What Does a Public Option Do? Evidence from California

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Abstract

An increasingly debated government intervention in markets with substantial market power is the creation of a public option that competes with private firms. I study the impact of a public option in the California ACA health insurance exchange, a novel setting where one-third of consumers have access to a public option sold by their county governments. I develop a framework for estimating a mixed oligopoly model with alternative public option objectives. In the best-fitting model of the data, the public option places more weight on consumer surplus than producer surplus. Adding a public option decreases premiums by up to 21.2%, improves social welfare in rural markets with limited competition, and provides the largest consumer surplus gains to disadvantaged subpopulations. By comparison, enhancing subsidies for purchasing plans from private firms, a leading alternative intervention that was adopted in the American Rescue Plan (ARP), increases premiums and reduces social welfare.

Keywords: Mixed oligopoly, health insurance, adverse selection.
JEL Codes: I11, I13, L51, L88, H51

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Governments often intervene in sectors such as agriculture, education, energy, and health care that are perceived to be socially consequential, but suffer from high prices and an underprovision of goods and services. Government interventions can take many forms. Nationalization of entire industries, such as the National Health Service in the U.K. or the proposed "Medicare-for-all" in the U.S., is the most extreme form of intervention. A less intrusive intervention is the provision of subsidies for purchasing goods and services from private firms, such as tax credits for electric vehicles, child care, and health insurance in the U.S. A third approach is the introduction of a public firm or "public option" that competes directly with private firms.

The market impact of introducing a public option depends on several factors, including the public option's objective function and product design. A market where at least one firm has an objective function that diverges from the objectives of the other firms is termed a mixed oligopoly (De Fraja and Delbono, 1990; Matsumura, 1998; Casadesus-Masanell and Ghemawat, 2006). De Fraja and Delbono (1990) review the theoretical literature where profit-maximizing firms compete with a public firm that maximizes some other objective, usually a weighted combination of consumer and producer surplus. Competition between public and private firms occurs in numerous U.S. industries, including delivery services, hospitals, and schools. The United Parcel Service (UPS) and FedEx Corporation (FedEx) coexist with the U.S. Postal Service (USPS) by offering faster and often more reliable shipping at a higher price point. Private teaching hospitals can compete with public hospitals by providing higher quality of care and offering more advanced treatments. Private schools coexist with public schools by promising more individual attention and a tailored education; the impact of voucher programs for private schools has been the subject of a well-developed literature (Abdulkadiroğlu et al., 2011; Chetty et al., 2014; Epple et al., 2017). A common market feature sustaining these mixed oligopolies is substantial product differentiation.

In this paper, I study the equilibrium and social welfare implications of introducing a public option that competes with private firms. I focus on the proposed addition of a public option in U.S. health insurance markets, which often suffer from limited competition and high premiums that limit access to health insurance for millions of Americans. Discussion of adding a public option in health insurance featured prominently in the original debate over the Affordable Care Act (ACA) and was resurrected during the 2020 presidential campaign. Washington state started a public option in its ACA exchange in 2021 and Colorado and Nevada plan to adopt a public option in the next several years. Supporters of the public option, including President Biden, believe adding a public option will reduce premiums, particularly in markets with limited competition between private firms. However, private firms may become insolvent, deciding to exit the market.

To study the public option in health insurance, I exploit consumer-level enrollment data from the ACA exchange in California, a novel setting where approximately one-third of consumers have access to a public option sold by their county governments. Consumers residing in three different counties – Los Angeles, Santa Clara, and Contra Costa – had access to a public option, whereas consumers living in the other California counties could only choose plans from private firms. Heterogeneity in exposure to the public option across county markets and across time provides identifying variation for consumer preferences for the public option. It also allows me to cleanly compare standard oligopoly markets with mixed oligopoly markets where the participating private firms are the same and government regulations are consistent across markets.

I develop a novel modeling framework for estimating a mixed oligopoly model of demand and supply that accommodates a wide range of public option objectives and design features. The model explicitly accounts for adverse selection and moral hazard and endogenizes key ACA policies such as the individual mandate for purchasing insurance, premium-linked subsidies, regulation on price discrimination (known as community rating), and risk adjustment. I use my consumer-level enrollment data along with data on plan costs from insurer rate filings to assess the fit of mixed oligopoly models with alternative specifications of the public firm's objective. In the best-fitting mixed oligopoly model, the public firm places 63% weight on consumer surplus and 37% weight on producer surplus. The best-fitting mixed oligopoly model yields a statistically significant improvement in fit relative to the fit of the standard oligopoly model where the public firm is assumed to maximize profit. My best-fitting model also indicates that consumers are willing to pay an average of $39 or 8.9% more in premiums for a private plan relative to a public option plan, controlling for observables such as premiums, plan generosity, and the provider network. Older, higher-income, and non-Hispanic White consumers have a much higher willingness-to-pay for a private plan. Conversely, Hispanic and African American consumers have a negative willingness-to-pay for a private plan and therefore prefer public plans, all else equal. This finding suggests the public firm plays a key role in expanding health insurance to disadvantaged subpopulations.

I next use the best-fitting mixed oligopoly model to simulate the impact of adding a public option (with the same design as it exists in LA, Santa Clara, and Contra Costa Counties) to five different local markets in California. Two main results emerge from my simulations: (1) adding a public option improves social welfare most in more rural markets with limited competition, but reduces social welfare in more urban markets with robust competition and (2) disadvantaged subpopulations benefit most from the addition of a public option. The introduction of a public option leads to a reduction of 21.2% in average premiums and an increase of $462 in annual per-capita social welfare in a more rural market comprised of Monterey, Santa Cruz, and San Benito Counties. Conversely, average premiums decrease by only 2.7% and annual per-capita social welfare decreases by $261 when a public option is added in San Diego County, an urban market with robust competition. Profit decreases by less than 20% in four of the five simulated markets, making it unlikely that adding a public option would lead to a mass private firm exodus. Adding a public option increases African American enrollment by 10.5% and Hispanic enrollment by 10.6%. Annual per-capita consumer surplus increases $250 for African American consumers and $236 for Hispanic consumers.

An alternative intervention to the public option is to provide enhanced subsidies for purchasing plans from private firms. The American Rescue Plan Act of 2021 (ARP) provides a substantial, but temporary enhancement to premium subsidies available to ACA exchange consumers.[1] I use the estimated model to simulate the impact of ARP subsidies and find (1) ARP subsidies increase (unsubsidized) premiums between 0.5% to 3.2% across the five simulated markets and (2) ARP subsidies decrease annual per-capita social welfare between $198 and $561 across the five simulated markets. By comparison, adding a public option in these five markets unambiguously decreases (unsubsidized) premiums and improves social welfare in more rural markets with limited competition. Enhancing premium subsidies increases premiums because it shifts the demand curve "to the right." I find the resulting premium increases lead to government spending growth that more than offsets the gains in consumer and producer surplus. My simulations do not account for one-time entry costs for the public option or the cost of administering an income verification system for determining premium subsidy eligibility.

The final section of the paper considers alternative designs to the public option. As it currently exists in California, the public option has little apparent advantage over private to negotiate lower provider reimbursement rates. Using the best-fitting oligopoly model, I simulate the impact of the public option negotiating lower, "Medicare-like" reimbursement rates. Lowering reimbursement rate to 50% of that of private payers results in premiums falling by 10.1%. The premium reduction is significantly lower than the reimbursement rate reduction, indicating that the public option has limited ability to exert pressure on the private firms. Although lower premiums from the 50% reimbursement rate benefit consumers, unreimbursed medical claims impose a social cost that results in annual per-capita social welfare declining $788. I also consider the sensitivity of the public option's impact to its objective function by varying the weight on consumer surplus. Decreasing the weight on consumer surplus to 0% (i.e., profit maximization) increases premiums by 2.1% and hence increases the government's spending on premium-linked subsidies, reducing annual per-capita social welfare by $45. Increasing the weight on consumer surplus to 75% decreases premiums by 4.5%, but decreases annual per-capita social welfare by $281 because of substantial losses incurred by the public firm. Hence, the impact of the public option is quite sensitive to its design.

[1] The ARP enhances subsidies for two years. The Inflation Reduction Act extends ARP subsidies through 2025.

My work makes several methodological and empirical contributions to the literature. I develop a framework for estimating a mixed oligopoly model with alternative public firm objectives. The evaluation of alternative objectives contributes to the literature that studies nonprofit firms' objectives (Newhouse, 1970; Pauly and Redisch, 1973; Steinberg, 1986; Malani et al., 2003; Lakdawalla and Philipson, 2006; Gaynor et al., 2015; Philipson and Posner, 2009; Horwitz and Nichols, 2009; Dranove et al., 2017; Chang and Jacobson, 2017; Capps et al., 2020). In addition, my approach for counterfactual simulations overcomes a significant computational challenge in correctly endogenizing risk adjustment, improving upon the approaches in Saltzman (2021) and Tebaldi (2022). I provide new evidence of how adding a public option affects the market equilibrium using data from a novel setting with geographic and temporal variation in public option exposure. I find adding a public option improves social welfare in rural markets with limited competition and provides the largest gains in consumer surplus to disadvantaged subpopulations. This work augments previous work assessing the potential impacts of a public option in health insurance (Blumberg et al., 2019; Shepard et al., 2020; Liu et al., 2020; Fiedler, 2020; Craig, 2022). I compare adding a public option to enhancing premium subsidies for purchasing plans from private firms. I find enhancing premium subsidies increases premiums and reduces social welfare, creating inefficiencies identified in the previous literature (Decarolis, 2015; Decarolis et al., 2020; Jaffe and Shepard, 2020; Polyakova and Ryan, 2021). Finally, I contribute to the literature studying the early performance of the ACA exchanges (Sen and DeLeire, 2018; Domurat, 2018; Diamond et al., 2021; Drake, 2019; Panhans, 2019; Einav et al., 2019; Polyakova and Ryan, 2021; Tebaldi, 2022).

This paper is organized as follows. Section 1 describes the data and empirical setting. Section 2 estimates consumer preferences for the public option. Section 3 evaluates alternative public firm objectives. Section 4 simulates the impact of the public option. Section 5 analyzes alternative designs of the public option. Section 6 concludes.

1 Data and Institutional Background

1.1 What is the Public Option in Health Insurance?

The term "public option" most commonly refers to a publicly insured plan that competes directly with private health insurance plans in a managed competition market (Halpin and Harbage, 2010). The idea represents a compromise between a "Medicare-for-All" or single payer system where the government serves as the sole health insurer and the ACA exchange model of managed competition between private health insurance plans. Advocates of the public option point to its potential to reduce administrative costs, stimulate competition between insurers, and leverage the bargaining power of a large government payer to negotiate lower provider reimbursement rates. Opposition to the public option is strong among private insurers, who fear they will be unable to compete with the public option, and providers, who fear losing revenue due to lower reimbursement rates.

The most significant policy design issues for implementation of the public option are (1) determining the target population and identifying consumers likely to enroll; (2) establishing the public option's objective and how it should price its plans to achieve that objective; (3) determining the public option's scale and setting provider reimbursement rates (Halpin and Harbage, 2010). I focus on the first two design issues in Sections 2 and Section 3, respectively. Section 5 address the third issue through policy simulation.

1.2 The Public Option in Practice

The idea of a public option that competes in a market with private health insurance plans first surfaced in California in 2001, but failed to gain traction at the state or federal level (Halpin and Harbage, 2010). The public option featured prominently in the original debate on the ACA, but was omitted from the final legislation due to lack of political support in Congress. Adding a public option to the ACA exchanges continues to be a top political issue. Most recently, President Biden proposed including a public option in the exchanges during the 2020 presidential campaign.

Although federal efforts to adopt a public option have thus far failed, some state and local governments have had more success. At the state level, Colorado, Nevada, and Washington have adopted legislation to add a public option to their state exchanges. Washington's public option became available in 2021. Colorado residents will be able to select a public option in 2023 and Nevada residents in 2026. Monahan et al. (2021) summarize the reform efforts in these three states and detail the challenges Washington faced in forming adequate provider networks in rural counties.

When California's ACA exchange (called Covered California) launched in 2014, there was a public firm competing with private firms in 4 of the 19 markets or rating areas: Contra Costa County (rating area 5), Santa Clara County (rating area 7), East Los Angeles County (rating area 15), and West Los Angeles County (rating area 16). Figure 1a shows the 19 ratings areas in California and Figure 1b indicates where a public option is present. Approximately one-third of Covered California enrollees reside in the four rating areas with a public firm.

