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

Rajarshi Bhowal*

Abstract

This paper explores how competition among firms can be used to improve the quality of plan offering in a managed care setting like the Medicare Advantage. In a managed market, private firms provide government sponsored services at a regulated price and compete for subsidies. Our paper analyzes how Medicare Advantage markets would evolve in terms of plan quality under a competitive quality bonus payment system where plans are rewarded for better quality performance as compared to their competitors in a local market. We model firm choice using a dynamic discrete game where forward looking firms strategically choose whether to invest in plan quality improvement as measured by the CMS star rating. The counterfactual market outcomes are calculated in terms of average plan quality by introducing a competitive bonus payment system and simulating the markets forward. Our results show that 65.25% of the counties improve under the new payment rule compared to their observed outcomes in data with 67.88% counties having an average rating of four or more stars.

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1 Introduction

Medicare is a national health insurance program in the United States that provides government sponsored health insurance coverage to eligible beneficiaries, mostly comprised of citizens above

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the age of 65. A potential drawback of such government operated healthcare services is the inefficiency that stems from the lack incentives to improve efficiency and quality due to the absence of any competition. Managed competition in healthcare aims to exploit strategic interactions among private firms to improve the cost efficiency of such programs by allowing private entities to deliver these public health insurance services. Competing agents with profit maximization motives are believed to have incentives to improve efficiency and this can be exploited in a properly designed market. Such private delivery of public health insurances has been a growing phenomenon in the United States in recent times (Gruber, 2017) and their introduction is primarily based on this rationale.

The US Medicare Advantage (MA) program allows private insurers to provide traditional Medicare services to eligible beneficiaries and subsidies are paid by the government to the insurers for every beneficiary who enrolls in their plans. Beneficiaries can choose from a set of available plans in a market and forgo traditional Medicare services. Private insurers compete with each other for beneficiary enrollment like in a normal insurance market but for earning government subsidies. However, designing such a managed healthcare market comes with a lot of unanswered issues which are currently being debated by economists and policymakers. One such pressing concern is monitoring the quality of service provided by the private insurers.

This paper explores how firms in a managed care setting like Medicare Advantage compete in terms of quality and how the quality of care can be improved by generating more competition at the local market level through redistributive quality bonus payments. We introduce a model of dynamic discrete game where firms choose the quality of their insurance plans in each period. Our model captures the strategic interaction among firms while choosing plan quality offering and also the intertemporal nature of the payoffs where investments in quality improvement initiatives affect the future values and outcomes. We estimate the cost of such quality improvement initiatives in the context of Medicare Advantage plans using our structural model.

Assessing quality of healthcare services itself is a difficult task and so is inducing private entities to improve the same. We use Centers for Medicare and Medicaid Services (CMS henceforth) assigned contract level star ratings as a measure of quality. We provide more details regarding their calculation in Section 2. While a growing part of the literature studies how competition relates to the financial efficiency of managed healthcare markets, not much work has been done from a supply side perspective regarding the plan quality choice of the firms. This is especially important in the context of public health insurance plans as any reduction in cost might come from compromises on the quality of care which is an undesirable outcome.

The aim of this paper is to predict if quality of Medicare Advantage plans can be improved by inducing quality competition among firms through changes in the reimbursement policy. We do this by introducing a quality bonus payment system where plans are paid based on their relative performance compared to their peers in a local market area. In particular, we study the effects of bonus payments through redistribution among plans in a market where these are paid as transfers from low-performing plans to high-performing plans. Such a payment policy change can generate a lot of competition among firms as each of them can earn rewards by being better than the others in a market in terms of quality.

Thus, it is important to understand the nature of competition and strategic interact among firms in terms of quality to assess the effect of this structural change. In our model, the payoff of each firm is dependent on its own quality and also the quality of its competitors and the firms take into account the strategies of its competitors when making a quality improvement investment. This is captured by our dynamic game of firms' choice and we use it to estimate the cost of such quality improvement initiatives using a parametric specification. In our counterfactual analysis, we simulate the Medicare Advantage markets forward by calculating the equilibrium policy function for the firms under the new bonus payment rule given the estimates of our structural parameters and assess how each market evolves in terms of offered plan quality.

Our counterfactual analysis has important policy implications. The new bonus payment mechanism takes into account the relative performance of a plan in a local market area. This is in contrast with the current bonus payment policy where they are paid based on their absolute quality measure and a national threshold. In other words, that quality bonuses are paid only when a plan's measured quality is above a threshold which is the same for all markets in the United States. As explained in Figure 2 (source: The Medicare Payment Advisory Commission or MedPAC) with the help of three example markets, Market 3 has all the plans operating above the threshold whereas Market 1 has none. There can be several market characteristics that result in under-performance of Market 1. These differences however are not taken into account by the national threshold based bonus payments. However, as illustrated in Figure 3 where bonus payments are based on relative performance in a market, some plans in every market get access to quality bonus payments.

Figure 5 illustrates the county level average star rating of available MA contracts in 2016. The regional differences in plan quality offering across counties can be observed here and this leads to a regional disparity in terms of subsidy spending as the government ends up paying more subsidy to certain regions and does not take into account the market or beneficiary characteristics. It also points to the fact that a regional difference exists in terms of access to plan quality for a federal healthcare program. We analyze if such differences in plan quality across counties can be reduced by a payment policy change.

MedPAC in its report to Congress in 2019 addresses this problem and proposes, among other changes, moving to a comparative bonus payment system. Our counterfactual analysis predicts the market outcome in terms of average plan quality for this policy change. We predict that under the new bonus payment policy 65.25% of the studied counties perform better when compared to observed data under the status quo payment policy. It is also predicted that more number of counties will have a star rating greater than 4 stars. We also observe less variation in average plan quality across counties with most markets having a value between 4 and 4.25 stars. Lastly, counties having low average plan quality shows the most improvement.

Related Literature. We contribute to the existing literature regarding Medicare Advantage. Gruber (2017) studies the changing nature of public health insurance in the United States and the extensive use of "managed competition" approach employed by the government to deliver health insurance. Our work is most related to Miller et al. (2019) and Curto et al. (2021). 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 finds 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 surplus generated by the competitive bidding process. Though the aforementioned papers relate to competition and designing subsidy schemes in Medicare Advantage, they do not take into consideration the effect of quality of service. Alternatively, we study the supply side of Medicare Advantage regarding how competition and subsidy affect quality of plan offerings in the market.

We are methodologically indebted to the extensive existing literature regarding estimation of dynamic games. Our model and solution procedure for the value function by linear parametric functional approximation closely follows Sweeting (2013), and Benitez-Silva et al. (2000). We implement a nested pseudo-likelihood approach for estimating the dynamic game is based on Aguirregabiria and Mira (2007, 2010) and Pakes, Ostrovsky, and Berry (2007). Our model of dynamic game also borrows from Aguirregabiria and Ho (2012), Aguirregabiria (2012), and Blevins (2014).

This paper is similar in essence to other works in the literature regarding market structure, competition, and quality. Though they study different markets, in essence, this paper is similar to them regarding the study of quality competition and how strategic interaction among agents affects quality. Hoxby (2000) 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.

