Reallocating Bonus Payments Through Competition to Improve Medicare Advantage Plan Quality: A Dynamic Game Approach

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Abstract

This paper explores how competition among firms can be used to improve the quality of plan offerings in a managed care setting like Medicare Advantage through changes in the reimbursement policy. In a managed market, private firms provide government-sponsored services at regulated prices and compete for subsidies. Our paper studies how firms offering Medicare Advantage plans compete in terms of quality and evaluates how the markets would evolve under a competitive bonus payment system, rewarding them based on their relative quality performance in a local market. We introduce a dynamic discrete game model of firm quality investment choice and use it to estimate the cost of quality improvements. The estimated model is used to predict the market outcomes in terms of average plan quality under the alternative payment system by calculating the counterfactual equilibria and simulating the markets forward. Our results show that 65% of the counties improve under the new payment rule compared to their observed outcomes in the data, with underperforming counties improving more.

JEL Codes: L15, I11, L13, M38,

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1 Introduction

Medicare is a national health insurance program in the United States that provides government-sponsored insurance coverage to eligible beneficiaries, mostly comprised of citizens over the age of sixty-five. Traditional Medicare works on a fee-for-service (FFS) basis, where the government pays for a portion of a beneficiary's costs of any covered medical service. A potential drawback of such government-operated healthcare services is the inefficiency that stems from the lack of incentives for the organization to improve and innovate due to the absence of competition. Managed competition in healthcare systems lets private entities deliver these public health insurance services with the aim of reducing the cost of such provisions. Competition among profit-maximizing firms is believed to provide incentives to improve efficiency, which can be exploited in an adequately designed market. Such private delivery of public health insurance has been a growing phenomenon in the United States in recent times (Gruber, 2017) [21] primarily based on this rationale.

The Medicare Advantage (MA) program allows private insurers to provide traditional Medicare services to eligible beneficiaries, and the government pays subsidies to the insurers for every beneficiary they enroll in their plans. Beneficiaries can choose from a set of available plans in a local market and forgo traditional Medicare services. Private insurers compete with each other as in a standard insurance market for beneficiary enrollment but generate revenue primarily through government reimbursements. However, designing such a managed healthcare market is challenging and comes with a lot of unanswered issues that economists and policymakers are debating. One such pressing concern is monitoring the quality of service provided by private insurers. Competition in health insurance markets may fail to improve health outcomes if consumers are not able to identify high-quality plans (Abaluck et al., 2020) [1] and thus may require interventions.

This paper explores how firms in a managed care setting like Medicare Advantage compete in quality and how it can be improved by generating more competition at the local market level. We introduce a dynamic discrete game model where firms choose the quality of their offered insurance plans in each period with a costly investment. Our model captures and quantifies the strategic interaction among firms while choosing plan quality. It also captures the intertemporal nature of the game, where investment in quality in one period affects the outcomes and payoffs for the next period. The primary objective of the paper is to study the supply side effects of such bonus payments and designing the payment rules that can improve access to quality healthcare.

We use the Centers for Medicare and Medicaid Services (CMS) assigned star ratings as an objective measure of plan quality. The plan star ratings are publicly available and provide the beneficiaries with quality information. CMS also pays bonus subsidies to plans with higher star ratings. We provide the details regarding their calculations in Section 2. Thus, under the condition that the consumers value quality, a firm's payoff is dependent on both its own plan quality and also the quality of the competing plans through the market share. However, the current quality bonus payments are based only on the absolute value of a plan's quality rating and are independent of the quality of its competitors. There exists some empirical evidence casting doubt on the ability of the current financial incentives to improve quality (Layton and Ryan, 2015)[26].

This paper aims to predict if the quality of Medicare Advantage plans can be improved by fostering quality competition among firms through changes in the reimbursement policy. We do this by introducing a new quality bonus payment system where firms are paid based on their relative performance compared to their peers in a local market area. In other words, firms earn bonuses if their plan quality is better than other plans in the same local market. We also consider bonus payments as transfers from low-performing to high-performing plans to maintain budget neutrality. We predict if this payment policy change can generate more competition among firms and evaluate its effects on quality outcomes.

Two critical aspects of program design are often debated in the context of pay-for-performance programs that our counterfactual bonus payment rule addresses. On the one hand, it moves from an absolute target-based payment system to a relative performance-based payment system. On the other hand, this transfer-based payment system uses a mixture of penalties and rewards instead of injecting extra bonus payments for satisfactory performance. We find empirical evidence in the context of Medicare Advantage whether these changes can lead to improved outcomes and thus address some key issues regarding the design of pay-for-performance programs. To our knowledge, there are no theoretical results that can compare the effectiveness of these two methods for implementing a performance bonus payment. This paper provides empirical results and insights regarding comparing the two forms of pay-for-performance in the context of Medicare Advantage Quality Bonus Payments, which provides us with the appropriate setting. However, these results can also be potentially helpful in other settings where similar performance bonus payments are implemented

It is essential to understand the nature of the strategic interaction among firms in terms of quality to assess the effects of this proposed payment policy change. We introduce a framework where beneficiaries choose plans based on their characteristics, plan-specific heterogeneity, and quality ratings. Multiproduct firms choose prices and whether to invest in quality improvement in each period. Profit-maximizing firms consider their competitors' strategies when investing in quality. We estimate the cost of such quality improvement initiatives in the context of Medicare Advantage using our dynamic discrete game model. The study of quality investment choice in a managed healthcare market under strategic interactions is an essential contribution of this paper.[1]

Implementing a dynamic game model in managed healthcare markets is challenging. The payoff relevant state space for the firms is large as they take into consideration characteristics of their own, their competitors, and also market characteristics. Some of these variables are continuous, providing computational challenges while solving the value function. Moreover, their relationship with the payoffs is not straightforward. We deal with this problem of dense state space by assuming a linear parametric approximation of the value function like Sweeting (2013) [32], which reduces the computational burden of our estimation procedure. Given the estimates of our structural parameters, we simulate the Medicare Advantage markets forward by calculating the equilibrium policy function of the firms under the new bonus payment rule and predict how each market would evolve in terms of offered plan quality.

Our counterfactual analysis has important policy implications. The current bonus payment sys-

[1] Gowrisankaran and Town (1997) [20] studies quality investment choice in hospitals using a dynamic equilibrium framework.

tem in Medicare Advantage rewards plans if their quality ratings are above a national threshold. This can generate regional differences in government spending as shown in Figure 1 with three example markets. Under this payment system, government expenditure on quality bonuses is skewed towards Market 3, where all the plans have a quality rating above the threshold, whereas Market 1 receives none. In other words, government expenditure on quality bonuses is skewed towards markets where more plans exceed the threshold, neglecting regional differences and varying incentives for improvement. Also, the incentives to improve may vary across markets. Plans closer to the national threshold have more incentives to improve as smaller investments take them to bonus status. Thus, markets with more marginal firms may see more quality investments and, consequently, more reimbursements from the government.

We implement the counterfactual bonus payment rule based on the Medicare Payment Advisory Council (MedPAC) report to Congress in 2019, which addresses these observed distortions due to the current payment rules. As illustrated in Figure 2, under the counterfactual payment rule, some plans in every market get access to quality bonus payments. Also, this payment system distorts the firms' incentives to invest in quality. In contrast to the threshold-based payment rule, a small improvement in quality for low-performing plans can earn bonus payments if it makes them better than other plans in the market. This can potentially generate more quality competition in every market regardless of their initial conditions as the firms will try to outperform each other in terms of quality.

In the context of our empirical analysis of Medicare Advantage, this is a relevant problem. The threshold-based quality bonus payment system only rewards plans that have a rating greater than or equal to four stars. Thus, marginal plans with a rating of three and a half stars get bonus payments by investing in quality improvement by half a star. In contrast, the same level of improvement comes with no additional payment for plans with a lower star rating. In this paper, we will provide evidence from the data that these marginal plans show more quality improvement initiatives to reach a four-star compared to lower-performing plans to motivate the question. Also, there exists regional disparity in terms of average plan quality across counties, as shown in Figure 6. We explore if the quality of care in the underperforming Medicare Advantage markets can be improved under the new payment policy we study in the counterfactual.

We show that our model performs well in predicting the observed transition of the market outcomes in terms of the quality rating of the offered plans. The counterfactual results predict that under the new bonus payment system, 65% of the studied counties perform better when compared to the observed data under the status quo payment policy and that more counties will have a quality rating greater than four stars. This improvement is mostly seen in historically underperforming markets that are observed to have lower average ratings in the data. The results indicate that the quality of care can be improved by introducing payment rules that induce more competition among firms. We also observe less variation in average plan quality across counties in our counterfactual, with most markets having an average quality rating between 4 and 4.25 stars, reducing the heterogeneity in access to quality across regions. Though our estimates are specific to the Medicare Advantage markets, these results provide key insights regarding the proper use of financial incentives to improve the quality of care that may apply to other similar markets.
[21] primarily based on this rationale.

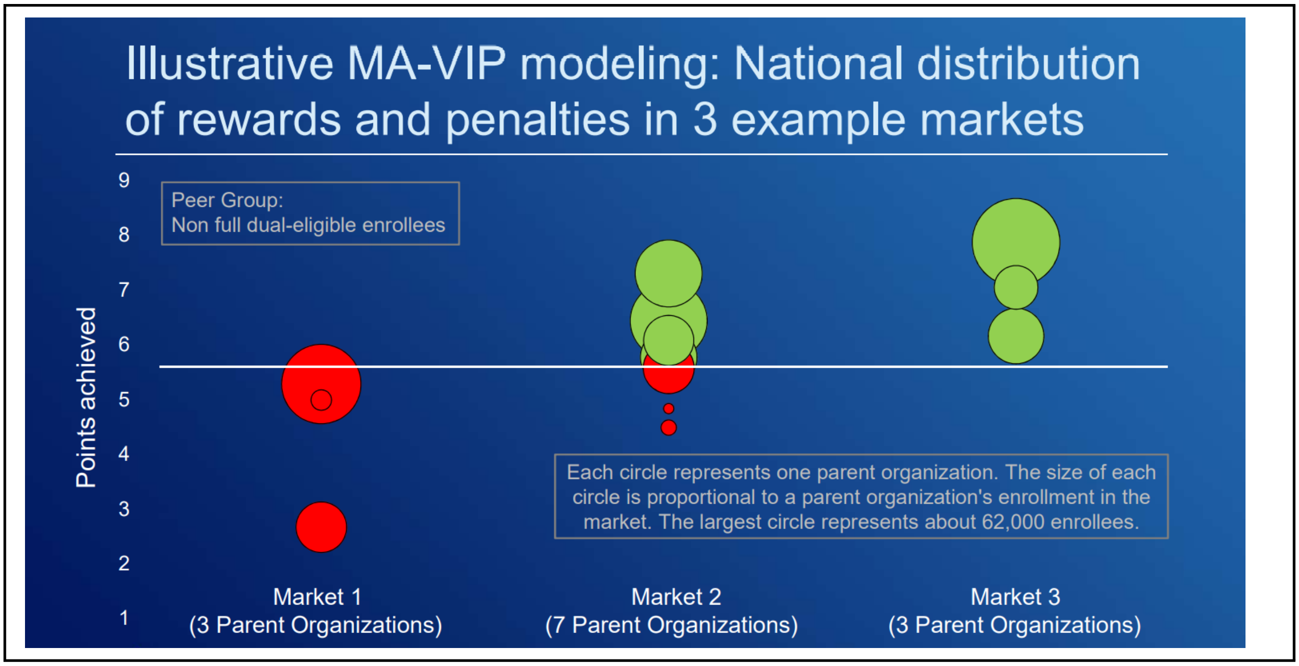

Figure 1: Bonus distribution in example markets for threshold-based bonus payment system. Source: MedPAC