The public firms operating in Covered California are the Local Initiative Health Authority for Los Angeles County (L.A. Care), Valley Health Plan (Valley), and Contra Costa Health Plan (CCHP). Although independent, the three public insurers are fairly similar in their business practices. They exclusively sell HMO plans, target low-income and disadvantaged subpopulations, and have limited ability to negotiate preferential reimbursement rates because of their small sizes. L.A. Care was established in 1997 and offers plans through Medicaid, the Children's Health Insurance Program (CHIP), Medicare Advantage, and Covered California. L.A. Care's goal is to "provide access to quality health care for Los Angeles County's vulnerable and low-income communities and residents and to support the safety net required to achieve that purpose."[2] Owned and operated by the County of Santa Clara, Valley was established in 1985 and offers insurance through employer-sponsored insurance and Covered California. One of Valley's principal values is to "embrace a commitment to ensuring that our members are treated with dignity and respect, and the importance of insuring health equity in both treatment and outcomes."[3] Established in 1973, CCHP first offered coverage through Medicaid and then expanded to employer-sponsored insurance and Covered California. CCHP's mission is to "serve the low-income and vulnerable population through safety net providers." After participating in Covered California in 2014, CCHP exited due to new regulatory guidance from the Centers for Medicare and Medicaid Serves (CMS) that prevented it from offering competitive rates to its target population.[4]

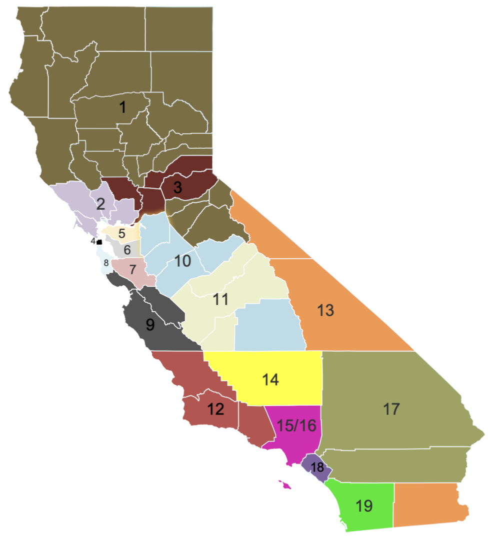
1.3 Data

Demand-Side Data

I use data from numerous data sources that allow me to exploit the exogenous variation in public option availability in the Covered California setting. My demand-side data come from two primary sources: (1) Covered California and (2) the American Community Survey (ACS) (Ruggles et al., 2022). I obtain administrative data on consumer-level enrollment through a Public Records Act (PRA) request from Covered California. There are approximately 10 million records between 2014 and 2019 in my data. The administrative data indicate each consumer's chosen plan and key enrollee characteristics that enable me to define every household's complete choice set and the household-specific premium for each plan in its choice set. I merge the enrollment data with plan provider network directories that were obtained through a second PRA request from Covered California. These directories list the national provider identifiers (NPIs) and hospitals that participate in each plan's network. To construct the outside option population (i.e., those forgoing insurance), I use consumer-level survey data on the uninsured from the ACS between 2014 and 2019. The uninsured

[2] https://www.lacare.org/about-us/about-la-care/mission-vision-and-values
[3] https://www.valleyhealthplan.org/about-us
[4] https://cchealth.org/healthplan/pdf/Exchange-FAQs.pdf

Figure 1: California Rating Regions and Public Firm Penetration



(a) Premium Rating Regions in California

(b) Public Firm Penetration by County

Notes: Panel (a) shows the partition of California's 58 counties into 19 rating areas (Department of Managed Health Care, 2016). Several rating areas (1, 10, and 13) are not contiguous and Los Angeles County is divided into two rating areas (15 and 16). Panel (b) indicates which categories of insurance firms (large private, regional private, and public) were present in each county for at least one year during the study time frame. Large private firms include Anthem, Blue Shield, Health Net, and Kaiser. Regional private firms include Chinese Community, Molina, Oscar, Sharp, United, and Western. Public firms include CCHP, LA Care, and Valley.

sample from the ACS excludes consumers who are explicitly or de facto ineligible for the exchanges, such as undocumented immigrants and consumers with access to another source of coverage (e.g., employer-sponsored insurance, Medicaid). I combine administrative data from Covered California with survey data from the ACS to form the universe of consumers in the market.

Supply-Side Data

My supply-side data come primarily from insurer rate filings (Department of Managed Health Care, 2016). The rate filings provide information on risk scores, medical claims, risk adjustment, and reinsurance. Most states do not collect data on risk scores; California collects plan risk scores as part of its supplemental rate review template (SRRT). I obtain information on firm administrative costs from the medical loss ratio reports published by CMS (Centers for Medicare and Medicaid Services, 2022a). Data on geographic cost factors are also from CMS (Centers for Medicare and Medicaid Services, 2022b).

2 Consumer Preferences for the Public Option

I characterize consumer preferences for the public option. My two primary goals in this section are (1) to identify which consumer types are most likely to choose the public option and (2) to distinguish whether choice of the public option is attributable to observable plan characteristics, such as premiums and the provider network, or unobservable plan characteristics, such as stigma or customer service. The first subsection presents descriptive evidence, the second subsection develops a model, the third subsection discusses estimation, and the fourth subsection presents the results.

2.1 Descriptive Evidence

My data indicate important differences exist between the insurers' enrollee populations. Figure 2 summarizes enrollee characteristics in the markets where a public option was available. I group the insurers into three categories: (1) *large private insurers* that operate in most or all of California's 19 rating areas (Anthem, Blue Shield, Health Net, and Kaiser); (2) *regional private insurers* that operate in a limited number of rating areas (Molina and Oscar)[5]; and (3) *public insurers* (CCHP, LA Care, and Valley). The public insurers' enrollee populations disproportionately draw from low-income and disadvantaged communities, consistent with the public insurers' mission statements.

[5] Molina and Oscar are the only regional insurers to operate where a public insurer also offers coverage. Other regional insurers include Chinese Community, Sharp, United, and Western.

About 75.1% of the public insurers' enrollees have income below 250% of the federal poverty level (FPL), whereas only 67.4% of the large private insurers' enrollees and 71.5% of the regional private insurers' enrollees have income below 250% of FPL.[6] In contrast, consumers with income above 400% of FPL account for only 6.8% of the public insurers' enrollees, but 12.1% of the large private insurers' enrollees. Non-Hispanic whites make up 18.9% of public insurers' enrollees, but 31.9% of large private insurers' enrollees and 25.4% of regional private insurers' enrollees. Public insurers' enrollees also skew slightly older; 29.9% of the public insurers' enrollees were over age 55, compared with 25.6% of the large private insurers' enrollees and 23.5% of the regional private insurers' enrollees. Gender and family size differences between the insurers are relatively small.

Another important issue is whether the public insurers increase takeup of exchange coverage in these disadvantaged subpopulations or simply cannibalize enrollment from the private insurers. In Table 1, I exploit the cross-sectional variation in public option presence to determine whether availability of the public option is associated with increased takeup. I run descriptive binomial logit regressions at the household-year level where the dependent variable is an indicator of whether the household is enrolled in the exchange and the main covariate of interest is an indicator of whether the household's choice set includes a public option. Controls include the cheapest premium in the household's choice set and relevant demographic variables. I find having a public option increases the odds of enrolling in the exchange by $\exp(0.413)-1 = 51\%$ in the population with income below 250% of FPL and by $\exp(0.733) - 1 = 108\%$ in racial minority populations. Hence, the public option has a statistically significant and positive impact on takeup in disadvantaged subpopulations.

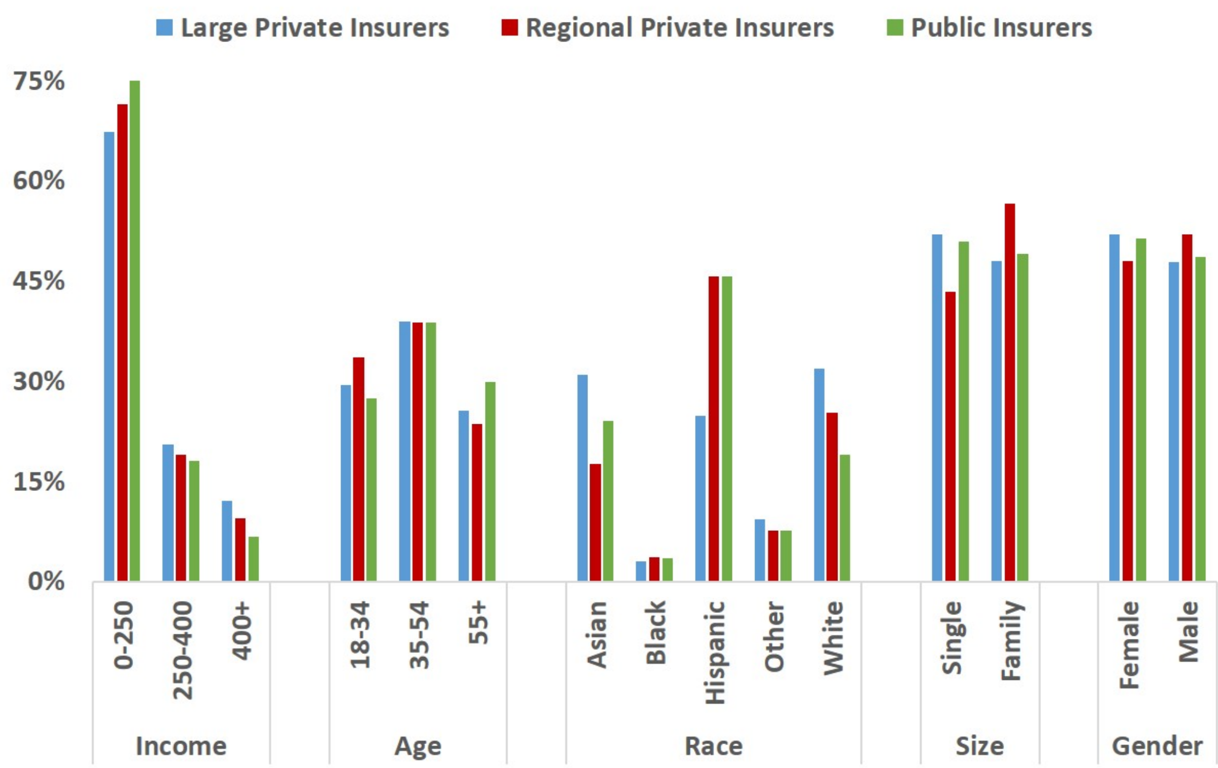
Figure 3 compares silver plan premiums and market shares over time in Santa Clara, East Los Angeles, and West Los Angeles. The four actuarial value (AV) or "metal" tiers include bronze (60% AV), silver (70% AV), gold (80% AV), and platinum (90%).[7] Every Covered California insurer must offer a plan in each metal tier; plans within a metal tier are standardized to have the same cost sharing parameters (e.g., deductible, copays, etc.). A majority of consumers choose silver because consumers must purchase a silver plan to receive cost sharing reductions (CSRs).

Several important insights emerge from Figure 3: (1) consumers are highly sensitive to premiums; (2) the public insurers initially set similar premiums to the private insurers and had little market share, but then set relatively lower premiums and gained substantial market share; and (3) premiums alone cannot explain consumer choices. Evidence of high sensitivity to premiums is

[6] The federal poverty level is adjusted each year and varies with household size. The federal poverty level (i.e., 100% of FPL) was $11,490 for a single person and $23,550 for a family of four in 2014. The federal poverty level was $12,490 for a single person and $25,750 for a family of four in 2019.

[7] The actuarial value of a plan is the expected share of enrollee claims that the plan will cover given the plan's deductible, copays, coinsurance, etc.

Figure 2: Enrollee Characteristics By Insurer Category



Notes: Figure summarizes enrollee demographic characteristics for the large private insurers (Anthem, Blue Shield, Health Net, and Kaiser), regional private insurers (Molina and Oscar) and public insurers (CCHP, LA Care, and Valley) in the counties where the public option is available. Each bar corresponds to the share of enrollees within each insurer category with the given demographic characteristic. Income is measured as a percentage of the federal poverty level.

Table 1: Effect of Public Option Availability on Takeup of Exchange Coverage

	Low-Income	Minority
Public Option Available	0.413^{***}	0.733^{***}
	(0.006)	(0.006)
Cheapest Premium Available	-0.006^{***}	-0.004^{***}
	(0.000)	(0.000)
Family Household	1.671^{***}	2.030^{***}
	(0.003)	(0.003)
Male	-0.373^{***}	-0.550^{***}
	(0.002)	(0.003)
Ages 0-17	0.701^{***}	0.141^{***}
	(0.028)	(0.011)
Ages 18-26	-1.318^{***}	-1.819^{***}
	(0.004)	(0.004)
Ages 26-34	-0.712^{***}	-0.977^{***}
	(0.004)	(0.004)
Ages 35-44	-0.945^{***}	-0.731^{***}
	(0.004)	(0.004)
Ages 45-54	-0.574^{***}	-0.520^{***}
	(0.004)	(0.004)
FPL		-0.091^{***}
		(0.001)
Minority	-0.588^{***}	
	(0.002)	

Notes: Table shows the results of binomial logit regressions at the household-year level. The dependent variable is an indicator of whether the household has exchange coverage for both specifications. In the first specification, I restrict the sample to households with income below 250% of FPL. In the second specification, I restrict the sample to racial minority households. Both specifications include market and year fixed effects.