Our paper contributes to the existing literature regarding quality rating in Medicare Advantage. Reid et al (2013) study how star ratings affect plan choice in Medicare Advantage. Fioretti and Wang (2021) show how the current quality bonus payment system can widen the inequality in accessing social services by private insurers selecting healthier enrollees. Adrion (2019) 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) explore in more detail how narrow network in Medicare Advantage translates into higher star ratings. Similar work regarding information and publicly available performance reports and their effect on choice in healthcare and insurance markets have been done by Farley et al (2002), Scanlon et al. (2002), Wedig et al. (2002), Dafny and Dranove (2008), Darden and McCarthy (2015), and Handel and Kolstad (2015),

We organize this paper in the following way. 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

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 and went through a series of changes and modernization that led to the formation of the Medicare Advantage program.

Enrollment in MA has increased more than double from 12 million or 26% of total Medicare eligible population in 2011 to 26 million or 42% of Medicare population in 2021 . During this period enrollment grew 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 health sector 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 their 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 FFS spending in that county. Plans bidding below the benchmark charges a 0 premium while plans which bid above the benchmark charge the difference between the bid and the benchmark as extra premium.

Medicare Advantage allows beneficiaries to choose from differentiated insurance plans which is not possible in 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 different target population, 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 indicator of plan quality is of utmost importance. To serve this purpose, the CMS uses a 5 star rating system in order to measure plan quality.

2.2 Star Rating

Since 2009, the CMS has provided comprehensive data regarding MA plan performance through its Star rating program with the goal to encourage consumers to choose high quality plans and also to incentivize 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 appointment quickly, etc.)
- Access (Timely decision about appeals)

The measures come from various sources and comprises of 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 and the ratings are assigned using a clustering algorithm where contracts having similar aggregate scores belong to 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 besides being a source of plan quality information for the consumers are also of interest to private insurers offering MA plans as they constitute a source of generating extra revenues. 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 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 was introduced following the Affordable Care Act of 2010 which mandates that plan payments should be dependent on the quality.

Plan quality have improved in MA over the years, especially after the introduction of QBP as shown in Figure 1. This pattern is indicative of the fact that private insurers respond to these bonuses by improving 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 denote 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} receives 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_{jt}^{B}.

2.4 Quality Bonus Payments

Star rating of a plan 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 star 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 star and 70% for 4.5 star and above.

Thus keeping everything else equal, the current payment system rewards plans with higher star ratings favorably. However, these bonuses are paid based on absolute measure and not relative measure. 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 based to a relative measure based.

2.5 Quality Improvement Initiatives

In an effort to evaluate if the quality bonus payments in practice translated to 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 [1].

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

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 Ratings 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 avenue 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 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 5 stars.

ii) Provider Network formation and provider incentives are an important 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 MA plan's star ratings are based on physicians delivering appropriate services including providing screening tests, vaccines and managing chronic conditions. Such clinical measures cannot easily be improved by plans without a significant cooperation from primary care physicians and other clinicians. 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 choice represents 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 earns bonus payments in the future period. We use a dynamic model to capture this intertemporal nature of choice and payoff. Specifically, we use dynamic game to capture the strategic interaction between firms as discussed in Section 3.

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 and 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.

Table 1 shows the summary statistics of MA markets from 2013 to 2016 that we use in our analysis. We select these years as most of the quality improvement activities are observed to occur during this period after the introduction of the quality bonus payments. The average rating of available plans are observed to increase from 2013 to 2016. Among these years, 2013 to 2014 saw both maximum increase in the average rating and also the number of contracts improving. Average MA enrollment went up every year during this period and each contract enrolls on an average 4500 beneficiaries in every market. Average contract revenue in each market which is the sum of the total premium earnings and government subsidies shows an upward trend during these years. This increase is driven by both increased enrollment and quality bonus payments through improved quality rating.

3 Model

We introduce a stylized model of Medicare Advantage markets where firms offering differentiated plans in each market choose the premium and quality investment choice in each period. Quality improvement choice of the firms determines the quality ratings of the plans offered by them and their payoffs for the next period. The firms are forward looking, and take into consideration the effect of their quality investment choice on future profits and strategic reaction of their competitors. Our model of dynamic game closely follows Aguirregabiria and Ho (2012) and Sweeting (2013).

Our model captures the competition among firms in a market while deciding its plan quality offering. We let the payoff for the firms to depend on not only its own rating but the rating of its competitors and the firms strategically decide whether to invest in quality improvement initiatives taking into consideration the strategies of other firms in the market. We let the firms choose the plan premium in each market whether or not to improve service quality. Any initiative to improve quality is reflected as improved star rating in the next period.

3.1 Framework

Medicare Advantage contracts $f = 1, 2, ..., \mathcal{F}_m$ in a particular market m plays a discrete time infinite horizon game with periods $t = 1, ..., \infty$. Markets are assumed to be independent of each other. In each period, a firm observes its payoff relevant state variables denoted by S_{fmt} which includes 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}, total number of MA eligible population M_{mt}, FFS spending quartile, etc. County benchmarks are translated into plan specific subsidy amounts using the reported 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 price of each plan it offers and makes a quality investment choice. Premiums affect the profit of current period whereas investment in quality improvement affects their ratings and consequently payoffs for the next period. We drop the market index m for simplicity.

In each market period, a firm f owns a set of plans $\mathcal{J}_f$ and generate revenue by selling their plans to eligible beneficiaries. For each individual beneficiary who enrolls in one of their plans, a firm receives the premium and the per member subsidy assigned by the 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.

In every period, the firms choose an action $a \in A(S_{ft})$ from a discrete set of possible actions regarding 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 distributed Type 1 extreme value.

The sequence of the firm's decision is as follows

1. Each firm observes payoff relevant state variable S_{ft}
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 $a \in A_{S_{ft}}$
4. Each firm earns variable profit $R_{ft}(S_{ft}; \beta^{dd}, \gamma^{mc})$ from beneficiary enrollment and price competition where β^{dd} and γ^{mc} are the demand and marginal cost parameters respectively.
5. Each firm incurs an investment cost for quality improvement $I(a, S_{ft}; \theta)$ and receives a payoff shock ν_{aft}
6. The state variables evolve to the next period according to firms' choices and transition rule

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

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

I describe later in details each component of the profit function and the state transition rules.

In each period t a 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 the individual utility depend on observed plan characteristics, plan type, and observed and unobserved quality. Dropping the market subscript m, the utility individual i receives from a plan j in a given period t is given by the following utility function

$$U_{ijt} = \beta^p p_{jt} + \beta^\mu \mu_{jt} + X_{jt}\beta^x + \xi_{jt} + \epsilon_{ijt}, \tag{3}$$

where p_{jt} is the annual plan premium, 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, vision, etc. are covered by the plan. ξ_{jt} is the plan level characteristic that are observed by the consumers and the firms but are unobservable in our model.This captures the plan-market level heterogeneity and also plan qualities that are not captured by the star ratings. 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 possibly correlated with ξ_{jt} and are thus endogenous.