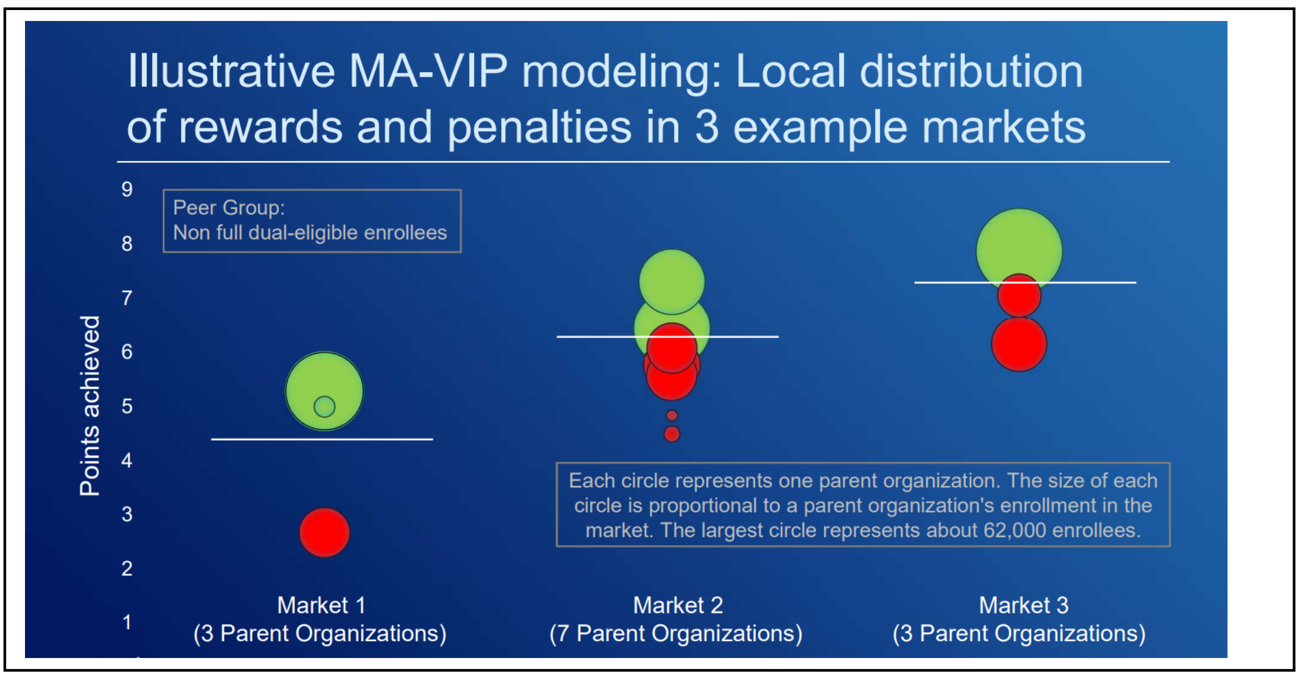

Figure 2: Bonus distribution in example markets for market level comparison based bonus payment system. Source: MedPAC

Related Literature. We contribute to the existing literature regarding managed healthcare markets and Medicare Advantage. Gruber (2017) studies the changing nature of public health insurance in the United States and the extensive use of the "managed competition" approach employed by the government to deliver health insurance. We share similar motivations to explore how these markets work, though they differ methodologically. Previous papers have studied the nature of competition and issues of subsidy design in these markets. Miller et al. (2019) address the issue that the market benchmarks based on which CMS pays subsidies to individual plans are sub-optimally set and find the optimal benchmarks to maximize consumer surplus. Curto et al. (2019) study how market competition works in the managed competition setting of Medicare Advantage and the surplus generated by the competitive bidding process. Decarolis, Plyakova, and Ryan (2020) look at the interaction between strategic insurers and the subsidy mechanism in Medicare Prescription Drug plans. Though the aforementioned papers are similar to our work in exploring issues related to competition and subsidy design in a managed care setting, they study the implications of these factors on consumer surplus without explicitly considering the quality of care. Our paper focuses more on the problems regarding quality offerings in a similar market and explores the scope of improving the same through competition generated by subsidy incentives.

Pay for performance has been increasingly used to provide incentives to health insurance healthcare providers to improve performance.[2]. It is widely applied in both the United States and the United Kingdom and is now being experimented with and implemented in many other countries. Many previous studies have looked into the question of how to structure incentive programs in terms of rewards versus penalties. The rationale for the introduction of penalties for under-performance is that agents may be more responsive to penalties rather than rewards (see Kahneman and Tversky (1979) [25]). However, Kahneman, Knetsch and Thaler (1986) [24] show how penalties might be deemed as unfair by the agents and may fail to elicit appropriate behavioral responses. Damberg et al. (2007) [13] conducts an environmental scan of hospitals under the pay-for-performance programs in the United States.

This paper compares an absolute measure-based payment system with a relative measure-based one. Though absolute targets are transparent and straightforward without any uncertainty involved, they may be inefficient because the bonuses may be paid to insurers or operators already above the target threshold and might fail to incentivize the ones below. A comprehensive study regarding whether financial incentives can help improve healthcare quality has been done by Conrad and Perry (2009) [11]. An absolute measure-based payment system might also generate regional disparity in the incentives. Doran et al. (2008) [15] empirically study whether incentive schemes can increase inequalities in the delivery of care if practices in affluent areas are more able to respond to the incentives than those in deprived areas in the United Kingdom. They study the quality and outcomes framework in the UK, which is a financial incentive scheme to incentivize general practices through bonus payments based on a set of quality indicators. Their results suggest that financial incentive schemes have the potential to make a substantial contribution to the reduction of inequalities in the delivery of clinical care related to area deprivation.

Previous papers have studied market structure, competition, and quality in other different market structures. Hoxby (2000) [23] studies how competition among public schools affects education quality. Fan (2013) studies the quality of content in newspaper markets and how the quality offerings are affected by mergers under a static framework. We introduce a dynamic model for understand-

[2]See Eijkenaar (2013) [16] for a detailed review

ing the relationship between competition and product quality which captures the time lag between investment and outcome.

Our paper contributes to the existing literature regarding quality ratings in Medicare Advantage. Reid et al (2013) [29] study how star ratings affect plan choice in Medicare Advantage by the beneficiaries. Similar work regarding the information and publicly available performance reports and their effect on choice in healthcare and insurance markets have been done by Farley et al. (2002) [18], Scanlon et al. (2002) [30], Wedig et al. (2002) [35], Dafny and Dranove (2008) [12], Darden and McCarthy (2015) [14], and Handel and Kolstad (2015) [22]. Fioretti and Wang (2021) [19] show how the current quality bonus payment system can widen the inequality in accessing social services by private insurers selecting healthier enrollees.However, we look at the supply-side problems in the Medicare Advantage markets associated with plan quality offerings.

Some previous papers explore the supply-side implications of the star ratings and quality bonuses in Medicare Advantage. Vatter (2022) [34] looks at the problem of construction of the star ratings and proposes a welfare-increasing optimal design of the scores. Adrion (2019) [2] finds that contracts operating in more concentrated MA markets receive higher star ratings and relates how market competition affects star ratings through negotiations between private insurers and providers while forming provider networks. Sen et al. (2021) [31] explore in more detail how narrow networks in Medicare Advantage translate into higher star ratings. We differ in our methodology from these papers and provide a structural framework for analyzing the effect of competition on quality offerings by firms. The introduction of a dynamic game to analyze this problem is a novel contribution of our paper.

This paper is methodologically indebted to the extensive existing literature on the estimation of dynamic games. We follow Ericson and Pakes (1995) [17] to assume that firms use stationary Markov Perfect Nash Equilibrium in strategies. Our model and solution procedure for the value function by linear parametric functional approximation is based on Sweeting (2013) [32], and Benitez-Silva et al. (2000) [8]. Our estimation procedure closely follows Pakes, Ostrovsky, and Berry (2007) [28] We implement a nested pseudo-likelihood approach for estimating the dynamic game based on Aguirregabiria and Mira (2007, 2010) [6][7]. Our model of the dynamic game also borrows from Aguirregabiria and Ho (2012) [5], Aguirregabiria (2012) [3], and Blevins (2014) [9]. A complete survey of estimating dynamic games can be found in Aguirregabiria et al. (2021) [4].

We organize the rest of the paper as follows. We discuss details regarding the Medicare Advantage and star ratings in Section 2. In Section 3 we give the details regarding the CMS data we use for our analysis. We introduce our model in Section 4 and proceed to estimation of the parameters in Section 5. In Section 6, we describe how we simulate the counterfactual market outcomes and discuss the results.

2 Empirical Setting and Data

In this section, we provide a detailed discussion regarding Medicare Advantage and our empirical setting.

2.1 Medicare Advantage

The Medicare program is a public health insurance program in the United States whose primary beneficiaries are citizens over the age of sixty-five. The goal of the Medicare program is to provide affordable healthcare services to retired beneficiaries, and it was started in 1965. Though initially, it provided a basic insurance program to cover beneficiaries without any health insurance, over time, it changed to provide more citizens access to quality and affordable healthcare. Medicare consists of four parts: A, B, C, and D. Part A covers hospitals and skilled nursing services, Part B covers outpatient services, and Part D mainly covers self-administered prescription drugs. Part C is an alternative called Managed Medicare or Medicare Advantage, which allows beneficiaries to access at least the services of Part A and Part B through a set of private health insurance plans from which they can choose. Thus, it introduced a choice-based system in a public health insurance program. In this paper, we will concern ourselves with only Part C or the Medicare Advantage. While Part A coverage is provided for free for most people and funded by the Medicare taxes paid by the beneficiaries while working, a monthly premium is charged for Part B

In response to the increasing costs of Medicare, in 1982, Congress authorized Medicare administrators to engage in a series of trials in which the government handed over management of the medical care of selected groups of Medicare enrollees to private insurers in exchange for a fixed payment that did not vary with the realized medical expenditures of each individual. Though it was not a success initially, it laid the foundation for introducing managed competition in Medicare. It went through a series of changes and modernization that led to the formation of the Medicare Advantage (MA) program. Currently, the Medicare Advantage allows each beneficiary to choose from a set of eligible plans that private insurers provide and forgo the traditional Medicare services that are provided directly by the government. In other words, a Medicare-eligible beneficiary can opt for either traditional Medicare or one of the available Medicare-approved private plans in their local area.

Original Medicare provides coverage for the majority of medically necessary services and supplies delivered in hospitals, doctors' offices, and other healthcare facilities. MA plans must cover all these necessary services that traditional Medicare covers. However, they can offer extra benefits that original Medicare does not cover, such as eye exams, most dental care, and routine exams. Any beneficiary choosing a Medicare Advantage plan must also pay the Part B premium they would pay if they chose traditional Medicare. However, some plans may charge an extra premium over the Part B premium for their additional services. When a beneficiary enrolls in a Medicare Advantage Plan, Medicare pays a fixed amount of money for the coverage to the company offering the Medicare Advantage Plan.

Medicare Advantage has been a success, with more and more people choosing an MA plan over traditional Medicare. Enrollment in MA has increased more than double from 12 million or 26% of the total Medicare eligible population in 2011 to 26 million or 42% of the Medicare population in 2021. During this period, enrollment grew by around 10% every year. At $343 billion per year, it comprises around 46% of total Federal Medicare spending and is one of the fastest growing healthcare sectors in the United States.

Enrollment in MA plans takes place during the Open Enrollment Period from October 15 to December 7. Beneficiaries may choose a new plan or switch to a different plan during this period. Each MA beneficiary has to pay a premium called the Part B premium and may need to pay an additional private plan premium as well. This additional premium is determined by a process where each MA plan must report its operation cost to CMS for providing services in a particular county before the enrollment period. Each county is assigned a benchmark that represents a weighted average of fee-for-service (FFS) spending in that county or the expenditure incurred by Medicare. Plans bidding below the benchmark charge a 0 extra premium, while plans that bid above the benchmark charge the difference between the bid and the benchmark as an extra premium.

Medicare Advantage allows beneficiaries to choose from differentiated insurance plans, which is not possible with traditional Medicare. Where traditional Medicare provides uniform benefits to all enrollees, private insurers compete in terms of prices, plan quality, and supplementary benefits and design plans to cater to the needs of the different target populations, thereby increasing the choice set of beneficiaries. Though this might be considered a desirable feature of the market, it is also necessary to make sure that well-informed choices can be made. Thus, in this kind of market, publicly available indicators of plan quality are of utmost importance. To serve this purpose, the CMS uses a 5-star rating system to measure plan quality.

