)	96.342	97.640	1.298
Government spending on TM ($ billion)	192.340	190.180	-2.160
Aggregate insurer surplus ($ billion)	18.771	19.503	0.732
Aggregate consumer surplus ($ billion)	29.377	30.599	1.222

Note: Gain loss, bid, rebates, cost sharing reduction, extra benefits, and consumer surplus are measured in thousand dollars. The aggregate consumer surplus is calculated at the individual level using equation (21) and then aggregated using the MCBS sample weights. Aggregate insurer surpplus is caculated using equation (22). Government payments to MA plans and Government spending on TM are calculated using equation (23).

was successful in incentivizing higher quality, but because this was paired with an overall reduction in rebate rates, the program's overall welfare impact was negative.

8 Conclusion

In this paper, we present a structural model of demand and supply of the Medicare Advantage market. On the demand side, Medicare beneficiaries choose either TM or a MA plan. We use the standard discrete choice model to describe it. On the supply side, MA firms simultaneously choose the star-rated quality for their contracts, and gain loss and supplementary benefits for all of their plans. We estimate the model using both aggregate plan-level data and individual-level data.

With the estimated model, we quantitatively evaluate the impact of the Quality Bonus Program that positively ties MA plans' rebate and bonus rates to their star rating and that lowers the rebate rates regardless of the star rating. We also evaluate an alternative quality incentive. The main finding is that QBP would increase star-related quality investment, increase premium, and lower supplementary benefits. We show that this is largely because QBP chose to alter a key payment parameter that relaxed the penalty for increasing plan profits.

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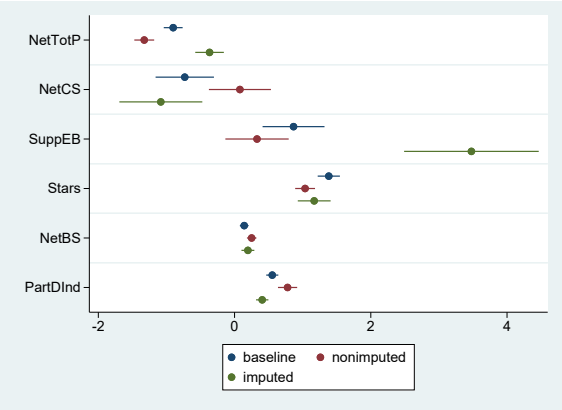
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Figure A1: Demand Estimates for All Plans and Plans With and Without Imputation for Missing Characteristics



A Imputing Missing Bidding Variables

For about 40% of plan-years between 2010–2017, certain bidding variables are missing: bb_{jt}, cs_{jt}, cs_{jt}^{red}, eb_{jt}, and ρ_{jt}. We still see b_{jt}, supp premium$_{jt}$, and C_{jt}^{O} for those plans. Missingness is not strongly explained by plan size or plan newness. We impute these variables in the following way:

1. Impute bb_{jt} using b_{jt} and j's enrollment in each county in t. Our rationale is that the cost of Medicare-covered medical care is highly dependent on county features such as the provider market. The R^2 of this regression is 0.95 (0.3 if using just county enrollments alone), and the predicted value has a correlation of 0.97 with bb_{jt} when non-missing. Note we also trim the extremes of the imputed bb_{jt} to have the same 1st and 99th percentiles as known bb_{jt}.

2. Impute cs_{jt} using the mean of cs_{jt}/bb_{jt}, which assumes that the TM-determined cost-sharing for each plan represents the same proportion (19%, se 1.8%) of the basic benefits in each plan.

3. Impute $cs_{jt}^{red} + eb_{jt}$ using the mean of $cs_{jt}^{red} + eb_{jt}$/supp premium$_{jt}$, which again assumes a fixed ratio (85%, se 7.3%).

4. Impute cs_{jt}^{red} and eb_{jt} using the mean of cs_{jt}^{red}/eb_{jt}. This ratio is equal to 69% on average (se 27%).

5. Calculate ρ_{jt} based on the identities for bid and supp

We report the estimates of our demand model for all plans as well as plans with and without imputation in Appendix Figure A1.

Table A1: Bonus and Rebate Rates By Year and Stars

Bonus Rate λ_t	2009	2010	2011	2012	2013	2014	2015	2016	2017
5 stars	1	1	1	1.05	1.05	1.05	1.05	1.05	1.05
4 or 4.5	1	1	1	1.04	1.04	1.05	1.05	1.05	1.05
3.5 stars	1	1	1	1.035	1.035	1.035	1	1	1
3 stars	1	1	1	1.03	1.03	1.03	1	1	1
<3 stars	1	1	1	1	1	1	1	1	1
new	1	1	1	1.03	1.03	1.035	1.035	1.035	1.035
no data	1	1	1	1.03	1.03	1.03	1.035	1.035	1.035

Rebate Rate η_t	2009	2010	2011	2012*	2013*	2014	2015	2016	2017
5 stars	0.75	0.75	0.75	0.7335	0.7165	0.7	0.7	0.7	0.7
4.5	0.75	0.75	0.75	0.7335	0.7165	0.7	0.7	0.7	0.7
3.5 or 4 stars	0.75	0.75	0.75	0.717	0.683	0.65	0.65	0.65	0.65
3 stars	0.75	0.75	0.75	0.6675	0.5825	0.5	0.5	0.5	0.5
<3 stars	0.75	0.75	0.75	0.6675	0.5825	0.5	0.5	0.5	0.5
new	0.75	0.75	0.75	0.6675	0.5825	0.65	0.65	0.65	0.65
no data	0.75	0.75	0.75	0.7335	0.5825	0.5	0.65	0.65	0.65

Sources: Literature/Evaluation of the Medicare Quality Bonus Payment Demonstration.pdf for 2009-2014, Table 4 for bonus rate, Table 24 for rebate percentages' "phase in". CMS Advance Notice for 2015: `https://www.cms.gov/Medicare/Health-Plans/MedicareAdvtgSpecRateStats/downloads/Advance2015.pdf` 2016 bonuses: `https://www.kff.org/report-section/medicare-advantage-2016-data-spotlight-overview-of-plan-changes-quality-ratings/` 2017 bonuses here but not explicit: `https://www.kff.org/medicare/issue-brief/medicare-advantage-2017-spotlight-enrollment-market-update/` 2016 & 2017 rebates: `https://bettermedicarealliance.org/wp-content/uploads/2020/03/BMA_StarRatings_WhitePaper_2018_10_24.pdf`

* In 2012 and 2013, the percentages were weighted averages. For 4.5 or 5 stars, the components were 0.7 and 0.75. For 3.5 or 4 stars, the components were 0.65 and 0.75. For 3 or <3 stars or new plans, the components were 0.5 and 0.75. In 2012, the weights were 0.33 on the lower number and 0.67 on the higher number. The weights were reversed in 2013. Plans with insufficient data followed different rules: 0.33*0.7+0.67*0.75=0.7335 in 2012 and 0.67*0.5+0.33*0.75=0.5825 in 2013.