The coefficients β^p, β^μ, and β^x are the demand parameters. The market share for each plan is derived from the individual choice probabilities using a standard procedure. A consumer chooses a particular plan if the utility from 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

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

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 and not plan level. This means that plans under the same MA contract use the star rating of the contract they are under. Let $\mathcal{J}_f$ be the set of plans offered by the firm-contract 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:

$$\xi_{jt+1} = \rho^{\xi}\xi_{jt} + \zeta_{jt}, \tag{4}$$

where $\zeta_{jt} \sim \mathcal{N}(0, \sigma_{\zeta})$

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

$$R_{ft} = \sum_{j \in \mathcal{J}_f} \{(p_{jt} + Reb_{jt} - mc_{jt}) \times s_{jt} \times M\}, \tag{5}$$

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

$$ln(mc_{jt}) = x_{jt}\gamma^{x} + \mu_{jt}\gamma^{\mu} + \omega^{mc}_{jt}, \tag{6}$$

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

The amount of subsidy each plan receives per beneficiary is given by the payment equation and depends on the market benchmark, the star rating, and the reported costs[2]. 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

[2]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).

of investment cost:

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

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

$$\mu_{ft+1} = \begin{cases} \mu_{ft} + \epsilon^{a_0}, & \text{if } a_{ft} = 0 \\ \mu_{ft} + 0.5, & \text{if } a_{ft} = 1 \\ \mu_{ft} + 1.0, & \text{if } a_{ft} = 2, \end{cases} \tag{7}$$

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

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

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[3].

[3]The star rating for a contract are 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.

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 a_{ft}. A firm's value function given strategies of all firms Γ is given by the following Bellman equation:

$$\begin{aligned} V^{\Gamma}(S_{ft}, \nu_{ft}) = max_{a\in A(S_{ft})}[R_{ft}(S_{ft}; \beta^{dd}, \gamma^{mc}) - I(a, S_{ft}, \theta) + \nu_{aft} \\ + \beta E\{V^{\Gamma}(S_{ft+1})|a, \Gamma_{-f}, S_{ft})\}], \end{aligned} \tag{8}$$

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

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

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

$$P_f(a|S_{ft}, \Gamma) = \frac{exp(\upsilon_f^{\Gamma}(a, S_{ft}, \Gamma_{-f}))}{\sum_{a'\in A(S_{ft})} exp(\upsilon_f^{\Gamma}(a', S_{ft}, \Gamma_{-f}))}. \tag{9}$$

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 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), Aguirregabiria (2012) and Sweeting (2013) 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:

$$V(S) = \sum_{k=1}^{K} \lambda_k \phi_k(S) \tag{10}$$

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

I proceed by first estimating the demand parameters and the plan level unobservables ξ_{jt}. We then back out the marginal costs form 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:

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

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) the Bellman equation can also be written as:

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

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 probabilities P^0 by using a reduced form multinomial logit model of observed actions on 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 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}

In our demand estimation, apart from the usual price endogeneity of 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 previous period, these two variables might be correlated.

Some prior literature regarding 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} is uncorrelated with μ_{jt} as it depends on the action of previous year before the realization of ζ_{jt}. Let Z be the instruments including X and μ. Under this assumption the moment condition $E(Z'\zeta) = 0$ holds true.

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}. Following Sweeting (2013), 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 2 reports the estimated parameters of our demand model. These estimates in general correspond to sensible priors. For plans with a positive premium the semi elasticity of increasing premium by $1 is around percent. An increase in star rating by one star leads to a 16 percent increase in market share. This indicates that though consumers prefer higher rated plans, star ratings effect on market shares is not very high and firms might not have enough incentives to improve ratings to attract more beneficiary enrollment. This is also indicative of the fact that firms care about improving ratings mostly for the bonus payments. We also find that beneficiaries prefer plans that offer dental and hearing coverage but not vision coverage. We also find that beneficiaries prefer PPOs compared to HMOs.

Table 3 reports the marginal cost parameters. We observe that star ratings increase the cost of providing service to each extra beneficiary. Subsidiary coverage like vision, dental, and hearing increase the marginal cost. The coefficient on demand unobservable ξ_{jt} is positive and significant. In addition, cost of providing service is higher for PPO plans compared to HMO plans.

Table 4 we reports the parameters of our dynamic model which are the estimates of improving quality rating of a firm in a market. These estimates report the cost of improving a firm's star rating by half star and are reported in million dollars.

We estimate that the firms undergo a fixed investment cost of $0.54 million every time they improve their rating. This cost increases by 1.21 million per current star rating. For example, a three star rated contract will face an additional $3.63 million above the fixed cost. This states that improving rating becomes costlier with increase in current rating of the star. Also the cost of improving star rating in a period goes up by $1.4 million if the contract improve its rating in the previous period.

Intuitively this makes sense as the avenues to improve quality declines as current quality of the firms improve. 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 $4.2 million in each market. On the other hand a 2.5 star rated contract moving to 4 star over the course of two years incur a cost of around $ 10 million. Thus the cost of moving to bonus status for low rated contract is much higher than the marginal contracts

We observe that markets which initially started with better quality plan evolved over the years to have high average plan quality whereas markets which 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. As proposed by CMS, we follow a budget balanced redistribution procedure, where plans having 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 as increased benchmark. 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 than the others' in a market fetches more subsidy.

Due to change in quality bonus payment structure, we begin our counterfactual by adjusting the per member subsidy of each plan in a market as stated. With all other plan characteristics in hand, we calculate the new equilibrium prices by iterating over $\frac{\partial s_j}{\partial p_j}$ matrix starting from observed prices with a non-negativity restriction. We match the data precisely when implementing this procedure 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 observed state, calculate the expected profit before realization of payoff shocks, estimate λ^{count,P_0^c} and update the conditional choice probabilities using the logit form of the choice specific value functions for the new λ^{count,P_0^c} and estimated $\hat{\theta}$ and continue this iteration until convergence is reached.

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 are used to move the model forward one period. As this process takes the market to a state not observed in the data, from here we move forward by solving for equilibrium choice probabilities for every period we simulate the model forward. [4].

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 4 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 was introduced. As we can see that most regions in the United States perform poorly in terms of offered plan quality except regions in the west coast, mid-west and northeast which perform better than other counties. Figure 5 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 Texas.

It is important to note that the counties with higher average rating in 2016 are mostly the ones which started with better initial condition in 2013. These regional patterns are captured by our model if we simulate it without implementing the new payment policy as shown in Figure 6. Our model does a descent job of predicting the regions that evolved to have a higher average quality. These results are driven by the initial market conditions, our estimates of value function, structural parameters and the national threshold based quality bonus payment system.

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 rating to move to a bonus status. For example, a plan with a 3.5 rating can move to bonus status by increasing its rating by half star only. So a half star

[4] We solve for the equilibrium choice probabilities in each market by iterating over the best response function. 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 recomputing the covariates.

increase is associated with an increase in government subsidies. The cost of moving to four star rating is much higher for plans with poorer initial rating. This coupled with the strategic interaction among firms drive the results for our model simulation.

We then introduce the competitive bonus payment system, simulate our model forward, and compare it with observed data. Figure 7 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 1,853 (65.25%) counties perform better than their observed average rating in 2016. Figure 8 shows the regions that would performed better under the competitive payment system. Low performing regions like west Texas, New Mexico, Florida etc. are predicted to improve under the new payment system.