2.2 Star Rating

Though cost-cutting for the government was the main driving factor for the introduction of Medicare Advantage, which allowed private insurers to provide public health insurance services, the need to monitor and improve the quality of care was felt very soon. Since 2009, the CMS has provided comprehensive data regarding MA plan performance through its Star rating program with the goal of encouraging consumers to choose high-quality plans and incentivizing health insurers to improve their service quality. The ratings are assigned at the MA contract level, and all plans under the same contract have the same rating. The star rating is an objective measure of plan quality that is calculated based on observable performance scores belonging to the following broad categories.

- Outcome (Improving physical health)
- Process (Cancer screening, Flu vaccination, etc.)
- Patient experience (Customer service, getting appointments quickly, etc.)
- Access (Timely decision about appeals)

The measures come from various sources and comprise data collected by CMS contractors, CMS administrative data, surveys of enrollees, and also data supplied by health and drug plans.

The overall score of a contract is calculated as a weighted average of these scores. The ratings are assigned using a clustering algorithm, where contracts with similar aggregate scores belong to the same cluster and thus have the same rating. The star ratings act as the only measure to assess the quality of MA plans' service.

The star ratings not only provide consumers with information about plan quality but also interest private insurers offering Medicare Advantage plans as they represent an opportunity to generate additional revenue. One obvious reason is that if consumers take into account observed ratings while making a plan choice, plans with higher ratings compared to their competitors might capture a larger portion of the market share. Also, a higher star rating in a particular market is usually associated with a higher benchmark and a higher rebate percentage the plan faces, which increases the plan payment for a given bid, also referred to as Quality Bonus Payments (QBP). This process will be explained in detail in the next subsection on plan payment. The bonus payment system was introduced following the Affordable Care Act of 2010, which mandates that plan payments should be dependent on quality.

Plan quality has improved in MA over the years, especially after the introduction of QBP, as shown in Figure 3. This pattern is indicative of the fact that private insurers respond to these bonuses by improving the quality of offered plans.

2.3 Plan Payments

Every MA market is characterized by a CMS-assigned benchmark B_{mt} based on which all subsidies are paid. The subscript m denotes a particular market and t a particular period. Each plan reports its cost of providing service b_{jt}. For each individual beneficiary i enrolled in plan j, CMS reimburses the plan Reb_{ijt} using the following rule:

$$\text{Reb}_{ijt} = \begin{cases} B_{mt} \times \text{R}_{it} & \text{if } b_{jt} \geq B_{mt} \\ \left(b_{jt} + \lambda^B_{jt} \times \left(B_{mt} - b_{jt}\right)\right) \times \text{R}_{it} & \text{if } b_{jt} < B_{mt} \end{cases} \tag{1}$$

where λ^B_{jt} is the rebate percentage or the portion of the surplus the plans get to keep, and R_{it} is the risk score assigned by the CMS to each individual beneficiary measuring how likely the beneficiary is to incur medical expenses relative to the county benchmark. An average beneficiary in the market receives a risk score of 1. These risk scores are calculated based on individual characteristics and prior medical history.

Plans reporting a cost b_{jt} more than the benchmark B_{mt} receive only the benchmark amount, and the difference is charged as an extra premium from the beneficiaries. If the reported cost is less than the benchmark, then the plan receives its reported amount and part of the difference between the benchmark and the reported cost as a reward for cost saving. This rebate percentage is defined by λ^B_{jt}.

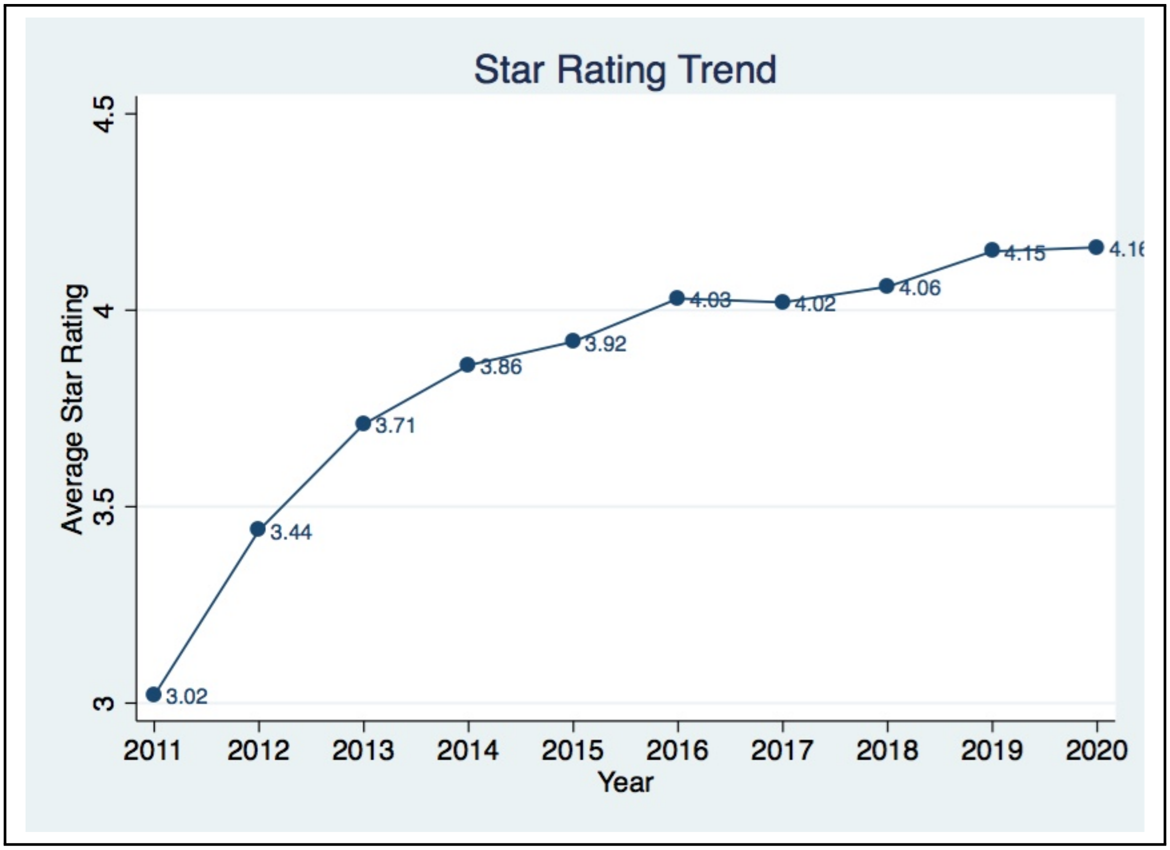

Figure 3: Enrollment weighted average star rating over the years. This figure shows the increasing enrollment trend weighted average star rating after quality bonus payments are introduced.

2.4 Quality Bonus Payments

A plan's Star rating affects its payments through the benchmark and rebate percentage in every market. A plan under a contract with a rating greater than or equal to 4 stars has its benchmark increased by 5% (10% in eligible counties). Rebate percentages are 50% for 3 stars or fewer and increased to 65% for 3.5 to 4 stars and 70% for 4.5 stars and above.

Thus, keeping everything else equal, the current payment system favorably rewards plans with higher star ratings. However, these bonuses are paid based on an absolute measure and not a relative measure. Only plans with a star rating above 4 stars receive this extra payment. In Section 6, we analyze the effect of the proposed change in the payment rule, where quality bonus payments would change from an absolute measure to a relative measure, where plans will receive quality bonuses if they have a higher quality rating with respect to their competitors in a market, irrespective of what the absolute rating is.

2.5 Quality Improvement Initiatives

In an effort to evaluate if the quality bonus payments in practice translated to the increasing trend in the plan quality that we observe in the data and to understand how the QBP may affect organizations' operations, CMS collected information regarding the quality improvement (QI) activities of MA plan sponsors through a contract-level survey and case studies with selected MA sponsors in 2016 [3].

The majority of survey respondents (88 percent) indicated that the budget for the contract's QI activities increased between 2010 and 2013. Linking survey results about organizations' QI activities to Star rating changes, we found that just one QI activity, provider incentive programs, was associated with changes in star ratings from 2013 to 2015. We enumerate some of the most important characteristics and avenues of MA contract's QI initiatives as stated in CMS reports in order to motivate our strategic model of firm choice.

i) MA organization's ratings and their competitors' ratings drive organizational star rating strategies:

This point illustrates how competition can mitigate or enhance the effects of QBP incentives and the Star Ratings program more broadly to attain higher star ratings. Respondents noted that in a market where all the competitors are 3-star plans, having a 4.5-star rating is good enough. But in markets where there are high-quality contracts on the cusp of very high ratings, they feel acute pressure to achieve five stars.

ii) Provider Network formation and provider incentives are an essential pathway of improving ratings:

Most experts in this industry agree that provider network formation is an important aspect of improving star ratings. Over half of the MA plan's star ratings are based on physicians delivering appropriate services, including providing screening tests and vaccines and managing chronic conditions. Plans without significant cooperation from primary care physicians and other clinicians cannot easily improve such clinical measures. Therefore, significant provider cooperation and buy-in are necessary for improving star ratings.

All MA insurers interviewed focused on star ratings when forming narrow networks, though different insurers took different approaches. One MA insurer that focuses on HMO products said that they narrow primary care networks because they believe primary care drives star ratings. The large national MA insurers said they generally form narrow networks around already high-performing physician groups or hospital systems that have proven track records on quality and utilization. All the health systems echoed the MA insurers' emphasis on star ratings, and the two health systems that partially or fully own an MA plan said their high star ratings were integral to their success in MA. All but one MA expert also agreed that star ratings are a crucial consideration for MA insurers when forming networks.

This discussion motivates our model, where firms' action choices represent these QI activities in our empirical setting. In each period, the firm decides whether to invest in these activities. Quality improvement initiatives are costly and improve the quality rating and earn bonus payments in the future period. We use a dynamic model to capture this intertemporal nature of choice and payoff. Specifically, we use the dynamic game to capture the strategic interaction between firms, as discussed in Section 3.

[3] https://innovation.cms.gov/files/reports/maqbpdemonstration-finalevalrpt.pdf

Pay for Performance is increasingly being used to stimulate the quality of services in public healthcare systems. It is widely being used in the United States and the United Kingdom and is gradually but steadily being implemented or experimented with in many other countries. However, evidence of their effectiveness is inconclusive, and their proper implementation is a debated topic in the literature. Proper program design is thus of utmost importance to make such pay-for-performance schemes work efficiently. Some important aspects of such program design are properly defining the performance measures and goals and finding out the best way to implement them, as flaws in doing so will translate into limited success.

One debated aspect of such program design is whether to use rewards or penalties to incentivize the agents to improve their Performance. Another question is whether to use absolute or relative targets to measure the Performance on which their payments will depend. This paper tries to answer both these questions in the context of Medicare Advantage and the effectiveness of the delivery of quality bonus payments to improve plan quality. In particular, we predict the effect of moving from a threshold-based quality bonus payment system to one where bonus payments are made based on the relative Performance of the plans compared to those of their competitors. It should be noted that the status-quo bonus payment rule, as discussed in this section, is an absolute target-based one. Also, the counterfactual bonus payment rule, whose effect this paper predicts is a mixture of rewards and penalties, where relatively underperforming plans in a local area are penalized in the form of reduced payment by Medicare, and this reduction is redistributed to the plans who perform better in comparison to them. We would like to see whether this redistribution increases quality competition among the insurers

2.6 Data

We use publicly available data from various CMS sources for our analysis. We use aggregate MA enrollment for every plan in every market. The data reports monthly enrollment, which we convert to annual enrollment by taking an average. The Plan Benefit Package data provides plan-level information regarding the premium and plan characteristics as provided by the plans during the annual bidding process. The plan payment data provides information regarding the average per month per member Part B payment, the rebate payment to each plan, and the average risk score of the beneficiaries enrolled. The landscape folder provides data regarding service contract area and the performance data provides detailed information regarding the star rating and individual measures.