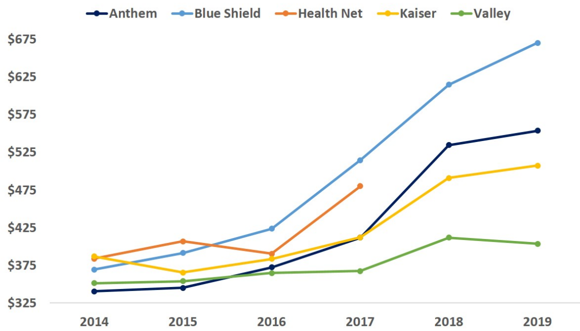
present in all three markets. In 2014, Anthem had the lowest silver premium and 62.2% market share in Santa Clara. Over the next five years, Anthem's silver premium increased 62.7%, making it the second-most expensive in Santa Clara, and its market share plummeted to only 10.1%. In East and West Los Angeles, Anthem's increasing premiums also resulted in substantial market share declines before its exit in 2018. Molina's market share in both East and West Los Angeles peaked in 2017 when it had the lowest silver premiums. However, these premiums were unsustainable, leading Molina to raise premiums the following year by 62.1% in East Los Angeles and by 52.4% in West Los Angeles. As a result, Molina's market share fell from 13.3% to 1.2% in East Los Angeles and from 21.8% to 4.4% in West Los Angeles.

During the ACA's initial years, the public insurers set similar premiums to the private insurers. Valley's premium in 2014 was the second-cheapest silver plan in Santa Clara, approximately 3.3% more expensive than Anthem's premium, and its market share was only 2.5%. In 2014, LA Care sold the second-cheapest silver plan in East Los Angeles and third-cheapest silver plan in West Los Angeles; its silver plan market shares were only 1.6% in East Los Angeles and 2.0% in West Los Angeles. Starting in 2016, Valley's silver plan became the cheapest and its relative premium continued to decline compared to the private insurers. Valley's silver premium in 2019 was 20.5% cheaper than Kaiser's, 27.1% cheaper than Anthem's, and 33.9% cheaper than Blue Shield's. Valley achieved 40.4% market share in 2019 as a consequence, slightly exceeding Kaiser's 40.2% market share. In Los Angeles, LA Care first became the cheapest insurer in 2018 because of Molina's aggressive pricing in 2017. As a consequence, LA Care's market share increased to 18.6% in East Los Angeles and to 32.1% in West Los Angeles by 2019.

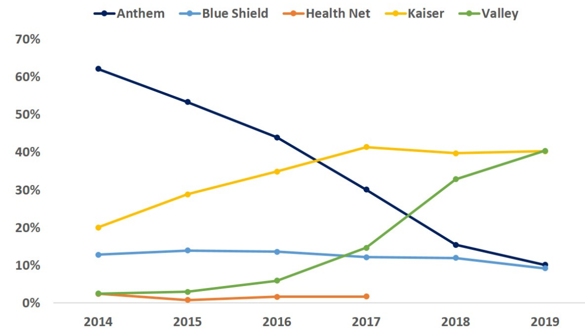
Although premiums are a key component of consumer preferences, the descriptive evidence in Figure 3 suggests other, potentially unobserved plan characteristics may be driving consumer plan choices (note that plan generosity is held constant in Figure 3). In Santa Clara, about as many consumers chose Kaiser as Valley in 2019, despite Valley's silver plan being 20.5% cheaper. Blue Shield's market share was relatively steady between 2014 and 2019, despite its silver plan costing only 5.1% more than Valley's in 2014 and 66.1% more than Valley's in 2019. The story is similar in West Los Angeles. Blue Shield's market share was relatively steady at just under 25% between 2014 and 2019, despite its silver plan costing only 9.4% more than LA Care's in 2014 and 45.7% more than LA Care's in 2019. In both Santa Clara and West Los Angeles, Kaiser gained market share throughout the study time frame despite increasing pricing pressure from the public insurer. In East Los Angeles, Kaiser's market share remained relatively steady at just under 10% despite being the most expensive insurer in every year except 2018.

Figure 4 compares the public option's provider network to that of the private insurers. I calculate

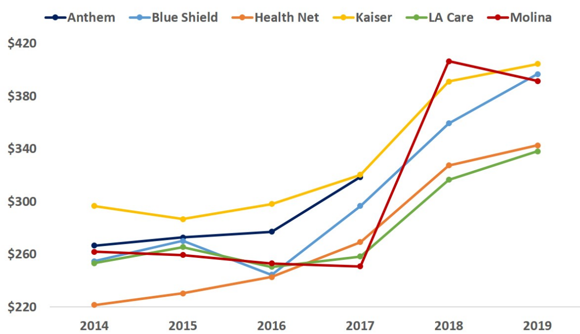
Figure 3: Average Premiums and Market Shares By Insurer and Year



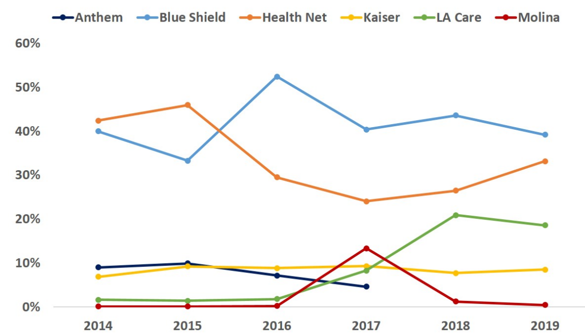
(a) Silver Premiums (Santa Clara)



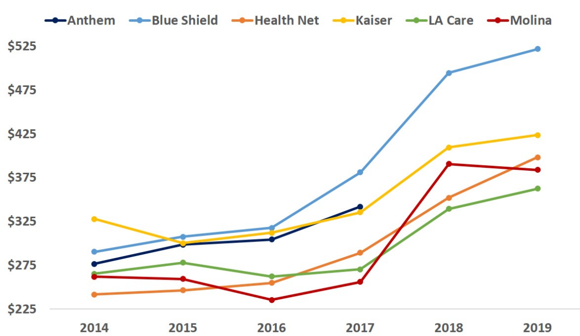
(b) Silver Market Shares (Santa Clara)



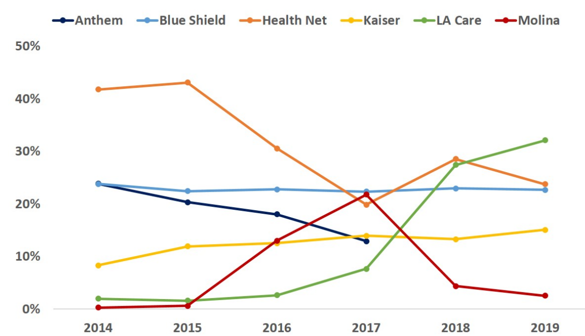
(c) Silver Premiums (East Los Angeles)



(d) Silver Market Shares (East Los Angeles)



(e) Silver Premiums (West Los Angeles)



(f) Silver Market Shares (West Los Angeles)

Notes: Figure shows silver premiums and market shares by insurer and year for Santa Clara County (rating area 7), East Los Angeles County (rating area 15), and West Los Angeles County (rating area 16). I report each insurer's silver premium for a 40-year-old (premiums for all other ages is proportional to the 40-year-old and can be obtained using the CMS age rating curve). For insurers that offer multiple silver plans (e.g., an HMO plan and a PPO plan), I report a weighted average silver premium using enrollee plan shares. I omit Oscar from the Los Angeles County figures because it only participated in the later years and never had more than 4% silver market share.

enrollee-weighted average provider network breadth as the percentage of primary care physicians that are covered within a consumer's 3-digit zip code. The public option's network breadth is 25.7% in Santa Clara, 24.3% in East Los Angeles, and 20.5% in West Los Angeles. Anthem and Blue Shield have substantially higher network breadth than the public option, whereas Kaiser has lower network breadth. In contrast to the other insurers, Kaiser has a vertically-integrated, staff HMO model in which it employs its providers. Health Net has higher network breadth than the public option in Los Angeles, but lower network breadth in Santa Clara.

2.2 Model

I now develop a model to explore these descriptive insights more formally. Households choose the plan that maximizes their (indirect) utility

$$U_{ijt} \equiv \beta_i^p p_{ijt}(\mathbf{p}_t) + \beta_{ij}^y y_{ij(t-1)}(\mathbf{p}_{t-1}) + \beta_i^w w_j + x_{ij}'\beta^x + \xi_j + \epsilon_{ijt}^d \tag{1}$$

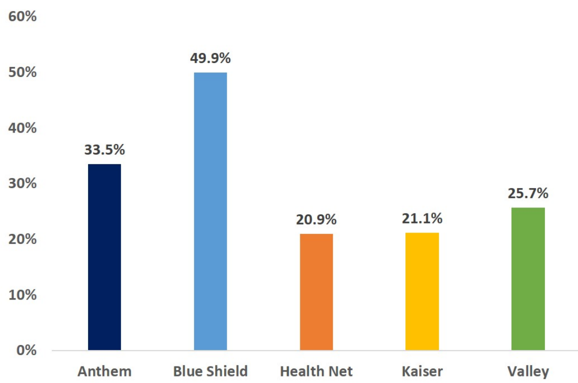
or choose to forgo insurance and realize utility $U_{i0t} \equiv \beta_i^p \rho_{it} + \epsilon_{i0t}$. The vector $\mathbf{p}_t$ is the plan base premiums in year t, $p_{ijt}(\mathbf{p}_t)$ is consumer i's premium for plan j as a function of the plan base premiums in year t, $y_{ij(t-1)}$ is an indicator for the household's choice in year $t-1$ as function of the plan base premiums in year $t-1$, w_j is an indicator of whether the plan is sold by a private firm, x_{ij} is a vector of observable non-premium plan characteristics such as the brand, plan AV, and network type, ξ_j is unobserved plan characteristics, ρ_{it} is the household-specific penalty for not having insurance, and ϵ_{ijt}^d is an error term. The premium parameter $\beta_i^p = \beta^p + z_{it}'\phi$ is a function of household characteristics z_{it}, the inertia parameter $\beta_{ij}^y = \beta^y + x_{ij}'\kappa + z_{it}'\nu$ is a function of plan and household characteristics, and the private plan parameter $\beta_i^w = \beta^w + z_{it}'\upsilon$ is a function of household characteristics. The private plan parameter β_i^w represents the additional utility household i obtains from choosing a private plan ceteris paribus, assuming w_j is uncorrelated with unobservables ξ_j. Alternatively, the negative of the private plan parameter $-\beta_i^w$ is the disutility or "stigma" that household i realizes from choosing a public plan. The household's premium $p_{ijt}(p)$ is

$$p_{ijt}(p) = \max\left\{ \underbrace{\sigma_{it} p_{jmt}}_{\substack{\text{full}\\ \text{premium}}} - \underbrace{\max\{\sigma_{it} p_{bmt} - \zeta_{it}, 0\}}_{\text{premium subsidy}}, 0 \right\} \tag{2}$$

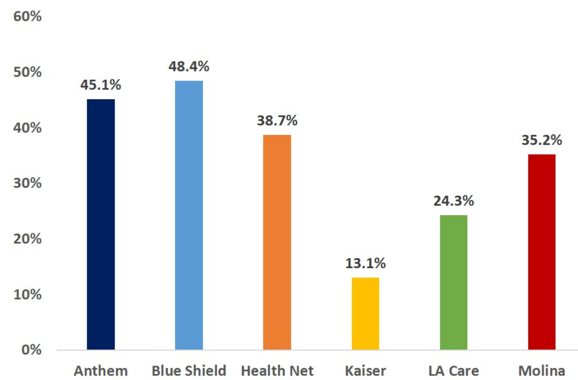
where σ_{it} is the household's rating factor, p_{jmt} is the base premium of plan j in market m and year t, p_{bmt} is the base premium of the benchmark plan, and ζ_{it} is the household's income contribution cap. The product of the rating factor and the base premium is the household's full premium.

Equations (1)-(2) include the key ACA demand-side policies, including (1) modified community

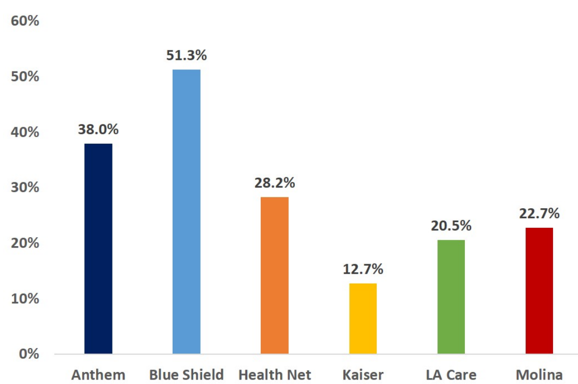
Figure 4: Provider Network Breadth By Insurer



(a) Santa Clara



(b) East Los Angeles



(c) West Los Angeles

Notes: Figure shows enrollee-weighted average provider network breadth by insurer for Santa Clara County (rating area 7), East Los Angeles County (rating area 15), and West Los Angeles County (rating area 16). Provider network breadth is the percentage of primary care physicians that are covered within a consumer's 3-digit zip code.

rating; (2) premium subsidies; (3) cost sharing reductions (CSRs); and (4) the individual mandate. The ACA's modified community rating rules restrict variation in the household rating factor σ_{it} in equation (2). Insurers cannot consider health status to determine household premiums and can only rate by age and geographic residence.[8] Insurers can charge a 64-year-old up to three times as much as a 21-year-old. Figure 1a shows the partition of California's 58 counties into 19 rating areas. Premiums within a rating area must be the same for all consumers of the same age.