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 67.88% counties are predicted to have an average rating greater than or equal to four star as compared to 48.09% in the data. This is a desirable outcome as the existing payment rule rewards plans having a rating four or higher. The competitive payment rule is predicted to better achieve this goal in the counterfactual. The other key feature of this distribution is that around 40% of counties have an average rating between 4 and 4.25 stars. Our model predicts that under the new payment rules most markets evolve and cluster around this region.

We then analyze which counties perform better under the new payment rule. We calculate for each county the difference between the counterfactual county average rating and the observed mean of 2016. 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 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 relative performance of the contract in a market where the contract just have 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 affect of the competitive bonus payment rule as illustrated.

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 are paid as transfers across plans. It is necessary to see how the firms might react in terms of premium 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 couterfactual still charges a 0 premium. However, the maximum annual premium charged in Medicare Advantage increases but only for a few offered plans. In Table 5, we show that for 24.83% of plans we study, the premium remains the same under counterfactual. Most of these plans are the ones charging a 0 annual premium. Though around 39.5% of the plans increase their premium, the mean increase in premium is $ 149.19 which is not an exorbitant increase. We also observe that 35.6% of the plans reduce their premium. These are mostly the plans which move into bonus status under the new payment system. The mean reduction is $ 346.92 for these plans. 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.

6 Conclusion

We study how competition among firms can be exploited in a managed care setting like the Medicare Advantage. While most studies regarding managed competition revolves around 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. 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 may 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 competitors behavior as the payoffs for improving quality measure under the new proposed rule depend on their relative performance. We use estimated model parameters to calculate 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 offering improves under this new payment rule. By comparing our simulated market outcomes with the observedn 2016 data, we see that 1,853 (65.25%) counties improve their rating with the redistribution bonus payment system. In 2016, we observe 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 to 67.88% 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 firm's decision to invest and do not consider entry and exit decision. In reality however, low performing firms may choose to leave the market or merge with better performing firms. Introducing entry and exit decision is a possible improvement 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. In future it will be interesting to see how provider network can improve plan quality and how it is affected by market competition.

Though our paper predicts improved quality outcomes in this particular empirical setting, it is not clear that these results will always hold. In other words, our results do not imply that such a competitive bonus payment system will always work better than an absolute measure based system like a national threshold. It is also important to derive some generalized results to find out if it is possible for the absolute measure based bonus payment system to work better than the competitive payment system under certain market conditions. In case this is possible, we can derive these conditions to have a more generalized theoretical result.

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8 Appendix: Tables and Figures

Variable	2013	2014	2015	2016
Average Star Rating	3.57	3.74	3.85	3.94
Number of Contracts Improving Next Year	146 (36.2%)	68 (17.3%)	94 (25.8%)	
Contract Average Enrollment per County (rounded)	4,205	4,786	5,109	5,415
Contract Average Revenue per County	6,105,121	6,610,965	6,780,367	7,455,344
Number of contract-market observations	19,426	20,616	20,162	20,060

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

Variable	Coefficient	S.E.
Annual Premium (per $1000)	-1.02	0.17
Star	0.16	0.08
Vision	2.79	0.13
Hearing	-0.23	0.12
Dental	-0.05	0.013
HMO	-6.76	0.5
PPO	-5.95	0.46

Table 2: **Estimates for Demand Parameter**

Variable	$ln(mc_j)$
Star	2.13
	(0.002)
Vision	0.66
	(0.01)
Dental	0.11
	(0.017)
Hearing	0.34
	(0.019)
Unobservable ξ_{jt}	0.06
	(0.005)
HMO	0.2
	(0.02)
PPO	1.15
	(0.015)

Table 3: **Estimates of marginal cost function**

Dynamic Investment Cost Parameters	$ million
Fixed Cost of quality improvement by 0.5 star	0.054 (0.02)
* Current Star Rating	1.21 (0.09)
* Rating Change in previous period	1.41 (0.03)

Table 4: **Dynamic Parameters for Quality Improvement Investment Cost**

Variable	Number of Plans (% of total observations)	Mean Difference in $ (S.D)
Observed Price= Counterfactual Price	8,997 (24.83 %)	0
Observed Price>Counterfactual Price	14,325 (39.53 %)	149.19 (122.63)
Observed Price<Counterfactual Price	12,913 (35.64 %)	-346.921 (192.5)