We have 1,48,392 year-county-plan level observations from 2013 to 2016 comprising HMO and PPO plans. The plans differ in the subsidiary services they offer. Among the observed plans, 38% of the plans provide vision coverage, 62% of the plans provide hearing coverage, and 50% of the plans have dental coverage included. Table 1 shows the summary statistics of the MA markets that we use in our analysis. We select these years as most changes in star ratings are observed to occur during this period after the introduction of the quality bonus payments. The average rating of available plans is observed to increase from 2013 to 2016. The number of observations where the rating improves in the next period remains fairly stable across the years. We observe the maximum improvement in the quality ratings from 2013 to 2014. Average MA enrollment went up every year during this period. The average contract revenue in each market, which is the sum of the total premium earnings and government subsidies, shows an upward trend over the years. The increase in average revenue is due to both the expansion of the MA program and also more bonus earnings by star rating improvement.

Table 1: **Summary Statistics of Medicare Advantage Markets by Year**

Variable	2013	2014	2015	2016
Average Star Rating	3.57	3.74	3.85	3.94
Number of Observed Rating Improvement	5127 (32.2%)	4033 (23.5%)	5489 (30.6%)	
Contract Average Enrollment per County (rounded)	4,205	4,786	5,109	5,415
Contract Average Revenue per County	7,213,630	7,723,691	7,502,888	8,212,173
Number of contract-market observations	19,426	20,616	20,162	20,060

Notes: The reported observations are at year-market-firm level.

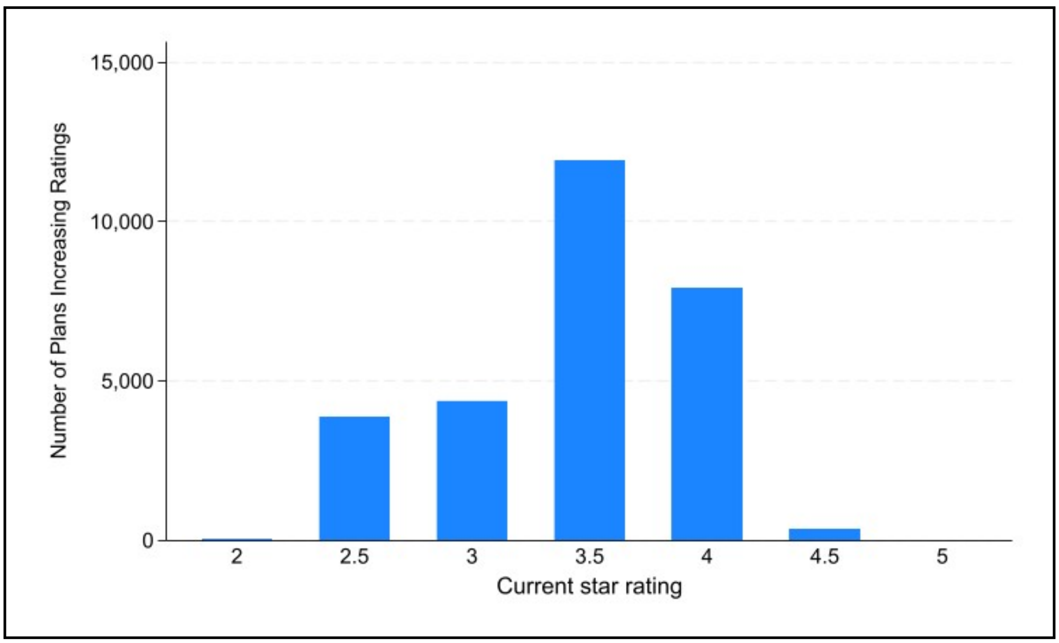

Figure 4: Number of plans in the data observed to increase their rating in the next period by their current star ratings

In the data, we observe that 28,477 plans (19.19%) improved their star ratings across all the years. The corresponding numbers at the contract level by year are provided in Table 1. Among all the plans observed to increase their star rating over the years, 11,927 (43%) of these plans have a current rating of three and a half. These are marginal plans in our case, as improving the rating by a half-star makes them eligible for quality bonus payments. Figure 4 shows that most of the increase in star ratings is observed for plans that are rated three and a half stars followed by four stars (28%

Table 2: **Probit Estimation: Effect of Marginal Contracts on Rating Improvement Probability**

	(1) Increase	(2) Increase
Marginal	0.0711***	0.0710***
	(24.94)	(24.90)
Lowstar	-0.269***	-0.275***
	(-4.36)	(-4.44)
Diff_meanstar	0.201***	0.201***
	(72.99)	(73.00)
Total_contract		0.00110***
		(5.18)
Year FE	Yes	Yes
State FE	Yes	Yes
N	109953	109953

t statistics in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Notes: Marginal effect on the probability of increasing star rating in the next year. The variable Marginal denotes whether the current rating is 3.5, Lowstar is contracted with a rating of 2 stars or less, and Diff_meanstar denotes the difference between the Mean rating of the county and the plan's star rating. The reported observations are at the year-market-plan level.

of the total observed increases). The patterns reveal that most of the plans try to be just above four stars, the national threshold for quality bonus payments. This provides evidence that the current bonus payment system generates a "cliff effect".

We explore patterns in the data to reflect on which plans are more likely to improve their ratings in the next period. Table 2 reports the probit estimates of the average marginal effect of being a three-and-a-half star-rated marginal contract, given by the variable Marginal on the probability of increasing the star rating in the next year to be 0.7 and statistically significant. It also shows a negative effect for the same for plans equal to or below two stars. The variable Diff_meanstar is the difference between a plan's current rating from the average star rating of all plans in the market (county). Thus, the positive significant average marginal effect of this variable on the probability of quality rating improvement shows the quality competition among Medicare Advantage plans. These star ratings are publicly available and are supposed to aid beneficiaries in choosing their MA plans from the set of alternatives. The probability of quality improvement initiatives increases with an increase in the magnitude of the difference between the country's mean quality rating and the plan's quality rating, demonstrating the effort of low-performing plans in a market to catch up.

In the following section, we will introduce a model of firm choice of quality investment initiative where we account for both the above-observed effect of quality bonus payments and quality competition in a market to model a firm's decision to invest in quality rating improvement.

3 Model

We introduce a stylized model of a managed competition setting where firms offer differentiated insurance plans in each market to generate revenue by enrolling beneficiaries in a market. The two main components of our model are the firm's profit function and the beneficiary demand function. In each period, a plan's market share is determined by the demand function where the beneficiaries choose from a set of alternatives and their choice depends on the plan characteristics, annual premium[4], observed quality measure provided by the star rating, plan level heterogeneity, and the beneficiary's private taste. For each beneficiary a firm enrolls in its plans, it earns a variable profit, which comprises the annual plan premium, and government subsidies. They incurs a marginal cost of providing service. The government subsidies depend on the given market characteristics and the quality ratings, marginal costs depend on the plan characteristics, both observed and unobserved, and the equilibrium plan premiums are set by the firms. In every period, the firms can decide to invest in quality and incur an investment cost associated with it.

The choice of firms' quality investment determines the quality ratings for the next period. The firms are forward-looking and maximize their expected discounted payoff while investing. This payoff depends on the firms' own quality ratings, as well as those of their competitors, and quality investments are strategic. Our model of the dynamic game closely follows Aguirregabiria and Ho (2012) [5] and Sweeting (2013) [32].

3.1 Framework

Medicare Advantage contracts, henceforth firms $f = 1, 2, ..., \mathcal{F}_m$ in a particular market m plays a discrete time infinite horizon game with periods $t = 1, ..., \infty$. Each firm offers a set of plans in each county which we will consider as a separate market in this model. Markets are assumed to be independent of each other.[5] In each period, a firm observes its payoff relevant state variables denoted by S_{fmt} which includes the firm's own characteristics, competitors' characteristics, and market characteristics. These state variables are assumed to be public information observed by all the firms in a market. A market is characterized by the CMS assigned subsidy benchmark B_{mt}, the total number of MA eligible population M_{mt}, and FFS spending quartile. County benchmarks determine the plan specific subsidy amount using the reported plan cost and the CMS payment rule as described in the previous section. We assume that in each period MA contracts (firms) observe the market characteristics, their own characteristics, and competitors' characteristics and set the premiums of each plan it offers, and make a quality investment choice. Premiums affect the profit of the

[4]A positive premium in our model is the excess premium some plans charge over the standard Part A B premiums Medicare beneficiaries already pay

[5]This assumption is essential for identification of the structural parameters in a dynamic game

current period whereas investment in quality improvement affects their ratings and consequently payoffs for the next period. We drop the market index m below for simplicity of notation.

In each market period, a firm f offers a set of plans $\mathcal{J}_f$ and generates revenue when an eligible beneficiary chooses their plan. The set of firms and plans are assumed to remain the same over time. For each individual beneficiary who enrolls in one of their plans, a firm receives the extra annual premium and the per-member subsidy assigned by CMS and incurs a marginal cost. The firm also chooses whether to invest in quality improvement. Any decision to improve quality results in an increase in star ratings in the next period and incurs a quality investment cost. We assume that this decision is made at the contract level[6]

In every period, the firms choose an action $a \in A(S_{ft})$ from a discrete set of possible actions that determines their quality rating in the next period. A firm may decide to improve its rating by half star, one star, or not improve at all. The action choices are state-dependent as, for example, contracts with a current rating greater than 4 cannot improve their rating by one star in the next period. Each action choice of the firm is associated with private information, independent and identically distributed (i.i.d.) payoff shock ν_{aft}. These shocks are assumed to follow a Type 1 extreme value distribution with dispersion parameter σ_ν. The sequence of the firm's decision is as follows:

1. Each firm observes payoff relevant state variable S_{ft} at the beginning of the period t
2. Each firm sets a premium for each plan $j \in \mathcal{J}_f$ offered in the market and reports their cost of providing service to CMS
3. Each firm observes the vector of action specific payoff shocks $\nu_{ft} = \{\nu_{aft} : a = 0, 1, 2\}$ and chooses an action $a \in A_{S_{ft}}$ to maximize the discounted sum of future payoffs
4. Each firm earns variable profit $R_{ft}(S_{ft}; \beta^{dd}, \gamma^{mc})$ from beneficiary enrollment where β^{dd} and γ^{mc} are the demand and marginal cost parameters respectively.
5. Each firm incurs an investment cost for quality improvement $I(a, S_{ft}; \theta)$ based on their action and receives a payoff shock ν_{aft}
6. The state variables evolve to the next period according to firms' choices and transition rule

The firm's flow profit function given payoff relevant state S_{ft} is given by

$$\Pi_{ft}(a, S_{ft}, \nu_{ft}) = R_{ft}(S_{ft}; \beta^{dd}, \gamma^{mc}) - I(a, S_{ft}, \theta) + \nu_{aft} \tag{2}$$

We now describe in detail each component of the profit function and the state transition rules.

The variable profit is earned by firms by beneficiary enrollment in their MA plans and is given by:

$$R_{ft} = \sum_{j \in \mathcal{J}_f} \{(p_{jt} + Reb_{jt} - mc_{jt}) \times s_{jt} \times M\}, \tag{3}$$

[6]The star ratings are provided at the contract level.

where M is the total Medicare eligible population in the market, s_{jt} is the market share of each plan j obtained from the demand model. We will later describe how the market shares are determined in this framework and how it depends on the observed star ratings.

The amount of subsidy each plan receives per beneficiary is given by the payment equation (1) and depends on the market benchmark, the star rating, and the reported costs[7]. The star ratings affect the variable profit of the firms through increased subsidies from the government in terms of quality bonus payments. Plans with a star rating greater than or equal to four stars receive bonus payments in the form of higher rebate percentages and higher benchmark as detailed in Section 2.4. In our counterfactual analysis, we will change the current national threshold based bonus payment system to a comparison based quality bonus payment system. Thus in our counterfactual, the relationship between the star rating of a plan and their annual revenue will be changed through this component of our model.

Given the timeline of the game, the equilibrium premium for each plan in a market is determined by maximizing the variable profit R_{ft} with respect to $p_{jt} \forall j \in \mathcal{J}_f$.