In California, approximately 90% of enrollees receive premium subsidies. To qualify, consumers must (1) have income between 100% and 400%; (2) be citizens or legal residents; (3) be ineligible for Medicaid/CHIP, Medicare, etc.; and (4) not have access to an affordable health insurance offer from an employer.[9] The premium subsidy in equation (2) is the difference between the household's full premium for the benchmark plan ($\sigma_{it}p_{bmt}$) and income-based contribution cap ζ_{it}. ACA premium subsidies are endogenous because they depend on the premium of the benchmark plan, defined as the second-cheapest silver plan available to the household. The benchmark plan varies across households because of heterogeneous firm entry. Subsidies can be applied to the purchase of any metal plan, but not catastrophic. Equation (2) prevents the subsidy from exceeding the premium, which could occur for certain bronze plans. This nonlinearity in equation (2) is an exogenous source of variation that I can use to identify the premium parameter as discussed below. Before passage of the American Rescue Plan Act of 2021 (ARP), the income-based contribution cap ranged from 2% to 9.5% of annual income, as shown in Table 2. The ARP substantially enhances ACA subsidies for the 2021 and 2022 plan years by reducing the contribution caps and allowing consumers with income above 400% of FPL to receive subsidies. The Inflation Reduction Act of 2022 extends ARP premium subsidies through 2025.

Consumers with income below 250% of FPL are eligible for CSRs, which reduce deductibles, copays, etc. Consumers must purchase a silver plan to receive CSRs. CSRs increase the AV of the silver plan in equation (1) from 70% to (1) 94% for consumers with income below 150% of the federal poverty level (FPL); (2) 87% for consumers with income between 150% and 200% of FPL; and (3) 73% for consumers with income between 200% and 250% of FPL. About two-thirds of consumers in my data are eligible for CSRs.

Consumers who fail to purchase insurance may be required to pay a penalty. Certain groups are exempt from the individual mandate, including individuals (1) with income below the tax filing threshold and (2) without access to a plan that is less than about 8% of their income. In 2014,

[8] Most states also allow rating by tobacco usage, but California prohibits tobacco rating.

[9] The ACA defines "affordable" as an offer for which the employee's contribution to the employer's single coverage plan is less than 9.5% of the employee's household income. The IRS adjusts this percentage slightly each year.

Table 2: Comparison of Original ACA Subsidies and Enhanced Subsidies Under ARP

	Max. Contribution to Benchmark Plan (% of Income)	
Income (% of FPL)	Original ACA Subsidies	ARP Enhancement
100%-138%	2%	0%
138%-150%	3% - 4%	0%
150%-200%	4% - 6.3%	0% - 2%
200%-250%	6.3% - 8.05%	2% - 4%
250%-300%	8.05% - 9.5%	4% - 6%
300%-400%	9.5%	6% - 8.5%
$>400\%$	N/A	8.5%

Notes: Table compares the income-based contribution caps (ζ_{it}) under the original ACA and under the ARP. Consumers receive a subsidy that ensures they pay no more for the benchmark plan than the percentage of income specified in the table. Under the original ACA, consumers with income above 400% of FPL were ineligible for subsidies. Within each income range, linear interpolation is used to determine the precise contribution cap. The IRS adjusts these contribution caps very slightly each year to account for inflation.

the penalty for a single person was the greater of \$95 and 1% of income exceeding the tax filing threshold. The penalty was full phased in by 2016, when it was the greater of \$695 and 2.5% of income. The Tax Cuts and Jobs Act of 2017 set the penalty to zero starting in 2019.

The ex-ante risk of a plan's enrollees (not to be confused with ex-post spending on health care) is an important measure in this market. Kautter et al. (2014) detail the procedure that CMS uses to compute the ACA risk score, a measure of ex-ante risk. CMS uses a regression-based procedure that calculates ex-ante enrollee risk as a function of plan generosity and enrollee characteristics, including age, gender, and diagnosed medical conditions. I write the plan risk score $r_{jmt}(\mathbf{p}_t)$ as

$$\ln r_{jmt}(\mathbf{p}_t) \quad = \quad \sum_{d \in D} \gamma^d s_{djmt}(\mathbf{p}_t) + MT_j' \gamma^{MT} + \epsilon^r_{jmt} \tag{3}$$

where $s_{djmt}(\cdot)$ is the share of plan j's enrollees in market m and time t with demographic characteristic d, MT_j is a metal tier fixed effect, and ϵ^r_{jmt} is an error term. I discuss estimation of the risk score parameters $\boldsymbol{\gamma} = (\gamma^d, \gamma^{MT})$ below.

2.3 Estimation and Identification

I assume the error term ϵ^d_{ijt} has the generalized extreme value distribution to estimate the demand parameters $\boldsymbol{\beta} = (\beta^p_i, \beta^y_{ij}, \beta^w_i, \beta^x)$. This assumption implies equation (1) is a nested logit model at the consumer level. I define two nests: (1) all exchange plans and (2) the outside option (i.e., forgoing insurance). The household-level choice probabilities are

$$q_{ijt}(\mathbf{p}_t) \quad = \quad \frac{e^{V_{ijt}(\mathbf{p}_t)/\lambda}\left(\sum_j e^{V_{ijt}(\mathbf{p}_t)/\lambda}\right)^{\lambda-1}}{1+\left(\sum_j e^{V_{ijt}(\mathbf{p}_t)/\lambda}\right)^{\lambda}} \tag{4}$$

where $V_{ijt}(\mathbf{p}_t) \equiv \beta_i^p p_{ijt}(\mathbf{p}_t) + \beta_{ij}^y y_{ij(t-1)}(\mathbf{p}_{t-1}) + \beta_i^w w_j + x'_{ij}\beta^x + \xi_j$ and λ is the nesting parameter. I estimate the model parameters using maximum likelihood at the consumer level following Train (2009). Assuming the subsidy does not exceed the full premium, the sensitivity of a subsidized consumer's demand to a premium change is

$$\frac{\partial q_{ikt}(\mathbf{p}_t)}{\partial p_{jmt}} = \sum_{l \in J_{mt}} \frac{\partial q_{ikt}(\mathbf{p}_t)}{\partial p_{ilt}(\mathbf{p}_t)} \frac{\partial p_{ilt}(\mathbf{p}_t)}{\partial p_{jmt}} \tag{5}$$

for all plans j, k, where

$$\frac{\partial p_{ilt}(\mathbf{p}_t)}{\partial p_{jmt}} = \begin{cases} 0 & l = j, j = b \\ \sigma_{it} & l = j, j \neq b \\ -\sigma_{it} & l \neq j, j = b \\ 0 & l \neq j, j \neq b \end{cases}. \tag{6}$$

For all plans except the benchmark plan, a dollar increase in a plan's base premium results in consumers paying σ_{it} additional dollars for that plan and does not affect what consumers pay for any other plan. However, a dollar increase in the benchmark plan increases the subsidy by σ_{it} dollars; consumers pay the same amount for the benchmark plan, but pay less for all other plans because of the subsidy increase. Firms may be able to exploit the benchmark plan premium to increase profit in markets with low firm participation, particularly in a monopoly market. My model explicitly accounts for this potential gaming behavior in equation (6).

My analysis of consumer plan choices requires credible identification of the premium parameter β_i^p and the private parameter β_i^w. Although most plan characteristics are observed, some unobserved plan characteristics that vary at the insurer-market level such as customer service or the plan formulary may be correlated with premiums. My richest specification includes insurer-market fixed effects to control for these unobserved plan characteristics. Key institutional details of the ACA setting also generate plausibly exogenous variation in premiums. The phase-in of the mandate penalty between 2014 and 2016 and subsequent elimination of the penalty in 2019 creates exogenous variation in household premiums relative to the outside option. The ACA's nonlinear subsidy formula in equation (2) also creates exogenous variation in household premiums between plans. Some households may have access to "free" bronze plans if the household's subsidy exceeds the full premium. The set of "free" plans varies across time and exogenously-determined household characteristics, including geographic residence, age, and income.

The private variable may also be correlated with unobserved plan characteristics. Identification of the private parameter leverages plausibly exogenous variation in firm participation across markets and across time. Figure 1b shows the geographic variation in large, regional, and public firm penetration. An example of exploiting this variation is to compare the choices of consumers in Santa Clara County, who can choose between the large firms and the public firm, with those in Alameda County and other neighboring counties, who only have access to the large firms. One concern is that consumers view the public firm as another regional firm. I address this concern by comparing the choices of consumers in Los Angeles County, who can choose from all categories of firms, with those in Orange County and San Bernardino County, who only had access to large and regional firms. Finally, CCHP departed after 2014 due to regulatory changes, allowing me to compare the choices of the same consumers across time. A significant caveat to exploiting this time variation is that CCHP only covered about 1,000 consumers in 2014.

The main challenge in identifying the risk score parameters is that I do not observe diagnosed medical conditions, potentially biasing estimates of γ^d. I address this potential source of omitted variable bias by computing predicted demographic shares using the estimated consumer-level choice probabilities from equation (4) instead of the observed demographic shares, which may be endogenous. My identifying assumption is that predictions of the demographic shares are based on exogenous determinants of consumer-level demand. The choice model serves as the "first stage" of an IV regression for obtaining unbiased plan risk score estimates. Similar empirical approaches are often used in the hospital choice literature to calculate unbiased estimates of hospital market concentration (Kessler and McClellan, 2000).

2.4 Results

Parameter estimates of $\boldsymbol{\beta}$ and $\boldsymbol{\gamma}$ are available in Table A1 in Appendix B. To interpret these parameter estimates, I compute elasticities and willingness-to-pay (WTP) for a private plan relative to a public plan. Table 3 indicates California exchange consumers are highly premium sensitive, consistent with the previous literature (Domurat, 2018; Drake, 2019; Saltzman, 2019; Tebaldi, 2022). The mean own-premium elasticity is -6.13 and the mean elasticity for exchange coverage is -0.90. Minority populations and especially young adults are highly premium sensitive.

Table 4 illustrates how consumers substitute between firms. The diagonal elements indicate the average response of a firm's demand to a change in one of its own premiums; the off-diagonal indicate the average response of the "row firm's" demand to a change in the premium of a plan sold by the

Table 3: Own-Plan and Coverage Elasticities

	Own-Premium		Exchange Coverage	
	Elasticity	Semi-Elasticity	Elasticity	Semi-Elasticity
Overall	-6.13	-10.31	-0.90	-1.73
Age				
0-17	-5.98	-9.02	-0.80	-1.41
18-34	-9.25	-13.89	-1.22	-2.14
35-54	-6.82	-10.28	-0.91	-1.60
55+	-4.10	-6.22	-0.56	-0.99
Gender				
Female	-6.00	-10.10	-0.88	-1.69
Male	-6.28	-10.52	-0.92	-1.75
Race/Ethnicity				
Asian	-7.01	-11.54	-0.98	-1.85
Black	-6.49	-10.76	-0.91	-1.73
Hispanic	-7.68	-12.54	-1.07	-2.00
Other	-5.59	-9.43	-0.80	-1.53
Non-Hispanic White	-5.28	-8.96	-0.76	-1.46
Household Size				
Single	-5.96	-10.00	-0.88	-1.69
Family	-6.64	-11.02	-0.97	-1.84

Notes: Table reports plan elasticities by demographic group. The first and second columns indicate how a plan's demand responds to a change in its own premium before subsidies. The third and fourth columns indicate how total exchange enrollment responds to a change in all exchange premiums. The semi-elasticities are calculated for a $100 change in annual premiums.

Table 4: Firm Elasticities

	Anthem	Blue Shield	Health Net	Kaiser	Regional Insurer	Public Insurer
Anthem	-4.90	1.50	1.29	1.11	1.02	1.12
Blue Shield	1.46	-5.56	1.36	1.26	1.12	0.91
Health Net	0.66	0.68	-5.89	0.61	0.65	0.78
Kaiser	1.57	2.38	2.14	-3.85	1.70	1.13
Regional Insurer	0.71	1.07	0.83	0.86	-4.94	0.43
Public Insurer	0.57	0.88	0.59	0.63	0.48	-4.66

Notes: Table reports firm elasticities in matrix form. The diagonal elements indicate the average response of a firm's demand to a change in one of its own plan premiums. The off-diagonal elements indicate the average response of the "row firm's" demand to a change in the premium of a plan sold by the "column firm."