Table 5: **Difference between Observed and Counterfactual Annual Premium**

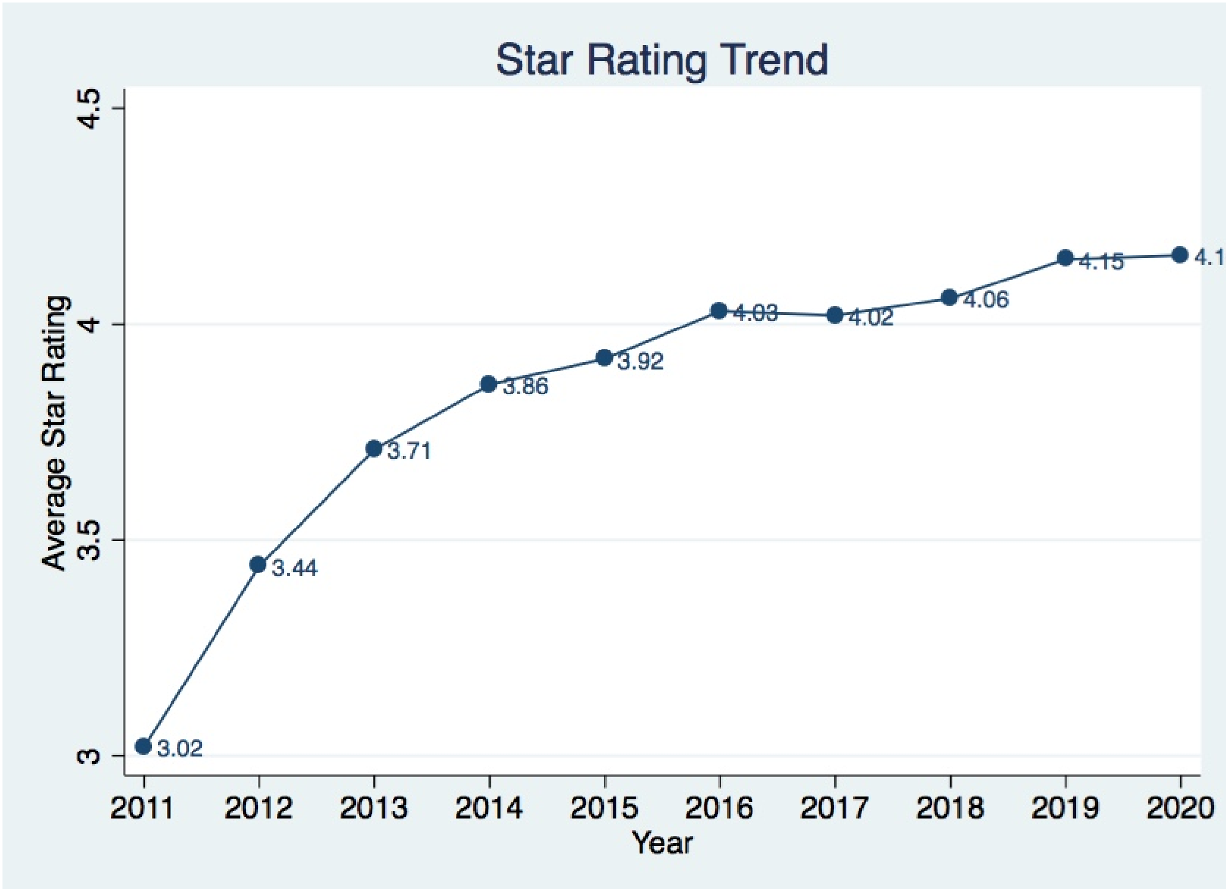

Figure 1: Enrollment weighted average star rating over the years

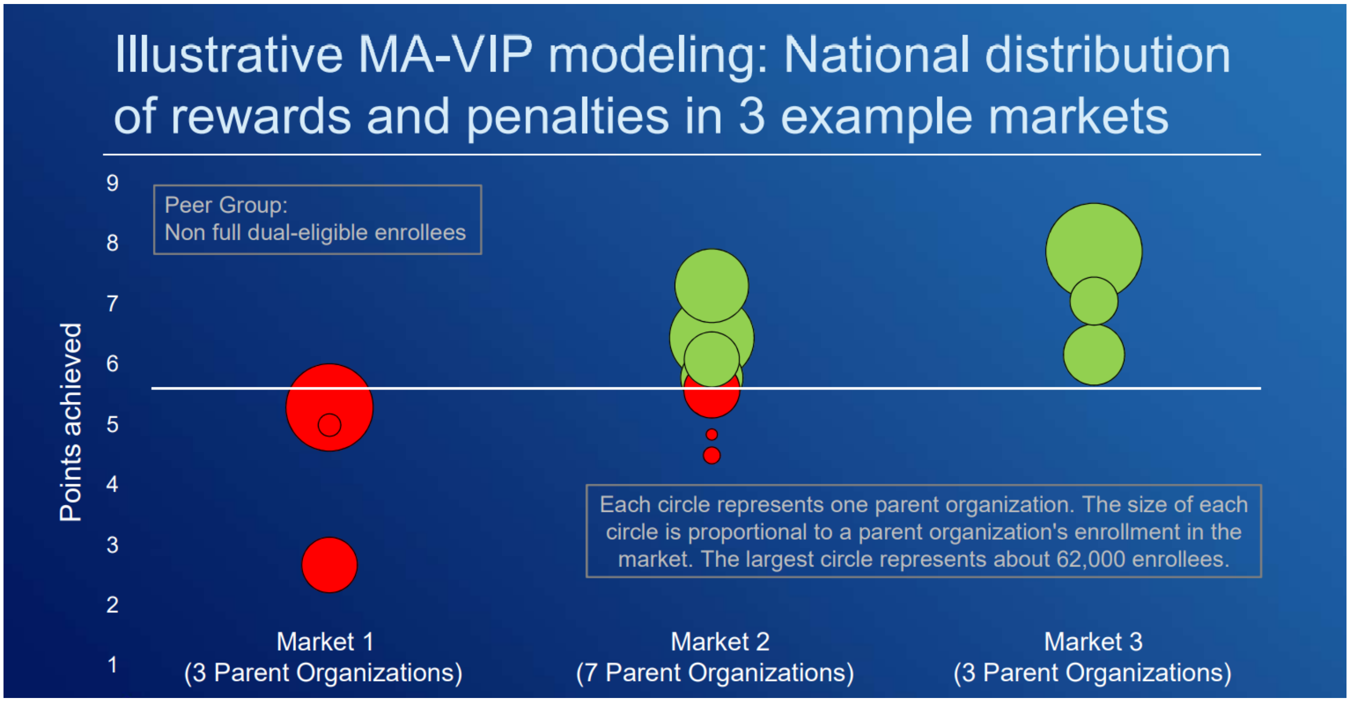

Figure 2: Source:MedPAC

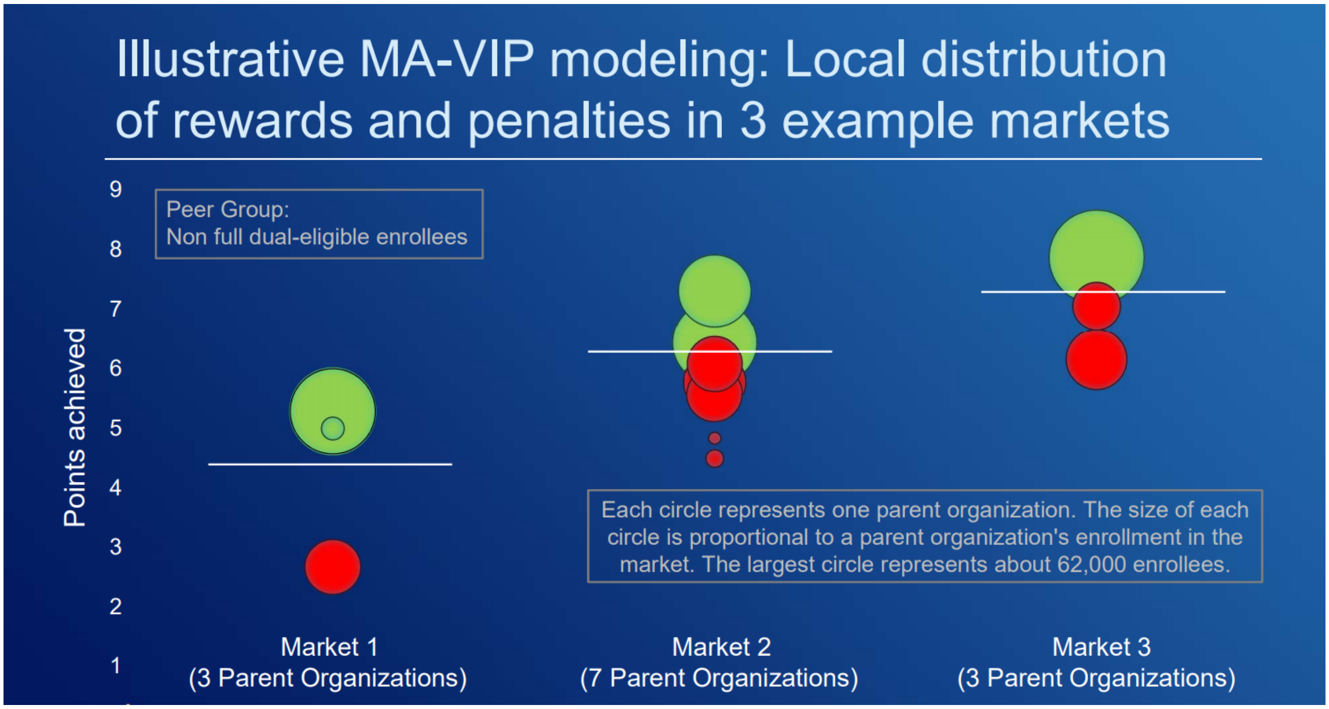

Figure 3: Source:MedPAC