In each period a firm takes quality improvement decision and incurs an investment cost $I(a, S_{ft}, \theta)$ based on its choice of action a and parameter θ. We assume the following parametric specification of investment cost:

$$I(a_{ft}, S_{ft}; \theta) = \theta^1 a_{ft} + \theta^2 a_{ft}\mu_{ft} + \theta^3 a_{ft} PS_{ft} \tag{4}$$

We let this investment cost depend on current star rating μ_{ft} and whether quality improvement occurred in the previous period PS_{ft} which takes the value 1 if the firm improved its rating in the previous period and 0 otherwise. In the data, we observe that most contracts do not improve ratings in consecutive periods. The scope of improvement is usually diminished for a contract that increased its ratings recently as the firms have to find new avenues through which the measures can be improved. This effect is captured by PS_{ft}. The set of parameters θ are our structural parameters of interest that determine the investment cost of improving quality that we will estimate.

The star rating for the next period is assumed to evolve based on the firm's action choice as follows:

$$\mu_{ft+1} = \begin{cases} \mu_{ft} + \epsilon^{a_0}, & \text{if } a_{ft} = 0 \\ \mu_{ft} + 0.5, & \text{if } a_{ft} = 1 \\ \mu_{ft} + 1.0, & \text{if } a_{ft} = 2, \end{cases} \tag{5}$$

where ϵ^{a_0} is a discrete random variable with the following probability mass function

[7]The reported cost is assumed to be a function of the true marginal cost. This assumption is based on the fact that the Affordable Care Act mandates each MA plan to have a minimum medical loss ratio of 85% which is observed by the CMS through its auditing process and failure to comply results in punitive actions. Similar assumption has been used in the literature previously by Miller et al. (2019). [27]

$$P(\epsilon^{a_0}) = \begin{cases} P_0^{\epsilon^a}, & \text{if } \epsilon^{a_0} = 0 \\ P_{0.5}^{\epsilon^a}, & \text{if } \epsilon^{a_0} = -0.5 \\ P_1^{\epsilon^a}, & \text{if } \epsilon^{a_0} = -1 \end{cases}$$

where the values of $P_0^{\nu}, P_{0.5}^{\nu}, P_1^{\nu}$ are exogenously given. During estimation, they are empirically calculated as some of the contracts are observed to see a reduction in rating[8].

We will now explain how the market share for each plan is determined. Though the main objective of the paper is to study the supply-side implications of different quality bonus payments, the following model for plan demand will be used to predict the market shares, equilibrium prices, and marginal costs for our counterfactual and welfare analysis. In each period, t consumer i in market m chooses a MA plan $j = 0, 1, 2, ..., J_m$ from all available plans offered in a market where $j = 0$ is the outside option of not choosing any MA plan. We let individual utility depend on observed plan characteristics, plan type, and observed and unobserved quality. The utility individual i receives from a plan j in a given period t is given by the following utility function

$$U_{ijt} = \beta^p p_{jt} + \beta^{\mu} \mu_{jt} + X_{jt}\beta^x + \xi_{jt} + \epsilon_{ijt}, \tag{6}$$

where p_{jt} is the annual plan premium,[9] μ_{jt} is the CMS assigned star rating of the plan, X_{jt} is the vector of plan types and plan characteristics and includes dummy variables indicating whether certain subsidiary services like vision, hearing, and vision, are covered by the plan. ξ_{jt} is the plan level characteristic that is observed by the consumers and the firms but is unobserved by the econometrician. This captures the plan-market level heterogeneity and also plan qualities that are not captured by the star ratings but can affect the demand. ϵ_{ijt} is the beneficiary-plan specific idiosyncratic taste shock assumed to be Type I extreme value distributed. We consider X_{jt} for each plan to be exogenous. Firms choose p_{jt} and μ_{jt} and are possibly correlated with ξ_{jt}. These two variables are treated as endogenous in our model.

The coefficients β^p, β^{μ}, and β^x are the structural demand parameters of our model. The market share for each plan is derived from the individual choice probabilities. A consumer chooses a particular plan if the utility of that plan is greater than all other available options in the market. Under the distributional assumption of ϵ_{ijt} the choice probability is given by the following logit form

$$s_{ij} = Pr(\text{i chooses j}) = \frac{exp(\delta_j)}{1 + \sum_{k=1}^{J_m} exp(\delta_k)}$$

where the plan mean utility δ_j of plan j is given by

$$\delta_{jt} = \beta^p p_{jt} + \beta^{\mu} \mu_{jt} + X_{jt}\beta^x + \xi_{jt}$$

[8]The star rating for a contract is mostly reduced due to institutional reasons difficult to incorporate in the model. Failure to comply with CMS rules or report data on time is associated with a reduction to a one star score for the associated measure which often leads to deterioration in rating.

[9]This is the premium over the standard Part B premium that the beneficiaries need to pay. If a plan doesn't charge any extra premium other than the Part B premium they pay to Medicare, it is considered a 0 premium plan.

Most plans in our data are observed to be \$0 plans. It does not however mean that the beneficiaries of these plans pay a \$0 premium. Instead, they pay the standard part B premium for traditional Medicare. A positive premium is thus any extra amount the plan charges in addition to this. Since all individuals choosing a plan in our setting are medicare eligible, traditional fee-for-service Medicare or a PFFS plan are considered to be the outside option.

It should be noted that the star ratings are assigned at the contract level in a particular market and not plan level. This means that plans under the same firm uses the star rating of the contract they are under. Let $\mathcal{J}_f$ be the set of plans offered by the firm f. Thus $\mu_{jt} = \mu_{ft} \forall j \in \mathcal{J}_f$.

We assume that ξ_{jt} evolves according to the following AR(1) process:

$$\xi_{jt+1} = \rho^{\xi}\xi_{jt} + \zeta_{jt}, \tag{7}$$

where ζ_{jt} is distributed with mean 0, and standard deviation σ_{ζ} and can be interpreted as an unanticipated innovation shock that affects demand.

The marginal cost of enrolling an extra beneficiary in a plan is assumed to be constant and depends linearly on plan characteristics as follows:

$$ln(mc_{jt}) = x_{jt}\gamma^{x} + \mu_{jt}\gamma^{\mu} + \omega^{mc}_{jt}, \tag{8}$$

where ω^{mc}_{jmt} is the unobserved marginal cost component assumed to be i.i.d. distributed.

3.2 Value Function and Dynamic Game

We assume that firms use a stationary Markov Perfect Nash Equilibrium in pure strategies in every market. A Markov Perfect strategy Γ_f of a firm is a mapping from (S_{ft}, ν_{ft}) to an action a_{ft}. We assume that the firms are forward looking and they maximize their sum of the discounted expected future payoff. A firm's value function given strategies of all firms Γ is given by the following Bellman equation:

$$\begin{aligned} V^{\Gamma}(S_{ft}, \nu_{ft}) = max_{a \in A(S_{ft})}[&R_{ft}(S_{ft}; \beta^{dd}, \gamma^{mc}) - I(a, S_{ft}, \theta) + \nu_{aft} \\ &+ \beta E\{V^{\Gamma}(S_{ft+1})|a, \Gamma_{-f}, S_{ft})\}], \end{aligned} \tag{9}$$

where $\beta = 0.95$ is the given discount factor assumed and $V^{\Gamma}(S_{ft+1})$ is the firm's value in the particular state before the realization of ν_{ft} takes place. Thus $E\{V^{\Gamma}(S_{ft+1})|a, \Gamma_{-f}, S_{ft})\}$ is the firm's expected future value given the current state, action of the firm and strategies of other firms Γ_{-f}. The expectation is taken over the possible realization of the state variables in the next period where a firm's own star rating evolves depending on firm's action a, the star rating of the competing firms evolve following Γ_{-f}, and all other state variables follow their respective transition rules.

We define the action specific value $v^{\Gamma}_f(a, S_{ft}, \Gamma_{-f})$ as the sum of the flow profit and discounted expected future value at any given state and for a particular action choice as follows:

$$v^{\Gamma}_f(a, S_{ft}, \Gamma_{-f}) = R_{ft}(S_{ft}; \beta^{dd}, \gamma^{mc}) - I(a, S_{ft}, \theta) + \beta E\{V^{\Gamma}(S_{ft+1})|a, \Gamma_{-f}, S_{ft}).$$

Under the Type I extreme value distributional assumption of the action specific payoff shocks, the conditional action choice probability of a firm can be written as a logistic function of the action specific values as:

$$P_f(a|S_{ft},\Gamma) = \frac{exp(v_f^{\Gamma}(a, S_{ft}, \Gamma_{-f})/\sigma_v)}{\sum_{a' \in A(S_{ft})} exp(v_f^{\Gamma}(a', S_{ft}, \Gamma_{-f})/\sigma_v)}. \tag{10}$$

3.2.1 Approximating the Value Function

The state space in our setting is exceptionally large which poses a problem for solving the value function. A firm's payoff relevant state variables include the firm's and competitors' own characteristics, characteristics of its competitors, and also market characteristics. Some of these state variables are also continuous variables. Solving for the value function for all states is computationally an infeasible task. In order to address this issue we follow Benitez-Silva et al. (2000) [8], Aguirregabiria (2012) [3] and Sweeting (2013) [32] and use a parametric approximation of the value function.

We assume that the value function can be approximated by linear function of K functions $\phi(\cdot)$. Given any particular state S the value function can be approximated as follows:

$$V(S) = \sum_{k=1}^{K} \lambda_k \phi_k(S) \tag{11}$$

where λ are the linear parameters and $\phi_k(S)$ $k = 1, .., K$ are the K approximating variables as a function of the state variable used for approximating the value function. We call these approximating variables for the value function. Under this assumption, solving for the value function boils down to solving for K linear parameters thereby reducing the computational complexity. We use all the observed states in the data to approximate the value function.

4 Estimation Results

We proceed by first estimating the demand parameters and the plan level unobservables ξ_{jt}. We then back out the marginal costs from firm profit maximization condition and estimate the model of marginal cost. With all the observed and estimated state variables, we estimate our dynamic parameters.

4.1 Estimation of Dynamic Model

We begin our estimation of the dynamic model by defining the expected profit for each state before the realization of action specific shock given some conditional choice probability P_f:

$$\widetilde{\Pi}\left(P_f, S_{ft}\right) = R\left(S_{ft}; \beta^{dd}, \gamma^{mc}\right) + \sum_{a \in A\left(S_{ft}\right)} P_f\left(a \mid S_{ft}\right)\left(-I(a, S_{ft}\theta) + \sigma_v\left(\chi - \log\left(P_f\left(a \mid S_{ft}\right)\right)\right)\right) \tag{12}$$

where χ is the Euler's constant. This formula is derived using the distributional assumption of choice specific payoff shocks. Given the conditional choice probability and firm's state variables, following Aguirregabiria and Mira (2007) [6] the Bellman equation can also be written as:

$$\sum_{k=1}^{K} \lambda_k \phi_k(S_{ft}) = \tilde{\Pi}(P_f, S_{ft}) + \beta \sum_{k=1}^{K} \lambda_k E_{P_f} \left(\phi_k(S_{ft}) \right). \tag{13}$$

The linear parameters for the value function approximation can be easily estimated from the above equation using a simple OLS.

We employ an Iterative Nested Pseudo-Likelihood estimation procedure as follows:

1. We start with an initial conditional choice probability P^0 by using a reduced form multinomial logit model of observed actions on a set of firm characteristics and an initial guess θ^0 of the structural parameter

2. At every step of the iteration, we calculate the expected profits given the state variable and conditional choice probability P_{iter} and parameter$\hat{\theta}$

3. Estimate the parameters $\hat{\lambda}^{P_{iter}}$ given the choice probabilities

4. Use $\hat{\lambda}^{P_{iter}}$ to calculate the choice specific value function, using (8) to form the pseudo-likelihood function and minimize it for the estimated values of $\hat{\theta}'$

5. Use (8) to update the conditional choice probabilities to P'_{iter}

6. The procedure stops if absolute differences between P_{iter} and P'_{iter} , and $\hat{\theta}$ and $\hat{\theta}'$ are less than the tolerance level set at 10^{-4}

For the identification of the quality investment cost parameter, we assume that the markets are independent and the same Markov Perfect Bayesian Nash equilibrium is used in every market, which is a standard identification assumption in the literature. The conditional choice probability function can be identified by exploiting the variations in the state variables and action choices across market. Further details regarding the identification and estimation procedure can be found in Sweeting (2013) [32] and Aguirregabiria et al. (2021) [4].