"column firm." The Blues – Anthem Blue Cross and Blue Shield – have high cross-premium elasticities, suggesting that they are close substitutes. The large cross-premium elasticities in Kaiser's row indicates that Kaiser is an attractive alternative for consumers when other firms' premiums rise. The cross-premium elasticities for the public insurer are generally the lowest, indicating consumers do not view public and private plans as close substitutes. Hence, the public firm can build a distinct consumer base from the private insurers rather than "steal business" from the private insurers.

Figure 5 provides further evidence that private and public firms serve differentiated consumer bases. I calculate WTP for a private plan relative to a public plan by computing the ratio of the private parameter to the premium parameter (i.e., $\frac{\beta_i^w}{\beta_i^p}$). The average WTP is \$39 or 8.9% of the average premium. This average masks substantial heterogeneity. Older, higher-income, non-Hispanic White, and female consumers have a much higher WTP. Conversely, Hispanic and Black consumers have a negative WTP and therefore prefer public plans, all else equal. These findings are consistent with the public firms' missions to target disadvantaged subpopulations. Hence, the public firm expands the market to disadvantaged subpopulations and can coexist with the private firms.

Figure 5: Willingness-to-Pay for a Private Plan Relative to a Public Plan

Notes: Figure shows consumers' willingness-to-pay (WTP) for a private plan relative to a public plan. WTP is the ratio $\frac{\beta_i^w}{\beta_i^p}$. I show heterogeneity in WTP by income, age, race, family size, and gender. Overall WTP of \$39 is shown by the black line.

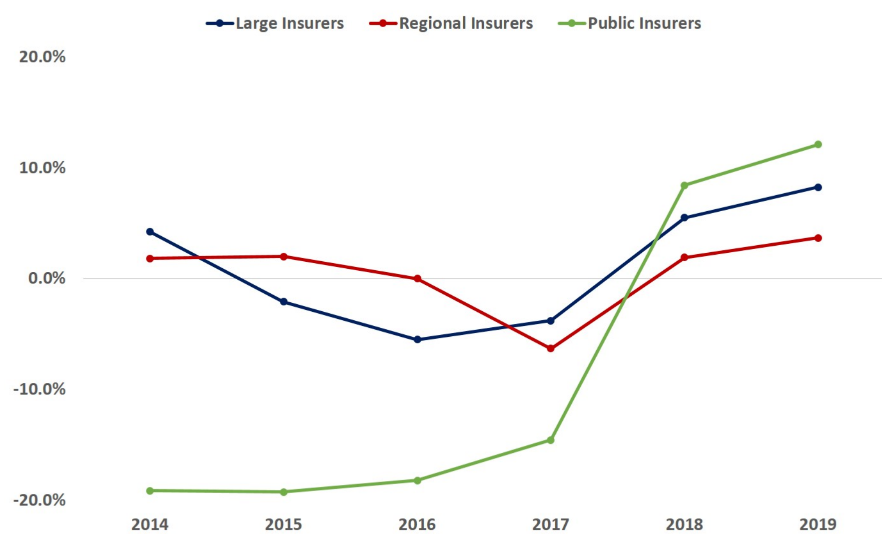
3 Public Firm Objectives

Now I evaluate alternative specifications of the public firm's objective function. The primary goal of this section is to determine which objective best explains the observed data. The first subsection presents descriptive evidence, the second subsection develops a model, the third subsection discusses model estimation, and the fourth subsection presents the results.

3.1 Descriptive Evidence

Figure 6 plots state-level insurer profit margins over time as reported in the MLR data.[10] The public insurers suffered losses of nearly 20 percent during 2014 and 2015; substantial losses persisted through 2017. However, the public insurers earned positive profits in 2018 and 2019 that even exceeded the private insurers. This empirical evidence suggests that the public insurers either did not operate with a budget constraint or were only constrained to earn zero profit over a long time horizon. The profit margins for the private insurers were much more stable. The small, regional insurers earned profit in all years except 2017. The large insurers sustained losses between 2015 and 2017, but losses were substantially less than those incurred by the public insurers. This descriptive evidence suggests that public insurer objectives may diverge from private insurer objectives.

Figure 6: Statewide Profit Margins By Year



Notes: Figure shows insurer profit margins by year. Profit margins are aggregated at the state level for the four large insurers, the six regional insurers, and the three public insurers. Profit cannot be computed at the market level because some administrative costs are market independent. The large insurers operate in all markets, whereas the regional private and public insurers operate in select markets.

I assess whether the public option puts competitive pressure on private firms to reduce pre-

[10] Profit cannot be computed at the market level because some administrative costs are market independent.

miums by constructing least squares regressions at the household-year level. These regressions leverage geographic variation in public option availability to evaluate the public option's impact on the benchmark premium and the cheapest premium available to the consumer. I control for regional differences in cost by using the geographic cost factors published by CMS and relevant demographic differences. Results are presented in Table 5. The availability of the public option is associated with a \$22 reduction in the benchmark premium and a \$29 reduction in the cheapest premium available to the consumer, suggesting the public option puts competitive pressure on private firms.

Table 5: Effect of Public Option Availability on Exchange Premiums

	Benchmark Premium	Cheapest Premium
Public Option Available	-22.400^{***}	-29.337^{***}
	(0.136)	(0.116)
Geographic Cost Factor	537.806^{***}	302.069^{***}
	(0.243)	(0.209)
Family Household	-6.736^{***}	-12.783^{***}
	(0.059)	(0.051)
Male	-2.161^{***}	-1.173^{***}
	(0.071)	(0.061)
Ages 0-17	-566.158^{***}	-385.935^{***}
	(0.173)	(0.149)
Ages 18-26	-482.878^{***}	-344.817^{***}
	(0.109)	(0.093)
Ages 26-34	-438.895^{***}	-311.794^{***}
	(0.088)	(0.076)
Ages 35-44	-391.237^{***}	-274.222^{***}
	(0.095)	(0.082)
Ages 45-54	-254.800^{***}	-177.086^{***}
	(0.090)	(0.077)
FPL	-0.002^{***}	0.001
	(0.001)	(0.001)
Minority	-2.353^{***}	-6.666^{***}
	(0.059)	(0.050)

Notes: Table shows the results of least squares regressions at the household-year level. The dependent variable is an indicator of whether the household has exchange coverage for both specifications. Both specifications include market and year fixed effects.

3.2 Model

I now develop a mixed oligopoly model that incorporates alternative specifications of the public firm's objective function. Consider a two-stage game where (1) private firms set premiums to maximize expected profit and public firms set premiums to maximize their objective as defined below and (2) consumers choose plans to maximize utility as discussed in Section 2. I first discuss the private firm's objective and then propose alternative specifications of the public firm's objective.

3.2.1 Private Firms

Assume multi-product private firms are risk neutral and choose the base premium p_{jmt} for each plan that they sell to maximize expected profit

$$\pi_{ft}(\mathbf{p}_t) \quad = \quad R_{ft}(\mathbf{p}_t) - C_{ft}(\mathbf{p}_t) + RA_{ft}(\mathbf{p}_t) + RI_{ft}(\mathbf{p}_t) - V_{ft}(\mathbf{p}_t) - FC_{ft}. \tag{7}$$

where $R_{ft}(\mathbf{p}_t)$ is firm f's total premium revenue, $C_{ft}(\mathbf{p}_t)$ is total medical claims, $RA_{ft}(\mathbf{p}_t)$ is risk adjustment received, $RI_{ft}(\mathbf{p}_t)$ is reinsurance received, $V_{ft}(\mathbf{p}_t)$ is variable administrative costs (e.g., commissions), and FC_{ft} is fixed cost (e.g., overhead). Formulas for these terms are in Appendix A. Reinsurance was a temporary government program in effect between 2014 and 2016 that provided "insurance to insurers" for their highest-cost enrollees. Risk adjustment is a permanent program that disincentivizes insurers from cherry-picking low-risk consumers by transferring money from insurers with lower-than-average risk enrollees to insurers with higher-than-average risk enrollees. Pope et al. (2014) derive the risk adjustment transfer formula used in the ACA exchanges. The average (or per-capita) risk adjustment transfer received by a plan is

$$\begin{aligned} ra_{jmt}(\mathbf{p}_t) &= \widehat{c}_{jmt}(\mathbf{p}_t) - \widetilde{c}_{jmt}(\mathbf{p}_t) \\ &= \frac{\widehat{h}_{jmt}(\mathbf{p}_t)}{\sum_{n\in M, l\in J_{nt}} \widehat{h}_{lnt}(\mathbf{p}_t) s_{lnt}(\mathbf{p}_t)} \nu\overline{p} - \frac{\widetilde{h}_{jmt}(\mathbf{p}_t)}{\sum_{n\in M, l\in J_{nt}} \widetilde{h}_{lnt}(\mathbf{p}_t) s_{lnt}(\mathbf{p}_t)} \nu\overline{p} \end{aligned} \tag{8}$$

where $\widehat{c}_{jmt}(\mathbf{p}_t)$ is the plan's expected average claims with adverse selection and $\widetilde{c}_{jmt}(\mathbf{p}_t)$ is the plan's expected average claims without adverse selection. The cost factor $\widehat{h}_{jmt}(\mathbf{p}_t) \equiv \text{IDF}_j\text{GCF}_{mt} r_{jmt}(\mathbf{p}_t)$ is the product of the plan's induced utilization factor (or moral hazard factor), geographic cost factor, and risk score. The cost factor $\widetilde{h}_{jmt}(\mathbf{p}_t) \equiv \text{AV}_j\text{IDF}_j\text{GCF}_{mt} a_{jmt}(\mathbf{p}_t)$ is the product of the plan's AV, induced utilization factor, geographic cost factor, and average ACA age rating factor $a_{jmt}(\mathbf{p}_t)$ across the plan's enrollees. The plan's market share is $s_{lmt}(\mathbf{p}_t)$, the average statewide premium is $\overline{p}$, and the expected percentage of collected premiums that is spent on claims is ν.[11]

Average transfer formula (8) redistributes funds so that each firm faces the same (unobserved) enrollee health risk. It does not compensate firms for observable differences in age, geography, moral hazard, or plan AV that firms can price for. The cost factor $\widehat{h}_{jmt}(\mathbf{p}_t)$ in the firm term accounts for differences in moral hazard and geography, as well as age, plan AV, and enrollee health risk in

[11] From 2014-2017, ν was set to 100% in the ACA transfer formula. Starting in 2018, ν was set to 86%.

the plan risk score. The cost factor $\widetilde{h}_{jmt}(\mathbf{p}_t)$ in the second term accounts for differences in moral hazard, geography, age, and plan AV, but not enrollee health risk. Therefore, the difference between the first and second terms compensates firms for differences in enrollee health risk only.

A plan's realized average claims $c_{jmt}(\mathbf{p})$ may be diverge from the plan's expected average claims with adverse selection $\widehat{c}_{jmt}(\mathbf{p}_t)$ for several reasons. Some plans may include more expensive providers in their networks, whereas other plans may have narrow networks or restrict access to specialists (e.g., an HMO plan). There may also differences in a plan's bargaining leverage with providers in negotiating reimbursement rates. Formula 8 does not compensate plans for these cost differences or any other efficiencies that plans may realize.

Differentiating equation (7) with respect to the premium yields the first-order conditions

$$0 = \frac{\partial \pi_{ft}(\mathbf{p}_t)}{\partial p_{jmt}} = \frac{\partial R_{ft}(\mathbf{p}_t)}{\partial p_{jmt}} - (1-\iota_{ft})\frac{\partial C_{ft}(\mathbf{p}_t)}{\partial p_{jmt}} + \frac{\partial RA_{ft}(\mathbf{p}_t)}{\partial p_{jmt}} - \frac{\partial V_{ft}(\mathbf{p}_t)}{\partial p_{jmt}} \tag{9}$$

for all plans j sold by the firm in market m at time t, where ι_{ft} is the AV of the reinsurance contract. Formulas for each term in equation (9) are given in Appendix A. These formulas account for potential intra-firm cannibalization of demand between plans.