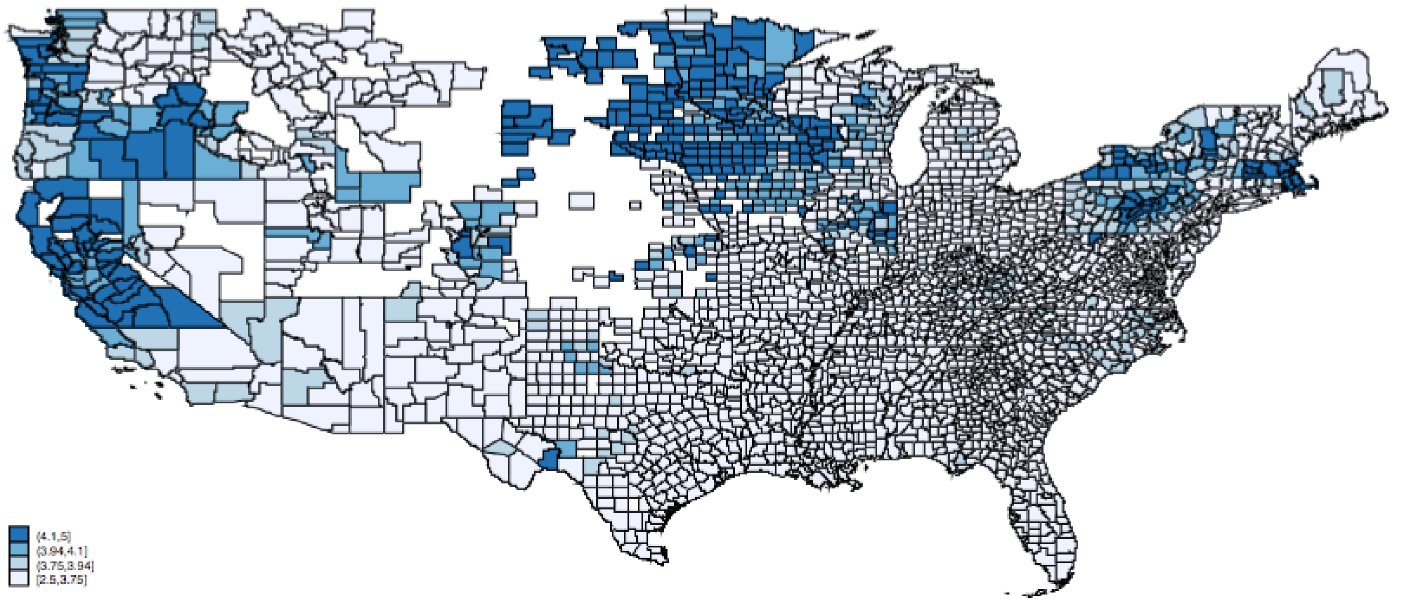

Figure 4: Average MA plan rating of county in 2013

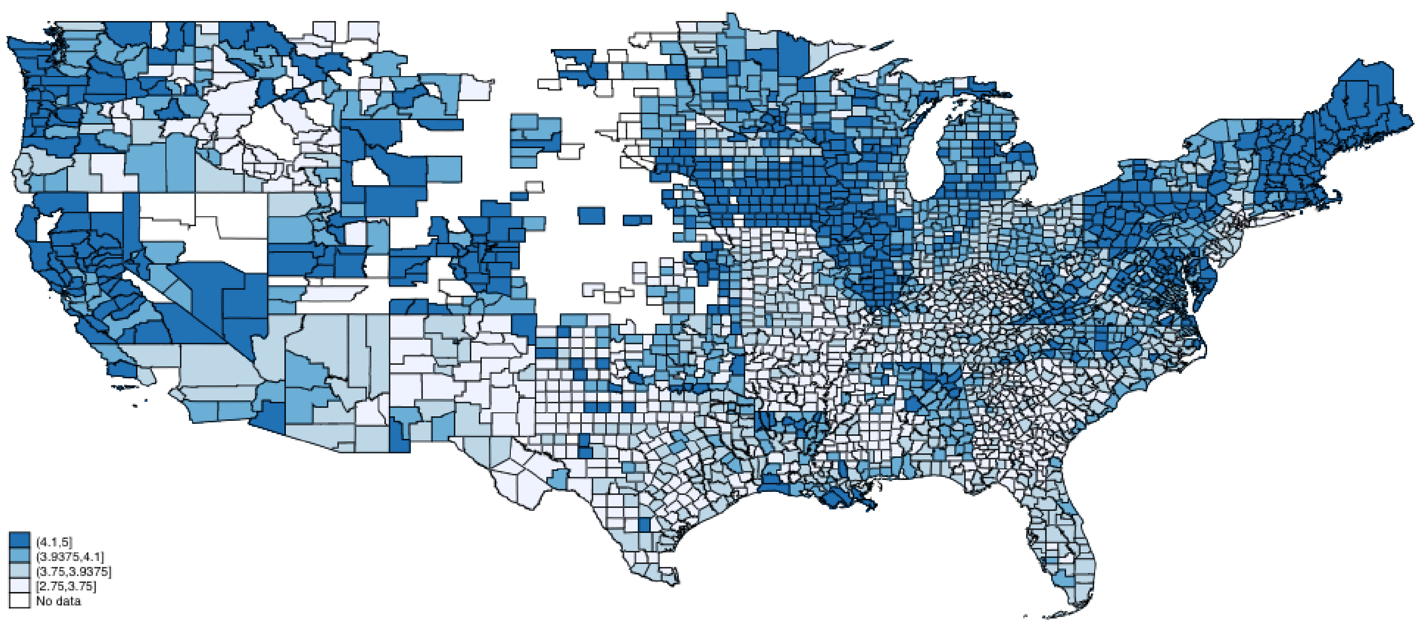

Figure 5: Average MA plan rating of county in 2016

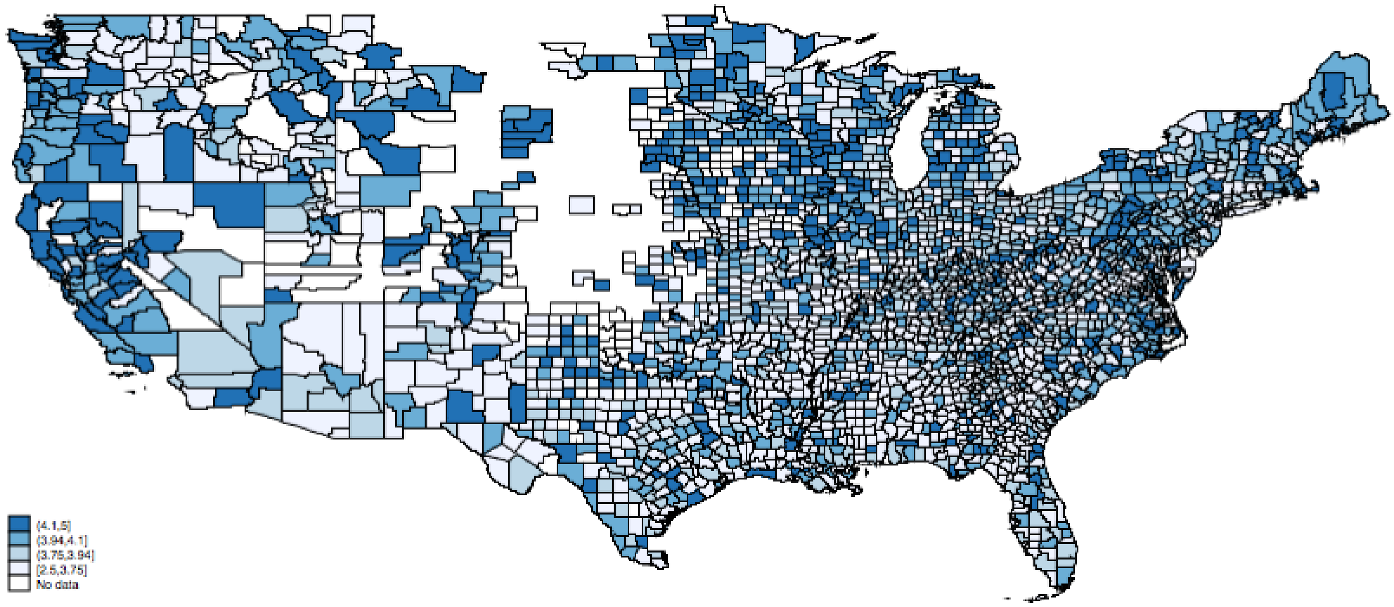

Figure 6: Model Simulated average MA plan rating of county in 2016