In our demand estimation, apart from the usual price endogeneity of the demand model, we also deal with the endogeneity of the observed star ratings. As the current plan level unobservable ξ_{jt} is related to previous periods ξ_{jt-1} by an AR(1) process, and the current star rating depends on action choices of the previous period, these two variables might be correlated. Some prior literature regarding the choice of quality, like Fan (2013), uses instruments to address the quality endogeneity. However, we exploit the panel nature of the data and the AR(1) transition assumption of ξ_{jt} to address this issue. We assume that the unanticipated shocks in "innovation" ζ_{jt} are uncorrelated with μ_{jt} as they depend on the action of the previous year before the realization of ζ_{jt}. Let Z be the instruments, including X and μ and the price instruments, where we use the BLP demand instruments [10]. Under this assumption, the moment condition $E(Z'\zeta) = 0$ holds true and is used to identify our demand parameters.

From (3), ζ_{jt} can be expressed as $\xi_{jt+1} - \rho^{\xi}\xi_{jt}$ where each of the $\xi_{jt} = \delta_{jt} - \beta^{p} p_{jt} + \beta^{\mu}\mu_{jt} + X_{jt}\beta^{x}$. Thus ζ_{jt} can be written in terms of all the observables and the parameter ρ^{ξ}. We estimate the parameters using a 'quasi-difference moment approach'.

The marginal costs are not observed but we use firms' profit maximizing F.O.C. to estimate them by solving the system of linear equations:

$$s_{jt} + \sum_{j' \in J_f} \frac{\partial s_{j't}}{\partial p_j}(p_{j't} + Reb_{j't} + m\hat{c}_{j't}) = 0 \quad \forall \text{j in } \mathcal{J}_f.$$

We then estimate the marginal cost parameters γ^{mc} using OLS

4.2 Estimation Results

This section presents the empirical results of our model using the aforementioned estimation procedure.

Table 3 reports the estimated parameters of our demand model. These estimates, in general, correspond to sensible priors. For plans with a positive premium, the coefficient on the premium is -1.62. A positive and significant coefficient estimate for the star ratings indicates that beneficiaries value the quality rating in choosing their MA plans. A higher star rating than the competitors leads to increased market share and increased variable profit for the firms. This is indicative of the fact that firms compete with each other in terms of quality ratings to increase enrollment, apart from the financial incentives provided by the government. We also find that beneficiaries prefer plans that offer vision coverage but have no significant preference for dental or hearing coverage. We also find that beneficiaries prefer PPOs compared to HMOs.

Table 3: **Estimates for Demand Parameter**

Variable	Coefficient	S.E.
Annual Premium (per $1000)	-1.62	0.82
Star	0.19	0.09
Vision	3.33	0.91
Hearing	-0.3	0.38
Dental	-0.03	0.46
Local HMO	-7.09	0.83
Regional PPO	-6.08	0.74
Local PPO	-6.9	0.64
rho (ρ^{ξ})	0.875	0.007

Notes: Estimated demand parameters parameters of equation (6) and (7) based on 146908 year-market-plan observations. The standard errors are clustered at the county level.

Table 4 reports the marginal cost parameters. We observe that star ratings increase the cost of providing service to each extra beneficiary for all possible range of star rating values. However, the negative and significant coefficient estimate for the star square implies that the marginal increase is decreasing as the rating goes up. Subsidiary coverage like vision and dental increases the marginal cost. The coefficient on demand unobservable ξ_{jt} is negative and significant, which indicates cost-saving abilities for plans with higher unobserved quality. In addition, the cost of providing service is higher for PPO plans compared to HMO plans.

Table 4: **Estimates of marginal cost function**

	(1) ln_mc
eye	0.0233***
	(-12.64)
hearing	-0.0100***
	(-7.95)
dental	0.00509***
	(3.87)
star	0.0523***
	(6.19)
star_square	-0.00467***
	(-4.08)
localhmo	8.985***
	(519.70)
ppo	9.010***
	(538.54)
unobservables (ξ_{jt})	-0.00260***
	(-7.87)
State FE	Yes
N	146908

t statistics in parentheses
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Notes: Estimation of (8) based on 146908 year-market-plan observations. The dependent variable is the log of the estimated marginal cost of each plan, and the dependent variables are the plan characteristics with state-fixed effects. The standard errors are clustered at county level

Table 5 we report the parameters of our dynamic model which are the estimates of improving the quality rating of a firm in a market. These estimates report the cost of improving a firm's star rating by half a star and are reported in millions of dollars.

Table 5: **Parameters for Quality Improvement Investment Cost**

Investment Cost for Half Star Improvement	$ million
For 2 star contract	0.091 (0.02)
Increase for one star increase in current rating	1.048 (0.09)
Increase if rating changed in previous period	0.893 (0.76)
Scale Parameter (σ_ν)	1.29 (0.12)

Notes: Reported costs are for a Medicare Advantage Contract per county in dollar millions based on parameter estimation of equation (4). The bootstrapped standard errors clustered at the county level are in parenthesis.

We estimate that firms with 2-star ratings undergo a fixed investment cost of $0.09 million dollars per county when they improve their rating by 0.5 stars. In our data, this is the lowest star rating observed. This cost increases by 1.048 million dollars per one-star rating increase in their current rating. For example, a three-star rated contract will face an additional $1.572 million dollars above the fixed cost for a 2-star-rated contract. This states that improving the rating becomes costlier with an increase in the current rating of the star. The cost of improving a star rating in a period goes up by $0.893 million if the contract improves its rating in the previous period, though the point estimates are insignificant.

Intuitively, this makes sense as the avenues to improve quality decline as the current quality of the firms improves. Higher-rated contracts often employ professionals and consultants to strategize and find ways through which they can improve their rating, and our estimates are reflective of these facts. The quality investment cost parameters also help us explain how the markets have evolved given the "cliff effect" national threshold rule. This rule rewards plans having a star rating of four or above and is only based on this absolute performance measure. From the dynamic parameters, it can be seen that the total cost for a 3.5-star rated contract to move to bonus status without any prior quality improvement activity is around $1.662 million in each market. On the other hand, a 2.5 star rated contract moving to 4 stars over the course of two years incurs a cost of around $ 5.87 million. Thus, the cost of moving to bonus status for a low rated contract is much higher than the marginal contracts

We observe that markets that initially started with better quality plans evolved over the years to have high average plan quality, whereas markets that started with poor quality plans seem to have been stuck there. Our dynamic parameters along with the current quality bonus payment policy can thus partly explain the current geographical differences in average plan quality.

5 Counterfactual

We now return to the problem of implementing the competitive bonus payment rule. After estimating the structural model parameters, we explore how markets might evolve in terms of plan rating if quality bonuses are paid to contracts performing better than their peers in the local market.

5.1 Procedure

We begin by adjusting the variable profit of each plan in a market based on the observed star rating. We follow a budget-balanced redistribution procedure, where plans with a rating lower than the median star rating of the market get a benchmark reduction of 5%, and this deducted amount is redistributed equally to plans above the median star rating. The rebate rate remains at 50% for plans at or below the median rating and 70% for plans above the median. This change in payment rule is intended to induce more competition among peers in the market, where being better quality than the others in a market fetches more subsidies in terms of quality bonus payment, and relative underperformance comes with a penalty.

Due to a change in the quality bonus payment structure as described above, we begin our counterfactual by adjusting the per-member subsidy of each plan in a market as stated. Given the plan characteristics, we calculate the new equilibrium prices by iteratively solving for the set of first-order conditions given by the $\frac{\partial s_j}{\partial p_j}$ matrix starting from observed prices with a non-negativity restriction similar to Miller et al. (2019) [27]. To make sure that this procedure works correctly, we precisely match the observed prices in the data when implementing this procedure of finding equilibrium prices with the existing payment rule. We then proceed to estimate the market shares given the plan characteristics and the new equilibrium prices.

With the counterfactual variable profits for each observed state of the firm and the parameters for quality investment initiative costs, we estimate the new parameters of the value function λ^{count} using an iterative process similar to the one used in the estimation procedure. We begin with a guess of counterfactual conditional choice probabilities P_0^c for each state, calculate the expected profit before realization of payoff shocks in equation (12), estimate λ^{count,P_0^c} using equation (13). These λ^{count,P_0^c} and the estimated investment cost parameter $\hat{\theta}$ are used to update the conditional choice probabilities given by equation (10) to P_1^c. These updated conditional choice probabilities P_1^c are compared to the initial guess P_0^c. The iterative procedure continues till the maximum absolute value is less than the tolerance (10^{-6}) and convergence is achieved. The final iteration provides us with the counterfactual parameters λ^{count}.

We then simulate the market forward based on λ^{count} to see how markets evolve under the new payment rule. We start from 2013, and the previous step provides the equilibrium choice probabilities for observed states for this year. These probabilities and the estimated transition process of ξ are used to move the model forward one period. As this process takes the market to a state not observed in the data, from this step, we proceed by solving for equilibrium choice probabilities for every period we simulate the model forward. We use initial choice probabilities approximated by a multinomial logit model. [10]. We solve for the equilibrium choice probabilities in each market by iterating over the best response function.

5.2 Simulation Results

We start from the observed states in 2013 and simulate the markets forward. We do this in order to compare the simulated markets with observed data. Figure 5 shows the county average ratings in the United States in 2013. This was the initial period when the rating system and the national threshold bonus payment system were introduced. As we can see, most regions in the United States perform poorly in terms of offered plan quality except regions on the West Coast, mid-west, and Northeast, which perform better than other countries. Figure 6 shows the county average rating of 2016 observed in data where we find that certain markets have evolved to have higher average plan quality compared to others like counties in the south.

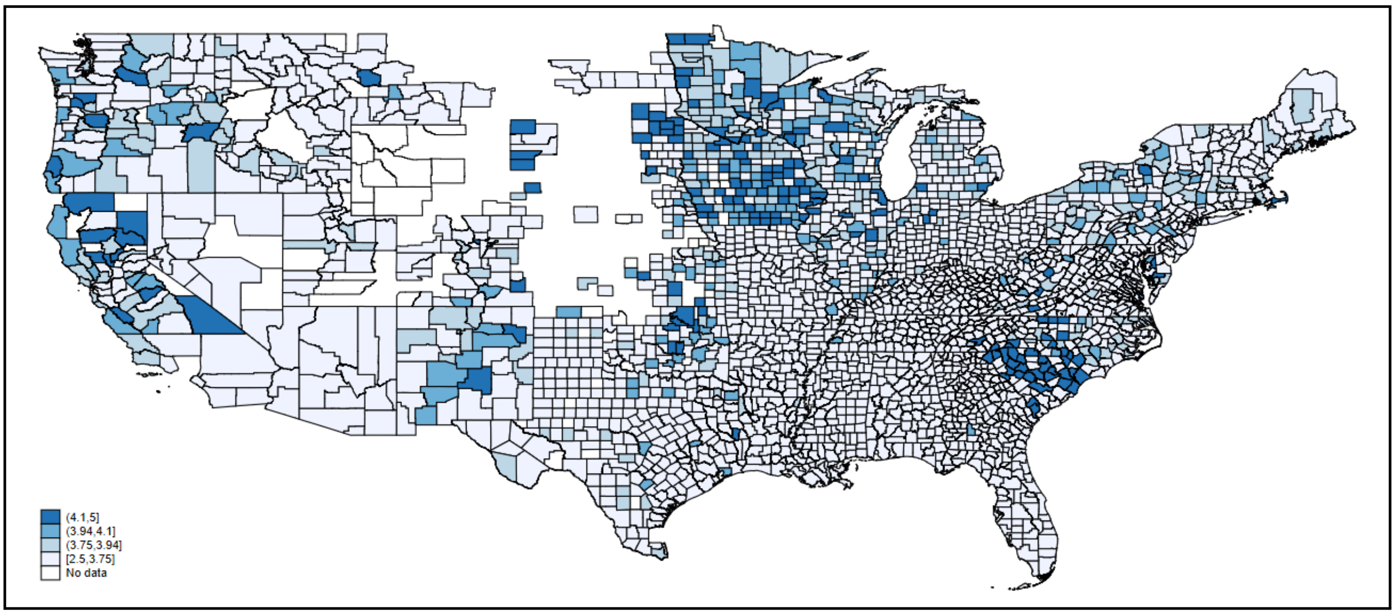

Figure 5: Geographical distribution of average MA plan star rating of counties in 2013