3.2.2 Public Firms

Most of the industrial organization (IO) literature assumes all firms maximize profit. I generalize the standard oligopoly model to a mixed oligopoly model with alternative specifications of the public firm's objective. Several objectives have been considered in the mixed oligopoly and nonprofit firm literature (Newhouse, 1970; Pauly and Redisch, 1973; Steinberg, 1986; De Fraja and Delbono, 1990; Matsumura, 1998; Malani et al., 2003; Lakdawalla and Philipson, 2006; Gaynor et al., 2015; Philipson and Posner, 2009; Horwitz and Nichols, 2009; Dranove et al., 2017; Chang and Jacobson, 2017; Capps et al., 2020). The most common objective is weighted social surplus. Others include budget (or revenue) maximization and output maximization. Let the weight $\omega \in [0,1]$. I define the following four families of public firm objectives:

$$MW(\mathbf{p}_t,\omega) \equiv \omega CS_{mt}(\mathbf{p}_t) + (1-\omega)\pi_{mt}(\mathbf{p}_t) \tag{10a}$$
$$FW(\mathbf{p}_t,\omega) \equiv \omega CS_{mt}(\mathbf{p}_t) + (1-\omega)\pi_{ft}(\mathbf{p}_t) \tag{10b}$$
$$MREV(\mathbf{p}_t,\omega) \equiv \omega R_{mt}(\mathbf{p}_t) + (1-\omega)\pi_{mt}(\mathbf{p}_t) \tag{10c}$$
$$FREV(\mathbf{p}_t,\omega) \equiv \omega R_{ft}(\mathbf{p}_t) + (1-\omega)\pi_{ft}(\mathbf{p}_t) \tag{10d}$$

where $CS_{mt}(\mathbf{p}_t) = \sum_{i\in I} \mathbb{I}_{i,m,t} CS_{it}(\mathbf{p}_t)$ is market consumer surplus, $\pi_{mt}(\mathbf{p}_t) \equiv \sum_{f\in F} \pi_{fmt}(\mathbf{p}_t)$ is market profit including the public firm's profit, and $R_{mt}(\mathbf{p}_t) \equiv \sum_{f\in F} R_{fmt}(\mathbf{p}_t)$ is market revenue including the public firm's revenue. Household consumer surplus is

$$CS_{it}(\mathbf{p}_t) = -\frac{1}{\beta_i^p} \ln \left(\left(\sum_{l \in J} \exp \left(V_{ilt}(\mathbf{p}_t)/\lambda \right) \right)^{\lambda} + \exp \left(\beta_i^p \rho_{it} \right) \right) + \sum_{l \in J} q_{ilt}(\mathbf{p}_t) \frac{\beta_{il}^y y_{il(t-1)}}{\beta_i^p} \quad (11)$$

The first term of equation (11) is the nested logit formula for consumer surplus and the second term of equation (11) "corrects" the first term to reflect gains in surplus that result from inertia.

The public firm objectives in (10) nest a wide range of firm behavior. Objective (10a) is equivalent to maximizing social welfare in the public firm's market when $\omega = 0.5$.[12] Objectives (10b) and (10d) are equivalent to profit maximization when $\omega = 0$. Objectives (10a) and (10c) are equivalent to maximizing market profit when $\omega = 0$. Objectives (10a) and (10b) are equivalent to maximizing consumer surplus when $\omega = 1$. Objective (10d) is equivalent to budget maximization and objective (10c) is equivalent to market budget maximization when $\omega = 1$. I do not constrain the public firm's profit to be nonnegative because the descriptive evidence in Subsection 3.1 indicates the public firms were willing to incur substantial loses. Losses are reflected in the objective for $\omega < 1$.

Differentiating the objectives in (10) with respect to the premium yields

$$-\omega \frac{\partial CS_{mt}(\mathbf{p}_t)}{\partial p_{jmt}} \equiv (1-\omega) \frac{\partial \pi_{mt}(\mathbf{p}_t)}{\partial p_{jmt}} \quad (12a)$$

$$-\omega \frac{\partial CS_{mt}(\mathbf{p}_t)}{\partial p_{jmt}} \equiv (1-\omega) \frac{\partial \pi_{ft}(\mathbf{p}_t)}{\partial p_{jmt}} \quad (12b)$$

$$-\omega \frac{\partial R_{mt}(\mathbf{p}_t)}{\partial p_{jmt}} \equiv (1-\omega) \frac{\partial \pi_{mt}(\mathbf{p}_t)}{\partial p_{jmt}} \quad (12c)$$

$$-\omega \frac{\partial R_{ft}(\mathbf{p}_t)}{\partial p_{jmt}} \equiv (1-\omega) \frac{\partial \pi_{ft}(\mathbf{p}_t)}{\partial p_{jmt}} \quad (12d)$$

where formulas for all partial derivatives in (12) are given in Appendix A. The model equilibrium conditions are the private firms' first-order conditions in (9) and the public firm's first-order conditions in (12), given the weight ω and objective family. The vector of premiums that solve these equilibrium conditions define a Nash-in-premiums equilibrium.

3.3 Estimation and Identification

I now discuss estimation of average claims. Following the literature (Nevo, 2001), I assume firms are playing a Nash-in-premiums equilibrium and obtain nonparametric estimates of average claims

[12] Spending on premium subsidies, CSRs, and other related expenditures is not included as a welfare cost because it is borne at the federal level, not the county level.

by inverting the model equilibrium conditions. Solving equation (9) for $\frac{\partial C_{ft}(\mathbf{p}_t)}{\partial p_{jmt}}$ and substituting in equation (24) yields

$$\frac{1}{1-\iota_{ft}}\left[\frac{\partial R_{ft}(\mathbf{p}_t)}{\partial p_{jmt}}+\frac{\partial RA_{ft}(\mathbf{p}_t)}{\partial p_{jmt}}-\frac{\partial V_{ft}(\mathbf{p}_t)}{\partial p_{jmt}}\right] = \sum_{k\in J_{fmt}}\left[c_{kmt}(\mathbf{p}_t)\frac{\partial q_{kmt}(\mathbf{p}_t)}{\partial p_{jmt}}+q_{kmt}(\mathbf{p}_t)\frac{\partial c_{kmt}(\mathbf{p}_t)}{\partial p_{jmt}}\right] \quad (13)$$

I can compute every term in (13) using my data and estimates from Section 2 except for average claims $c_{kmt}(\mathbf{p}_t)$ and its partial derivative $\frac{\partial c_{kmt}(\mathbf{p}_t)}{\partial p_{jmt}}$. In a typical market without selection, the partial derivative $\frac{\partial c_{kmt}(\mathbf{p}_t)}{\partial p_{jmt}}=0$ and hence it is possible to solve for average claims. If adverse selection is present, average claims are increasing in premiums such that $\frac{\partial c_{kmt}(\mathbf{p}_t)}{\partial p_{jmt}}>0$ and hence there are more unknowns than equations in (13). To identify average claims, I assume the functional form

$$c_{jmt}(\mathbf{p}_t) = \widehat{c}_{jmt}(\mathbf{p}_t)+\zeta_{jmt} \quad (14)$$

where $\widehat{c}_{jmt}(\mathbf{p}_t)$ is expected average claims with adverse selection from equation (8) and ζ_{jmt} captures factors such as the provider network that result in average claims diverging from $\widehat{c}_{jmt}(\mathbf{p}_t)$.

Equation (14) makes two key assumptions: (1) premium changes only affect average claims through $\widehat{c}_{jmt}(\mathbf{p}_t)$ and (2) ACA risk adjustment accurately captures selection. The first assumption is not particularly onerous. For example, the cost of maintaining the provider network is reflected ζ_{jmt}, but changes in enrollee risk due to selection on the provider network are reflected in $\widehat{c}_{jmt}(\mathbf{p}_t)$ through the risk score. The assumption that the ACA risk adjustment formula accurately captures selection is quite strong. Geruso and Layton (2020) find private plans engage in upcoding and generate 6-16% higher enrollee risk scores than they would under traditional Medicare. Early critics of the ACA risk adjustment formula thought it overcompensated firms with higher-than-average risk enrollees. In response, CMS reduced ν from 1 to 0.86 in 2018. I perform numerous robustness checks below to determine the degree to which the risk adjustment assumption biases my estimates.

Differentiating equation (14) with respect to the premium yields equation (23) in Appendix A. This equation provides me with a closed-form expression for computing $\frac{\partial c_{kmt}(\mathbf{p}_t)}{\partial p_{jmt}}$ using only my estimates from Section 2 and the geographic and moral hazard factors published by CMS. Substituting equation (23) into equation (13) allows me to identify and solve for average claims $c_{jmt}(\mathbf{p}_t)$. Using equation (14), I can calculate the difference $c_{jmt}(\mathbf{p}_t)-\widehat{c}_{jmt}(\mathbf{p}_t)$ to obtain estimates of the premium-independent portion of cost ζ_{jmt}.

3.4 Results

For each family of public firm objectives, I obtain 200 sets of average claims estimates corresponding to the model with weight $\omega\in\left\{0,\frac{1}{200},\frac{2}{200},\frac{3}{200},\ldots,\frac{198}{200},\frac{199}{200}\right\}$. I compute the root mean square error (RMSE) and mean absolute error (MAE) to assess how well these estimates match my data.[13]

Figure 7a summarizes goodness-of-fit for objective families (10a) and (10b). My results indicate the public firm places more weight on consumer surplus than market or firm profit. For family (10a), the objective that results in the smallest RMSE places 63% weight on consumer surplus and 37% weight on market profit; the RMSE is about 32% smaller than the RMSE for market profit maximization ($\omega = 0$). The objective that results in the smallest MAE places 59% weight on consumer surplus and 41% weight on market profit; the MAE is about 34% smaller than the MAE for market profit maximization. For family (10b),the objective that results in the smallest RMSE places 59% weight on consumer surplus and 41% weight on firm profit; the RMSE is about 25% smaller than the RMSE for firm profit maximization ($\omega = 0$). The objective that results in the smallest MAE places 59% weight on consumer surplus and 41% weight on firm profit; the MAE is about 20% smaller than the MAE for firm profit maximization. Both the RMSE and MAE for the best-fitting objectives in family (10b) are higher than the best-fitting objectives in family (10a).

Figure 7b indicates that objective family (10c) is a poor fit. The objective that results in the smallest RMSE and MAE places 100% weight on market profit and 0% weight on market revenue. Objective family (10d) performs better than (10c), but not as well as objective families (10a) and (10b). The objective that results in the smallest RMSE places 37% weight on the public firm's revenue and 63% weight on its profit. The objective that results in the smallest MAE places 28% weight on the public firm's revenue and 72% weight on market profit.

I now test whether the best-fitting objectives in each family yield statistically significant better predictions than profit maximization. Define the difference in squared prediction errors (DSE) as

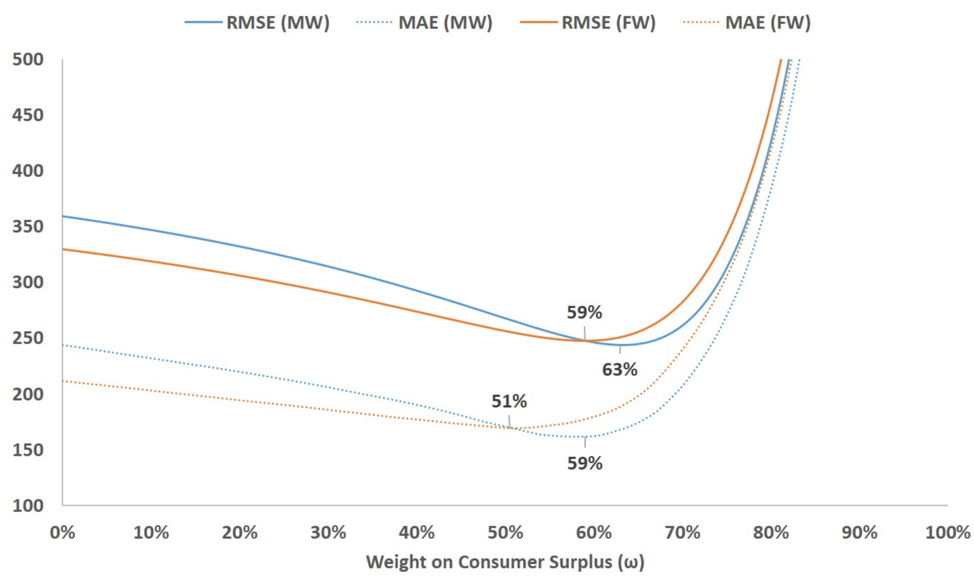
$$DSE \;=\; (c_{jmt}(\mathbf{p}, \omega) - c_{jmt})^2 - (c^*_{jmt}(\mathbf{p}) - c_{jmt})^2 \tag{15}$$

where c_{jmt} is observed average claims, $c_{jmt}(\mathbf{p}, \omega)$ is average claims estimated from the alternative model, and $c^*_{jmt}(\mathbf{p})$ is average claims under profit maximization. Following Doraszelski et al. (2018), I regress DSE on a constant. Table 6 shows statistically significant improvements in fit for the best-fitting objectives in families (10a), (10b), and (10d) compared to profit maximization. One concern with the estimates is that the market may not have been in equilibrium in the first couple of years. When I control for the years 2014 and 2015, I find both objectives yield an even greater improvement in fit over profit maximization for 2016 and later. Hence, the results may understate the enhancement in fit in the later years when the market is more likely to be in equilibrium.