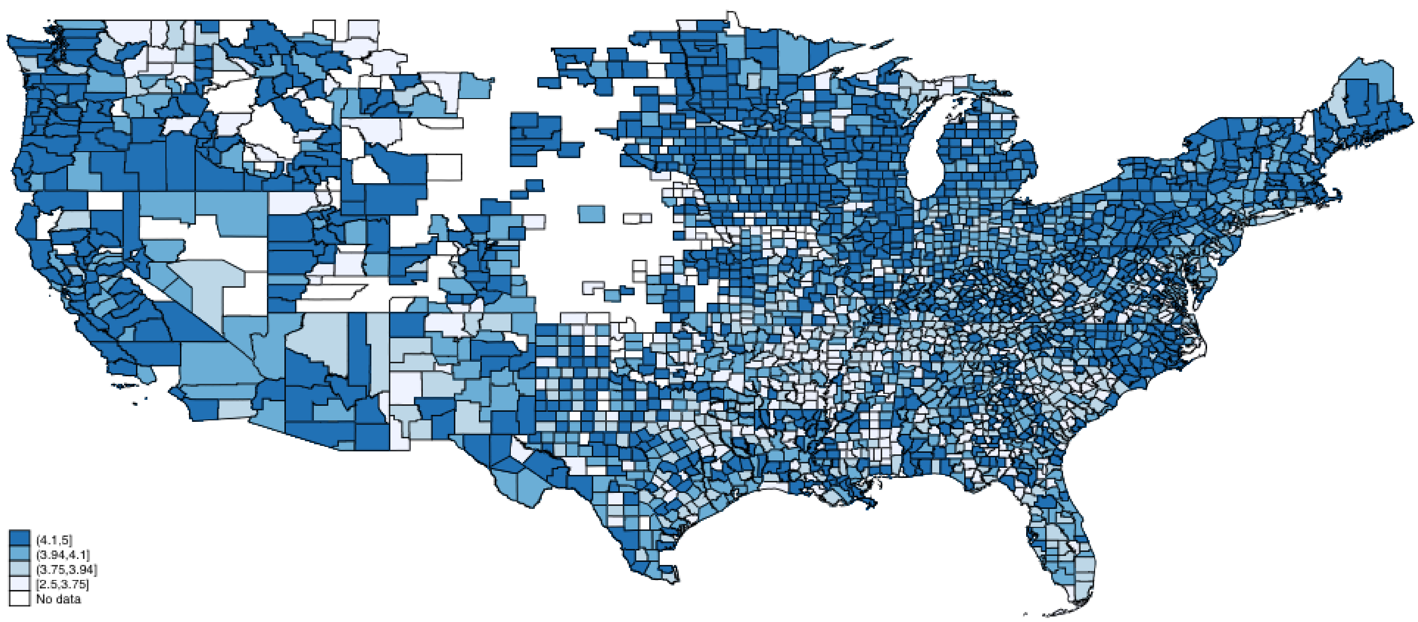

Figure 7: Counterfactual average MA plan rating of county in 2016

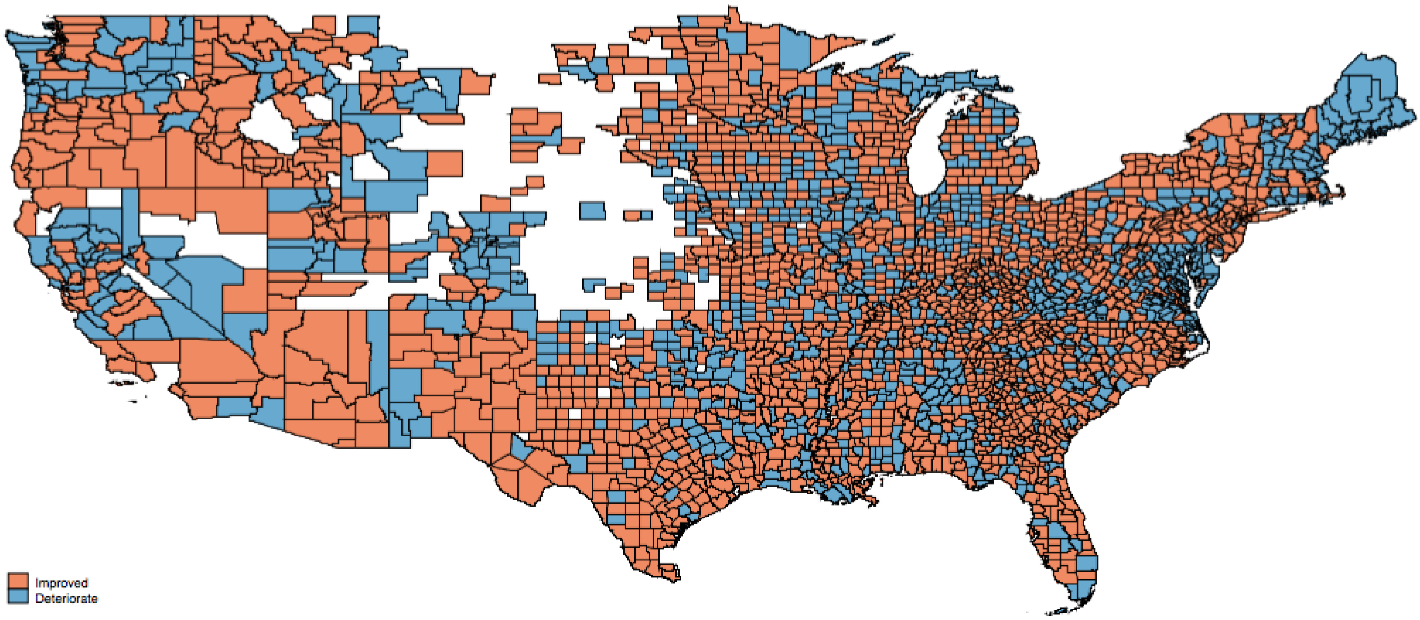

Figure 8: Counties improving mean rating in counterfactual payment rule

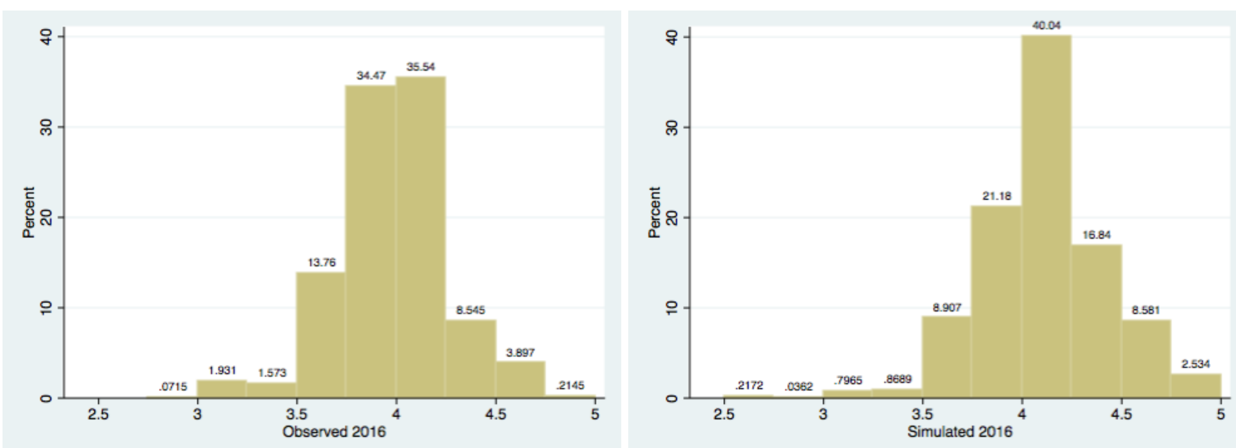

Figure 9: Distribution of mean county rating in observed data and counterfactual