It is important to note that the counties with a higher average rating in 2016 are mostly concentrated in the geographical areas that had better initial conditions in 2013 in terms of average ratings. This might be due to two facts that our model captures:

- There are more marginal firms in these regions that have incentives to improve their rating as a relatively smaller investment takes them to bonus status

[10]We initialize this iteration with a reduced form estimate of choice probabilities using a simple multinomial logit model of observed action on potential subsidy increase for each possible action if no other firms change and use this model to predict the choice probabilities under the new scheme by changing the covariates. See [33] Sweeting, 2013 Supplement

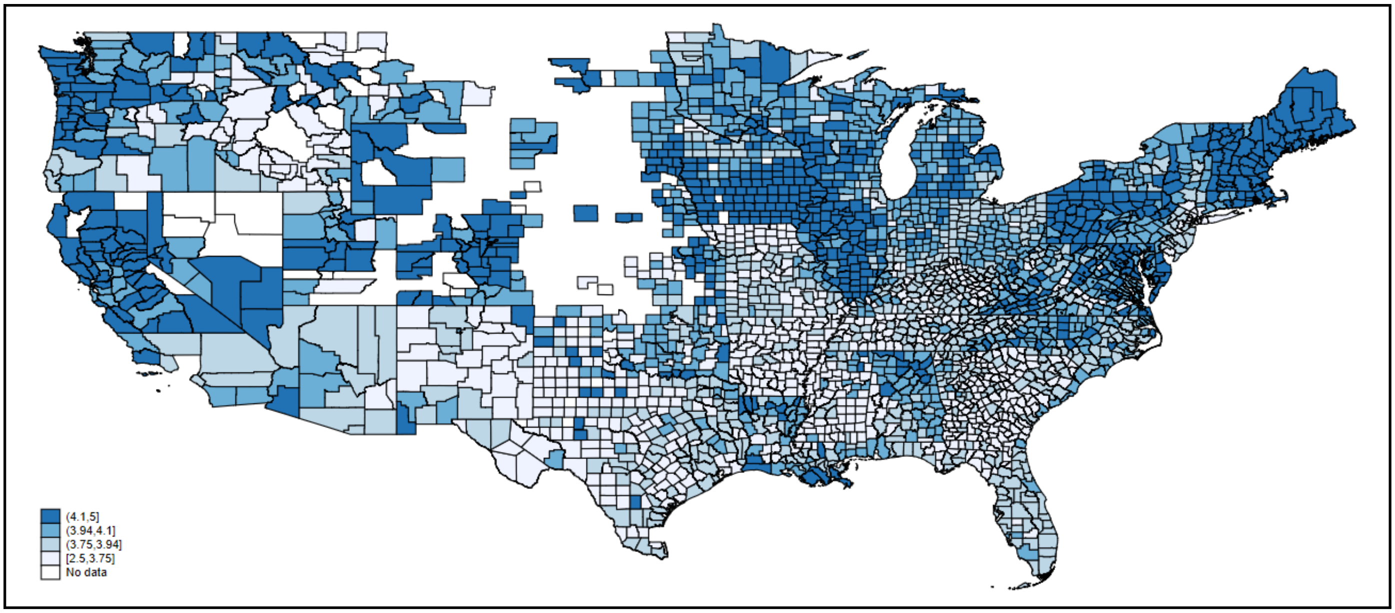

Figure 6: Geographical distribution of average MA plan star rating of counties in 2016

- Even nonmarginal firms are incentivized to improve their ratings due to the presence of marginal firms improving their ratings, increasing quality competition in these markets because of their effect on the demand side.

Our model of quality improvement initiatives captures both the overall and the regional distribution of mean county ratings if we simulate the model without implementing the new payment policy as shown in Figure 7 starting from the initial market conditions and predicts well the regions that evolved to a higher average quality in the data. The ability of our model to predict the market outcomes indicates that the model assumptions regarding the strategic interactions in terms of quality improvement initiatives are plausible.

As the initial payment system pays quality bonuses only to plans with a rating greater than four, it is less costly for plans with better initial ratings to move to bonus status. For example, a plan with a 3.5 rating can move to bonus status by increasing its rating by half a star only. So, a half-star increase is associated with an increase in government subsidies. The cost of moving to a four-star rating is much higher for plans with poorer initial ratings. This, coupled with the strategic interaction among firms, drives the results for our model simulation. This fact is illustrated by our estimates of investment cost parameter in Table 5.

We then introduce the competitive bonus payment system, simulate our model forward, and compare it with observed data. Figure **??** shows the average plan quality for the simulated markets under the competitive bonus payment system in 2016 starting from 2013. The figure illustrates a reduction in regional disparity in plan quality in our counterfactual, where 65.21% of the counties performed better than their observed average rating in 2016. Figure 8 shows the regions that would perform better under the competitive payment system. Low-performing regions like West Texas, New Mexico, and Florida. are predicted to improve under the new payment system.

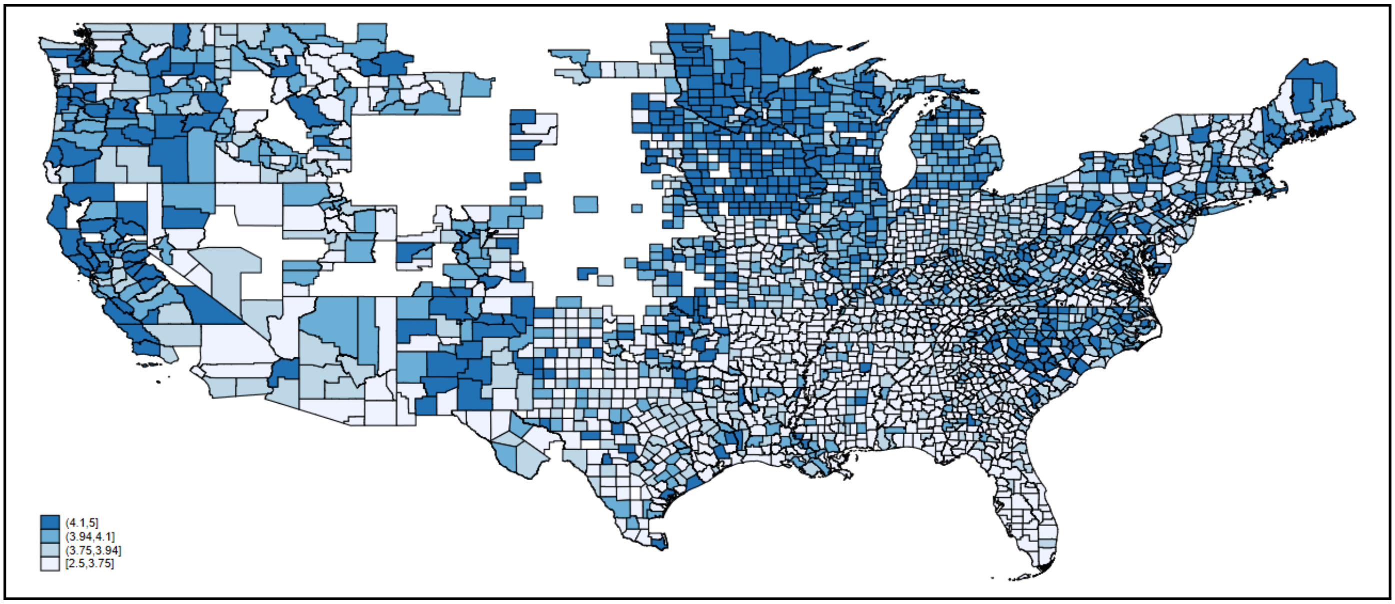

Figure 7: Geographical distribution of model simulated average MA plan star rating of counties in 2016

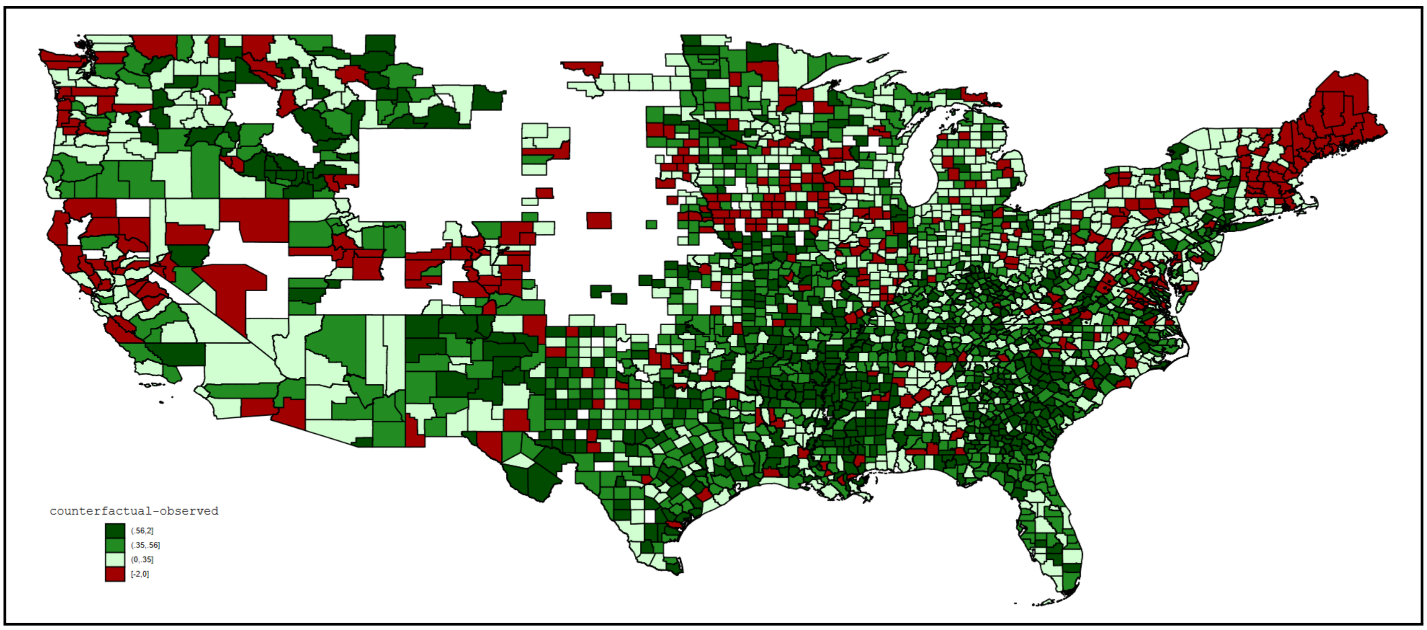

Figure 8: Counties improving mean star rating under the counterfactual payment rule

Figure 9 compares the distribution of observed and simulated average county star ratings in the United States in 2016. It can be noted that the distribution shifts rightwards as 66.7% counties are predicted to have an average rating greater than or equal to four stars as compared to 47.4% in the data. This is a desirable outcome as the existing payment rule rewards plan having a rating of four or higher. The competitive payment rule is predicted to achieve this goal better using the

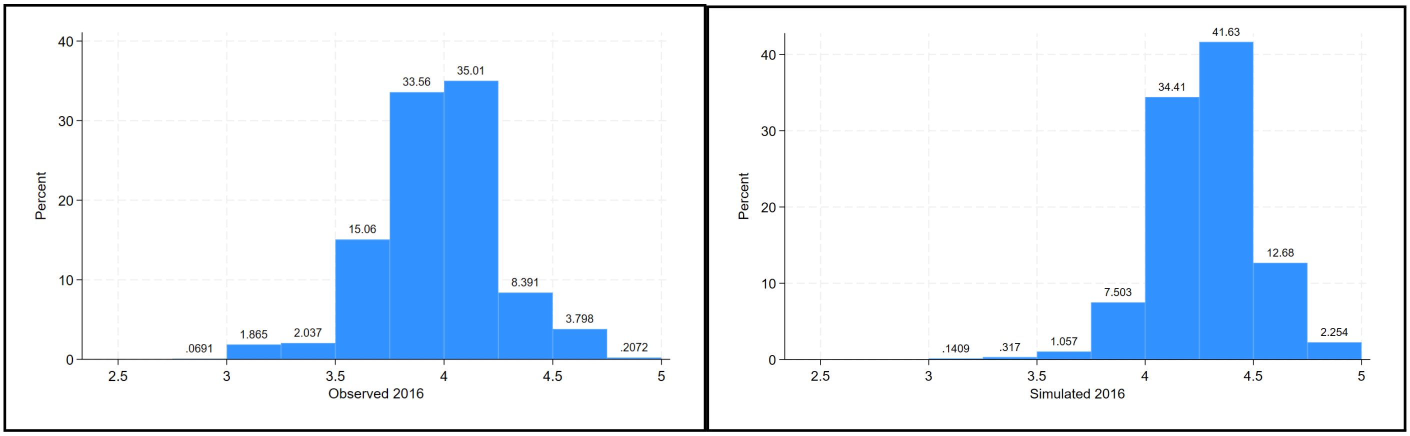

Figure 9: Distribution of mean county star rating in observed data and counterfactual. This figure shows that under the counterfactual payment rule, the distribution shifts to the right and is less dispersed.

counterfactual bonus payment rule. The other key feature of this distribution is that around 42% of counties have an average rating between 4 and 4.25 stars. Our model predicts that under the new payment rules, most markets will evolve and cluster around this region. This result is plausible given our counterfactual payment rule, which rewards plans above the median market rating. Thus, intuitively, the firms will tend to cluster near the median rating, and the empirical question of interest here is whether they will cluster around a higher or lower rating than that observed in the observed distribution. Our findings suggest that most markets evolve to have an average rating between 4 and 4.5 stars. This is a desirable outcome both in terms of the overall increase in the quality of the plans and a decrease in the regional heterogeneity across regions in terms of the availability of better quality plans.