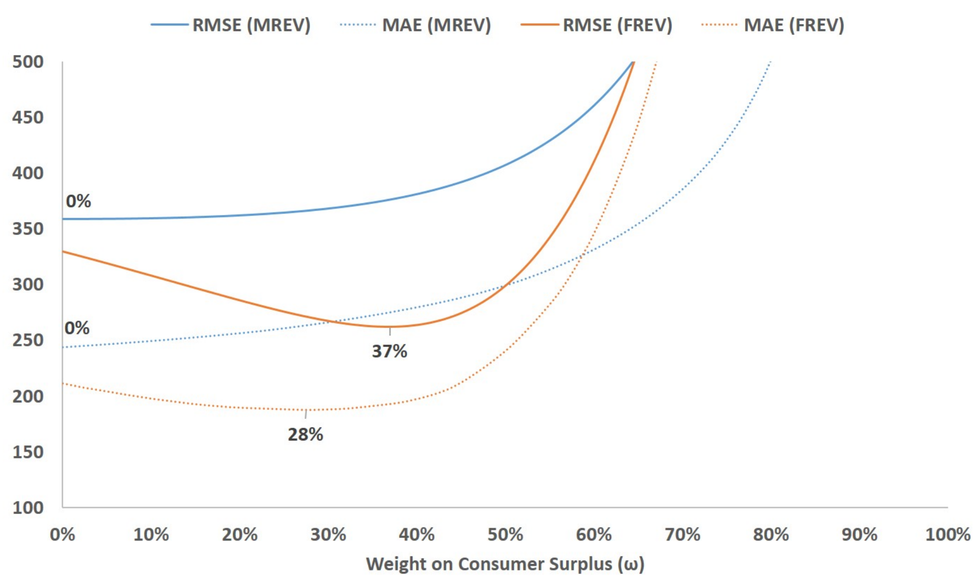
I perform two sensitivity analyses to assess the robustness of my results to the identifying as-

[13] $RMSE = \sqrt{\frac{1}{|J|}\sum_{j\in J, m\in M, t\in T}(c_{jmt}(\mathbf{p}, \omega) - c_{jmt})^2}$ and $MAE = \frac{1}{|J|}\sum_{j\in J, m\in M, t\in T}|c_{jmt}(\mathbf{p}, \omega) - c_{jmt}|$, where $c_{jmt}(\mathbf{p}, \omega)$ is average claims estimated from the alternative model and c_{jmt} is observed average claims.

Figure 7: Comparing Specifications of the Public Firm's Objective



(a) Surplus Maximization



(b) Budget Maximization

Notes: Figure compares how well each model objective predicts observed average claims. Two goodness-of-fit measures are shown: (1) root mean square error (RMSE) and (2) mean absolute error (MAE). Panel (a) plots RMSE and MAE for the surplus maximization objectives $MW(\mathbf{p}_t, \omega)$ and $FW(\mathbf{p}_t, \omega)$. Panel (b) plots RMSE and MAE for the budget maximization objectives $MREV(\mathbf{p}_t, \omega)$ and $FREV(\mathbf{p}_t, \omega)$. I obtain estimates of plan average claims for weight intervals of 0.5% between 0% and 100% and plot smoothed curves.

Table 6: Comparison of Alternative Public Firm Objectives with Profit Maximization

	$MW(\mathbf{p}_t, 0.63)$		$FW(\mathbf{p}_t, 0.59)$		$MREV(\mathbf{p}_t, 0)$		$FREV(\mathbf{p}_t, 0.37)$	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Constant	-1007.163*	-1385.915**	-966.624*	-1273.796*	411.022***	519.040***	-815.720*	-990.421
	(418.914)	(515.637)	(414.536)	(514.578)	(89.056)	(108.233)	(404.557)	(507.606)
2014		1744.193		1431.030		-443.482		889.298
		(1100.562)		(1098.302)		(231.009)		(1083.422)
2015		357.634		271.521		-162.695		69.583
		(1152.998)		(1150.631)		(242.015)		(1135.042)

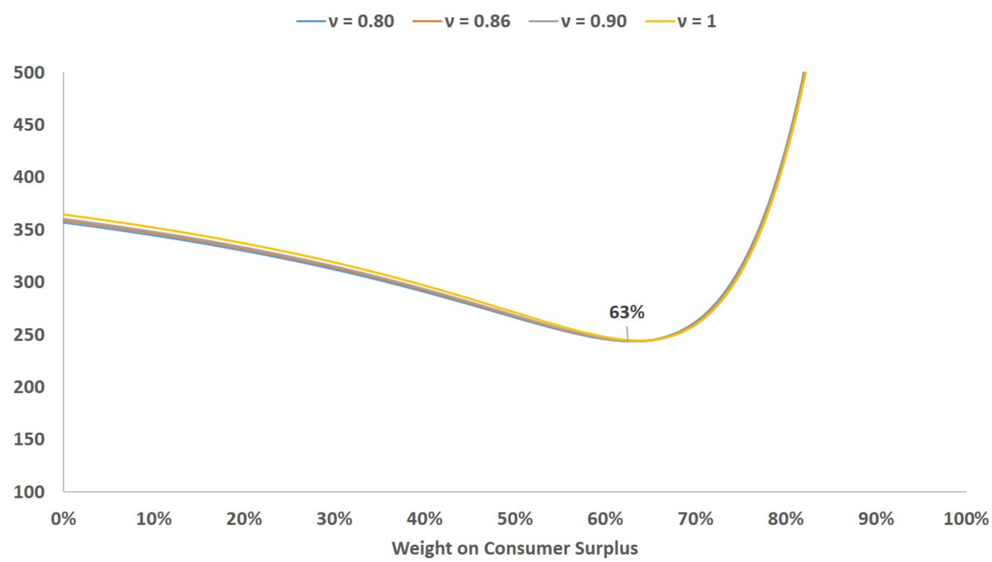
Notes: Table shows regression results that compare the fit of alternative public firm objectives to the fit of profit maximization. In all regressions, the dependent variable is DSE as defined in equation (15). A negative (positive) estimate means the alternative objective fits better (worse) than profit maximization. Specifications (1) and (2) compare the best-fitting objective from family (10a) with profit maximization, specifications (3) and (4) compare the best-fitting objective from family (10b) with profit maximization, specifications (5) and (6) compare the best-fitting objective from family (10c) with profit maximization, and specifications (7) and (8) compare the best-fitting objective from family (10d) with profit maximization.

sumption that the ACA risk adjustment formula accurately captures selection. First, I vary the expected percentage ν of collected premiums that is spent on claims from 80% (the MLR limit) to 100%. Figure 8a indicates that this parameter has minimal impact on the RMSE. Second, I allow the private firms to manipulate their coding of patients by increasing and decreasing their risk scores by up to 20%; risk scores for the public firm are held fixed. Figure 8b indicates that upcoding has some impact on the results, but the qualitative conclusion that the public firm places more weight on consumer surplus than market profit remains unaffected. If ACA risk scores overstate true risk by 20%, the best-fitting objective places 53.5% weight on consumer surplus and 46.5% weight on market profit. If ACA risk scores understate true risk by 20%, the best-fitting objective places 68% weight on consumer surplus and 32% weight on market profit.

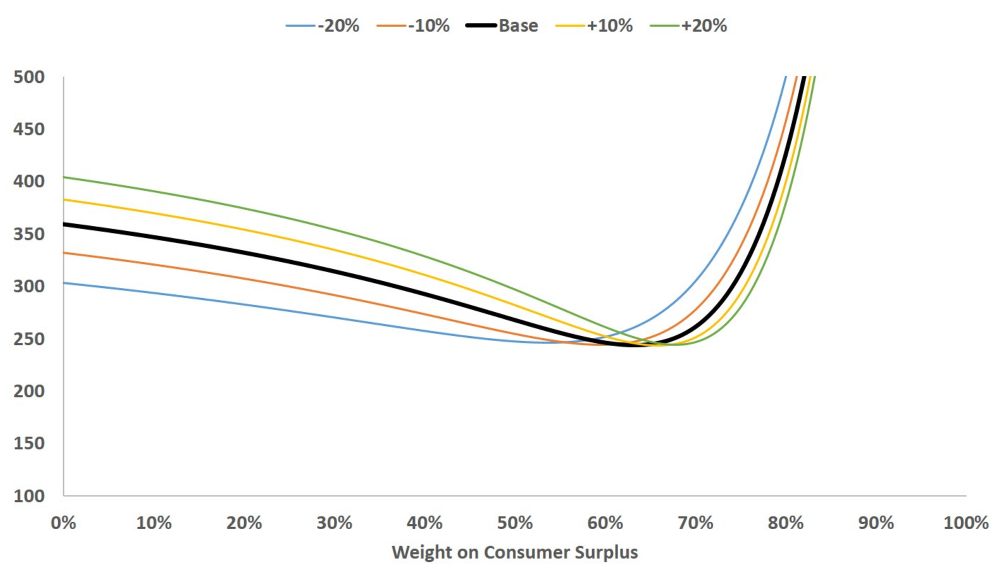
4 Impact of Adding a Public Option

In this section, I use the best fitting model from Section 3 ($MW(\mathbf{p}_t, 0.63)$) to simulate the impact of adding a public option. Several key stories emerge from my simulations: (1) adding a public option decreases premiums and increases enrollment, although there is substantial heterogeneity in the magnitude of the change across markets; (2) African American, Hispanic, and low-income consumers benefit most from the addition of a public option; (3) adding a public option can improve

Figure 8: Robustness of Risk Adjustment Assumption



(a) Sensitivity of Results to Amount Transferred



(b) Sensitivity of Results to Risk Score Upcoding

Notes: Figure shows the robustness of the model fit to the assumption that risk adjustment accurately captures adverse selection. Both panels show how well each model predicts observed average claims in terms of the root means square (RMSE) for objective family (10a). Panel (a) shows the robustness of the model fit to the amount of risk adjustment transferred between firms (i.e., the parameter ν in equation 8). The value of ν was 1 through 2017 and 0.86 after 2017. Panel (b) shows the robustness of the model fit to risk score upcoding. I compare the Base case to alternative settings where the true risk score relative to the public option is 20% lower (-20%), 10% lower (-10%), 10% higher (+10%), and 20% higher (+20%).

social welfare in certain markets, whereas an important policy alternative – enhancing premium subsidies – unambiguously reduces social welfare.

The first subsection explains my simulation methodology, the second subsection summarizes my results, and the third subsection compares the welfare and policy implications of adding a public option to the impact of enhancing premium subsidies. Throughout this section, I assume the public option has the same design features as it currently exists in Los Angeles and Santa Clara Counties.

4.1 Simulation Methodology

I simulate the impact of adding a public option in five markets: Alameda County (rating area 6), Monterey, San Benito, and Santa Cruz Counties (rating area 9), Kern County (rating area 14), Orange County (rating area 18), and San Diego County (rating area 19). These markets are diverse in their consumer demographic distribution and levels of firm competition. Rating area 9 presents an interesting case because a public option was added in San Benito in 2020 and Monterey in 2021.

To simulate the impact of adding a public option in a local market, I perform the following steps: (1) I add four plans (bronze, silver, gold, and platinum) to each consumer's choice set that have the same plan characteristics as the public option plans available in LA and Santa Clara Counties; (2) I allow a multiproduct public firm to set the premiums of the four plans to maximize the objective $MW(\mathbf{p}_t, 0.63)$; and (3) I solve for the new vector of premiums that satisfies the private firms' first-order conditions in equation (9) and the public firm's first-order condition in equation (12a).

Correctly simulating ACA risk adjustment in counterfactuals poses a significant computational challenge. The state-level risk adjustment program creates a dependency between local markets. Solving for the new vector of premiums in all 19 markets simultaneously is computationally infeasible because there are as many as 40 plans per market. To address this challenge, Saltzman (2021) endogenizes risk adjustment at the state level, but reduces the number of premium variables by assuming the ratios of plan premiums across local markets remain fixed. Tebaldi (2022) simulates each local market separately and allows plan premiums to vary without restriction, but holds risk adjustment fixed in counterfactual simulations. I develop a computationally feasible method that endogenizes risk adjustment and allows local market premiums to vary without restriction. The key insight for the method is that risk adjustment transfers in a local market m depend on consumer choices in other markets, but consumer choices in other markets do not respond to premium changes in market m. Mathematically, the partial derivative $\frac{\partial q_{knt}(\mathbf{p}_t)}{\partial p_{jmt}} = 0$ because plan k's demand in market n does not respond to plan j's premium in market m. Using this fact, I only need to hold in memory consumer choices in other markets when simulating a change in market m. Appendix A provides complete mathematical details on this approach.

For each simulation, I compute several outcome measures of the new equilibrium, including average premiums, enrollment, and social welfare. Net social welfare in year t is

$$SW_t \quad = \quad CS_t + \pi_t - \delta GS_t$$

where CS_t is consumer surplus, π_t is profit earned by the private firms, and GS_t is net government spending adjusted by the deadweight loss of taxation δ that results from distortions in prices and consumer behavior. The deadweight loss of taxation corresponds to the additional compensation consumers need in order to obtain their original utility levels (i.e., before government spending) at the distorted prices (Hausman and Poterba, 1987). Following Hausman and Poterba (1987) and Decarolis et al. (2020), I set $\delta = 1.3$.