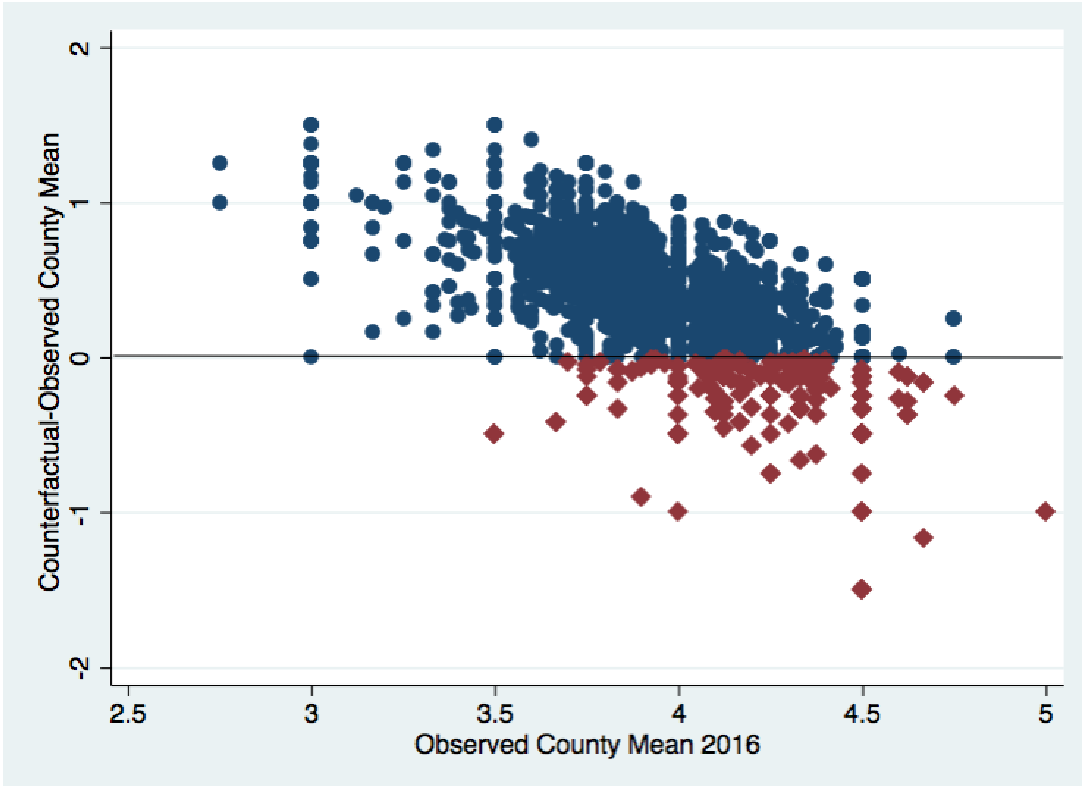

Figure 10: Scatter plot of observed average rating of a county and its difference from the counterfactual prediction

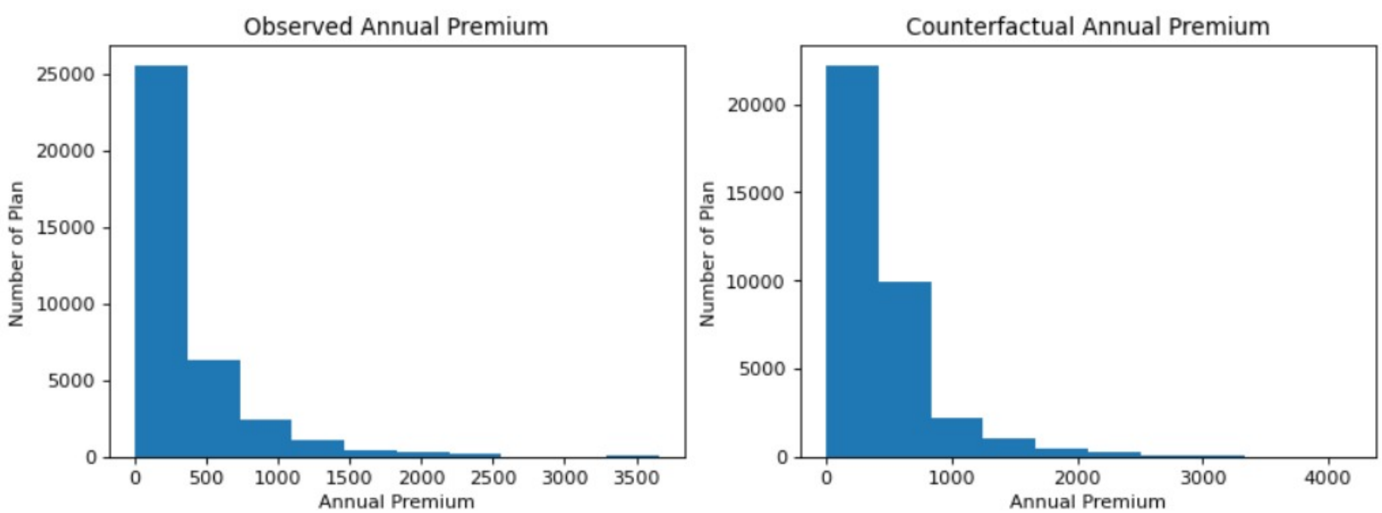

Figure 11: Distribution of Annual Premium in Observed Data and Counterfactual