We then analyze which counties perform better under the new payment rule. We calculate the difference between the counterfactual county average rating and the observed mean of 2016 for each county. A positive value of this variable signifies that the county improves in terms of plan quality offering under the new payment rule. In Figure 10, we plot for each county the value of their observed average rating in 2016 against the calculated difference as defined above. We observe that most counties that improve have a lower average rating in the data. No county below an observed average rating of 3.5 worsens in the counterfactual. Most of the counties predicted to worsen under the new payment rule have an observed average rating of 4 stars.

This pattern can be indicative of how the firms might allocate resources for quality improvement initiatives under the new payment rule. As explained before, under the existing rule, it was more profitable for firms to invest in quality improvement of contracts that were already performing better but just below the national benchmark. The cliff effect of the current payment policy generates the incentive to do so. However, when the bonus payments are based on the relative performance of the contract in a market where the contract has to be better than its peers, improving the rating of a low-performing contract in a low-performing market can become profitable. Our counterfactual predictions capture this effect of the competitive bonus payment rule, as illustrated.

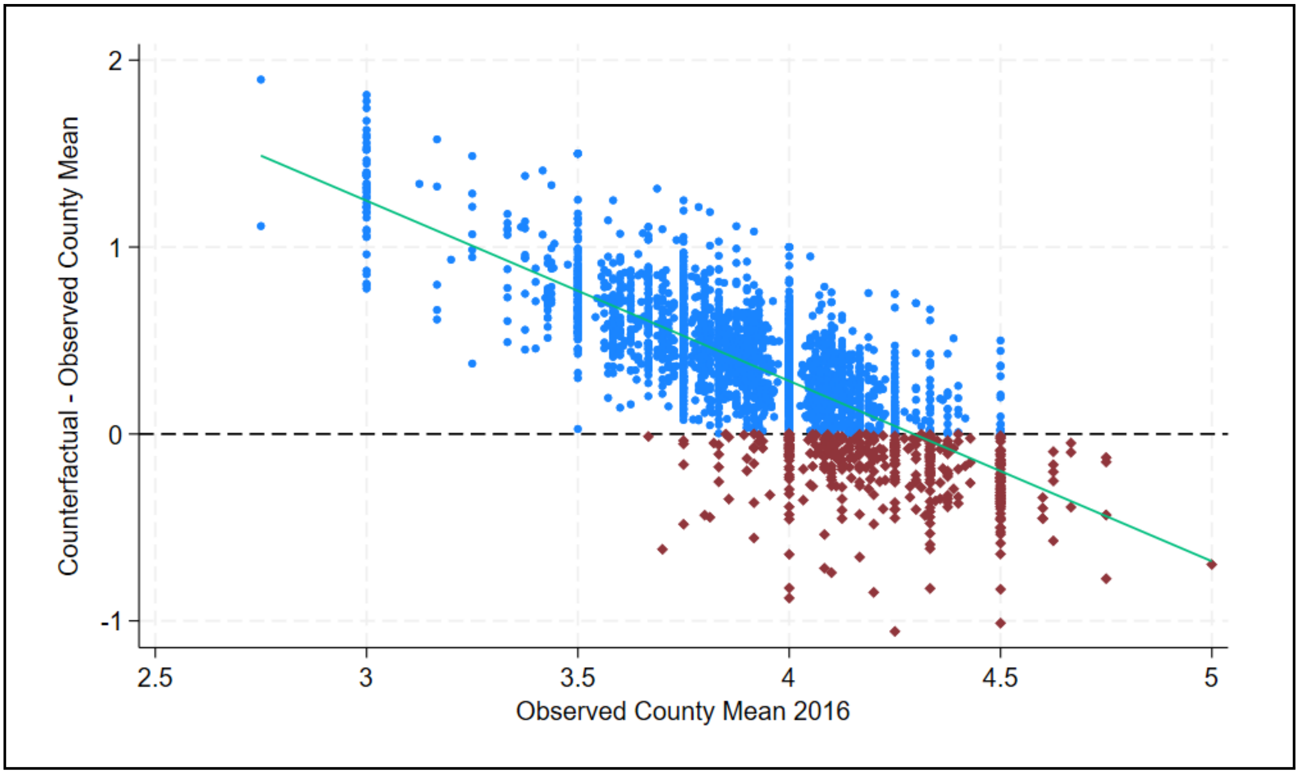

Figure 10: Scatter plot of the observed average rating of a county and its difference from the counterfactual prediction. A value greater than zero for the Y axis indicates that the market performs better in the counterfactual.

Finally, we analyze how the annual premiums will change under the counterfactual payment rule. The new bonus payment system is budget balanced as no extra dollar amount per beneficiary is injected into the system and is paid as transfers across plans. It is necessary to see how the firms might react in terms of premiums under such a payment system. In other words, we would like to see if this predicted increase in quality comes at an increased annual premium.

As shown in Figure 11, the distribution of annual premium does not change much in our counterfactual from the observed data. Most plans in the counterfactual still charge a premium of \$0 extra above the standard MA Part B premium. However, the maximum annual premium charged in Medicare Advantage increases but only for a few offered plans. In Table 6, we show that for 25.27% of plans we study, the premium remains the same under counterfactual. Though around 30.86% of the plans increase their premium, the mean increase in premium is \$ 4.58 (median \$ 5.33). Given the counterfactual predictions, it is safe to state that the new competitive quality bonus payment system does not put any excess premium burden on the beneficiaries.

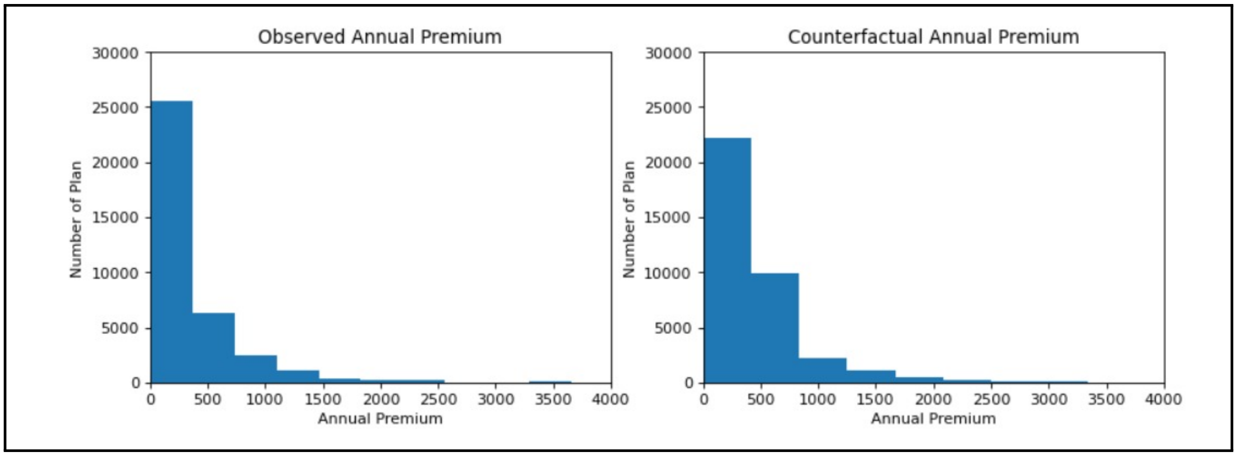

Figure 11: Distribution of Annual Premium in Observed Data and Counterfactual. This figure shows how the distribution of the annual premium of MA plans changes in the counterfactual.

Table 6: **Difference between Observed and Counterfactual Annual Premium**

Variable	Number of County-Plans (% of total observations)	Mean Difference in $ (S.D)
Observed Price= Counterfactual Price	9,707 (25.27 %)	0
Observed Price<Counterfactual Price	11,855 (30.86 %)	4.58 (1.95)

Notes: The level of observation is county-plan in 2016. This table reports the comparison of observed plan premiums and calculated counterfactual plan premiums in 2016.

Finally, because our counterfactual results show an increase in average star ratings across plans and across counties and also a mean overall increase in the excess premium that Medicare Advantage charges plans, we proceed to calculate the change in the consumer surplus under the new bonus payment system. The consumer surplus of individual i given product characteristics in a market can be written as follows:

$$CS_i = E[max_j u_{ij}]/\beta^p = \frac{1}{\beta^p} ln(1 + \sum_j exp(\delta_j))$$

where

$$\delta_j = \beta^p p_j + \beta^\mu \mu_f + X_j \beta^x + \alpha_s + \xi_j$$

This represents the mean utility gain converted to dollar amounts when any individual beneficiary chooses a Medicare Advantage plan over the outside option. We calculate this mean consumer surplus for each market under the existing payment system and our simulation. Our results predict a mean increase in this consumer surplus by 3% under the counterfactual payment system.

6 Conclusion

We study how competition among firms can be exploited in a managed care setting like the Medicare Advantage. While a lot of studies regarding managed competition are regarding improving financial efficiency, we explore how competition can be used to provide incentives to firms to improve the quality of service. We introduce a redistribution mechanism of quality bonus payment where, in every local market, plans are compared to each other in terms of measured quality, and bonus payments are made as transfers from low-performing plans to high-performing plans within the local market. Such a mechanism not only puts pressure on private firms to improve quality, it also makes it profitable for them to do so in low-performing markets.

We provide a framework to analyze how firms would behave under such a competitive bonus payment system and predict how the markets evolve in terms of offered plan quality. We use a dynamic game model where forward-looking profit-maximizing firms strategically choose whether to invest in quality improvement. The firms also take into account their competitor's behavior as the payoffs for improving quality measures under the new proposed rule depend on their relative performance. We use estimated model parameters to calculate the equilibrium quality investment decision of the firms under the new quality bonus payment rule and simulate the model forward to see how they evolve.

Our counterfactual predicts that the average quality of plan offerings improve under this new payment rule. By comparing our simulated market outcomes with the observed 2016 data, we see that 1,853 (65.21%) counties improved their rating with the redistribution bonus payment system. In 2016, we observed that 48.09% of the counties had an average MA plan quality of four or higher. Our counterfactual predicts that this number would go up to 66.7% under the new bonus payment policy. We also observe that historically, poor-performing markets perform better under the new policy.

In our model, we only consider the firm's decision to invest and do not consider entry and exit decisions. In reality, however, low-performing firms may choose to leave the market or merge with better-performing firms. Introducing entry and exit decisions is a promising extension of our model. Also, we do not explicitly model how these quality improvements take place through provider network formation. The ease of improving quality in a market might depend on the existing provider conditions. We leave for our future work to analyze how provider networks can improve plan quality and how it is affected by market competition.

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