A shortcoming of logit discrete choice models is that they overestimate consumers' taste for variety, particularly if there are many products in the market (Petrin, 2002; Ackerberg and Rysman, 2005). To address this issue, I compute two measures of consumer surplus. The first measure is

$$CS_t^{UB} \quad = \quad -\sum_{i \in I} \frac{1}{\beta_i^p} \ln \left(\sum_{j \in J} \exp\left(V_{ijt}(p;\boldsymbol{\beta}_t)/\lambda\right)^{\lambda} + \exp\left(\beta_{it}^p \rho_{it}\right) \right) + \sum_{j \in J} \left[q_{ijt}(p) * \frac{\beta_{ij}^y * y_{ij(t-1)}}{\beta_i^p} \right] \quad (16)$$

where the first term of equation (16) is the standard nested logit formula for consumer surplus and the second term "corrects" the first term to remove gains in welfare that result from inertia. I refer to this measure as the "upper bound" because of the logit model's tendency to overestimate consumers' taste for variety. A conservative lower bound measure of consumer surplus is

$$CS_t^{LB} \quad = \quad -\sum_{i \in I} \frac{1}{\beta_i^p} \ln \left(\sum_{j \in J_{\text{priv}}} \exp\left(V_{ijt}(p;\boldsymbol{\beta}_t)/\lambda\right)^{\lambda} + \exp\left(\beta_{it}^p \rho_{it}\right) \right) + \sum_{j \in J_{\text{priv}}} \left[q_{ijt}(p) * \frac{\beta_{ij}^y * y_{ij(t-1)}}{\beta_i^p} \right] (17)$$

where J_{priv} is the set of plans sold only by the private firms. This lower bound measure assumes consumers obtain zero utility from purchasing the public option's plans. The public option may indirectly increase consumer utility by decreasing private firm premiums.

Net government spending GS_t is calculated as

$$GS_t \quad = \quad PS_t + CSR_t + UC_t - PEN_t - \pi_t^{PUB} \quad (18)$$

where PS_t is spending on premiums subsidies, CSR_t is spending on CSRs, UC_t is uncompensated care for the uninsured, PEN_t is revenue collected from the individual mandate penalty, and π_t^{PUB} is profit earned by the public option. The overwhelming majority of government spending in equation (18) is premium subsidy spending, which is calculated as the sum of subsidies received by each consumer in equation (2). Spending on CSRs is computed as

$$CSR_t = \sum_{i \in I, j \in J} s_j^g q_{ijt}(p) c_{jmt}(p)$$

where s_j^g is the expected share of claims paid by the government for plan j.[14] I calculate spending on uncompensated care by multiplying the number of uninsured that I estimate in each scenario by \$2,025, the estimated annual uncompensated care cost per uninsured[15], and a factor accounting for the change in the uninsured population's risk score. Penalty revenue collected by the government equals $\sum_{i \in I} q_{i0t} \rho_{it}$, where q_{i0t} is the household's probability of choosing the outside option. Finally, I include any operating gains or losses incurred by the public option in government spending. I do not include any one-time entry costs that the public option may incur.

4.2 Results

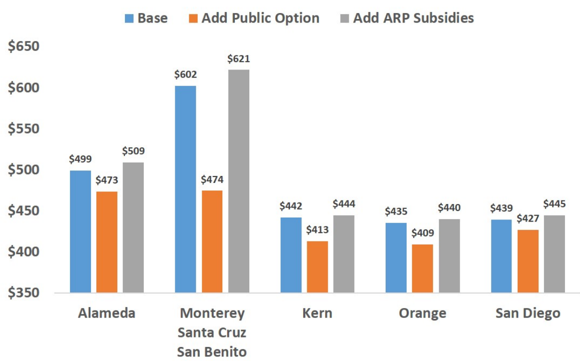
Figure 9 summarizes the impact of adding a public option on premiums and enrollment. Adding a public option reduces premiums and increases enrollment, although the magnitude of the changes varies considerably across markets. Average subsidized premiums decline by only 2.7% in San Diego County and by 21.2% in Monterey, San Benito, and Santa Cruz Counties. Average subsidized premiums also decline in all markets. Changes in enrollment are consistent with the premium changes. The percentage of consumers enrolled in the exchange increases by 6.3 percentage points in Monterey, San Benito, and Santa Cruz Counties, but by only 1.9 percentage points in Orange County. Across the five markets, the public firm captures 11.9% market share. The private plans retain significant market share and remain viable in the presence of a public option.

In Figure 10, I summarize the welfare impact of adding a public option. In all markets, adding a public option reduces annual per-capita profit earned by the private firms, as expected. Profit decreases by less than 20% in four of the five markets and by only 5.2% in San Diego County, making it unlikely that adding a public option would lead to a mass private firm exodus. In contrast, profit falls by 48.5% in Monterey, Santa Cruz, and San Benito Counties where in the Base case, profit was nearly double the profit earned in the other markets. Annual per-capita profit remains

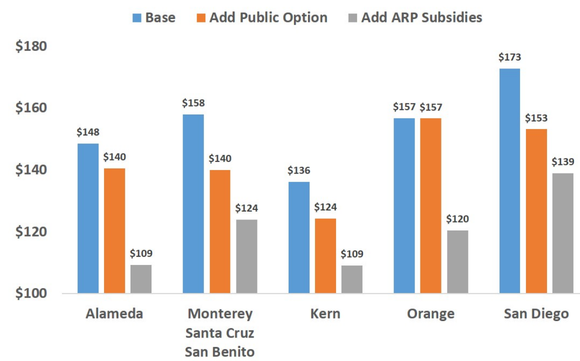
[14] Ignoring moral hazard, the government's expected outlay is $94 - 70 = 24\%$ of claims for the 94% CSR plan, $87 - 70 = 17\%$ of claims for the 87% CSR plan, and $73 - 70 = 3\%$ of claims for the 73% CSR plan. To account for moral hazard, I follow Pope et al. (2014) and assume there is no moral hazard for consumers in the 73% plan, while consumers in the 87% and 94% plans increase consumption by 12%. Including moral hazard, the $s_j^g = 26.88\%$ for the 94% CSR plan, $s_j^g = 19.04\%$ for the 87% CSR plan, and $s_j^g = 3\%$ for the 73% CSR plan.

[15] I multiply the per-capita amount of medical costs that are paid on behalf of the nonelderly uninsured as estimated by Coughlin et al. (2014) by an inflation factor using data from the National Health Expenditure Accounts to adjust the estimates to the time frame of this study (Centers for Medicare and Medicaid Services, 2018).

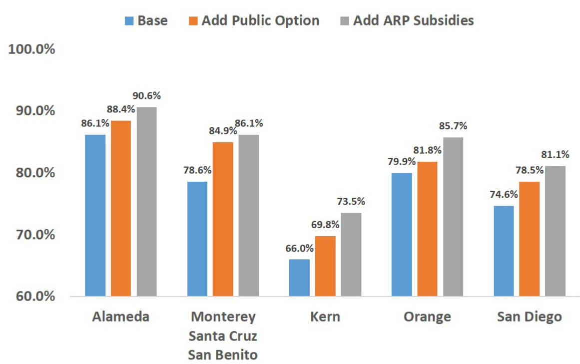
Figure 9: Impact of Adding the Public Option and ARP Subsidies on Premiums and Enrollment



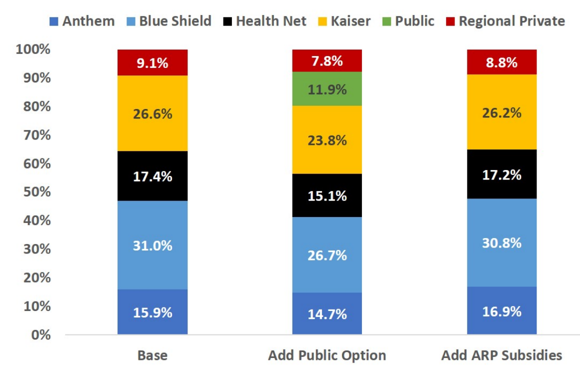
(a) Average Unsubsidized Premiums



(b) Average Subsidized Premiums



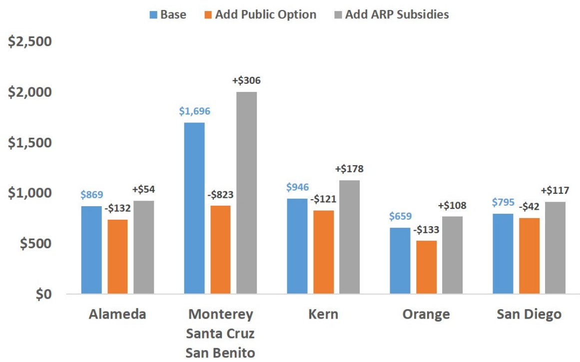
(c) % of Consumers Enrolled in Exchange



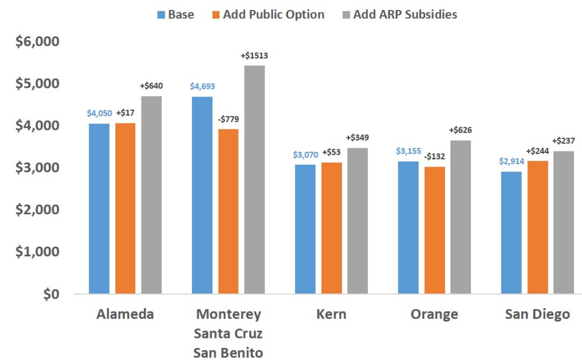
(d) Firm Market Share

Notes: Figure shows the impact of adding a public option and replacing original ACA premium subsidies with enhanced ARP premium subsidies on average unsubsidized premiums (panel a), average subsidized premiums (panel b), the percentage of consumers enrolled in the exchange (panel c), and firm market share (panel d). The effects of these policy changes are shown for five markets without a public option in the ACA/Base scenario: Alameda County (rating area 6), Monterey, Santa Cruz, and San Benito Counties (rating area 9), Kern County (rating area 14), Orange County (rating area 18), and San Diego County (rating area 19). Average premiums in panels (a) and (b) are computed using enrollee plan shares as weights. Firm market shares in panel (d) is across the five rating areas.

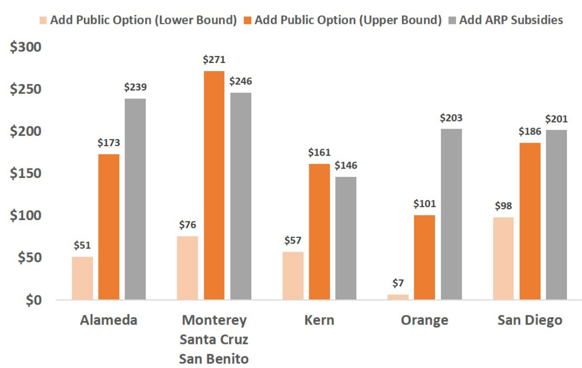
Figure 10: Impact of Adding the Public Option and ARP Subsidies on Social Welfare



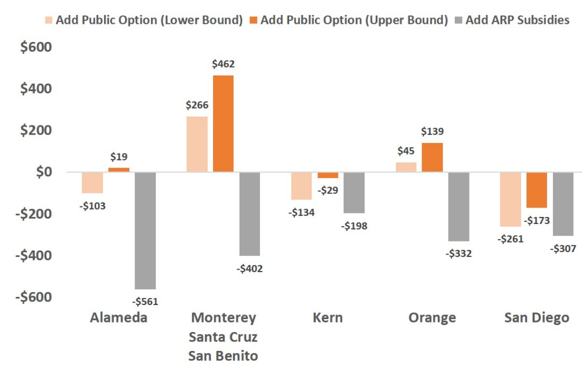
(a) Annual Per-Capita Profit



(b) Annual Per-Capita Net Government Spending



(c) Change in Annual Per-Capita Consumer Surplus



(d) Change in Annual Per-Capita Social Welfare

Notes: Figure shows the impact of adding a public option and replacing original ACA premium subsidies with enhanced ARP premium subsidies on annual per-capita profit (panel a), annual per-capita government spending (panel b), the change in annual per-capita consumer surplus relative to the Base scenario (panel c), and the change in annual per-capita social welfare relative to the Base scenario (panel d). The effects of these policy changes are shown for five markets without a public option in the ACA/Base scenario: Alameda County (rating area 6), Monterey, Santa Cruz, and San Benito Counties (rating area 9), Kern County (rating area 14), Orange County (rating area 18), and San Diego County (rating area 19). Panels (c) and (d) report changes rather than levels because absolute consumer surplus levels are not identified. In panels (c) and (d), the scenario "Add Public Option (Lower Bound)" uses equation (17) to compute consumer surplus and the scenario "Add Public Option (Upper Bound)" uses equation (16) to compute consumer surplus.

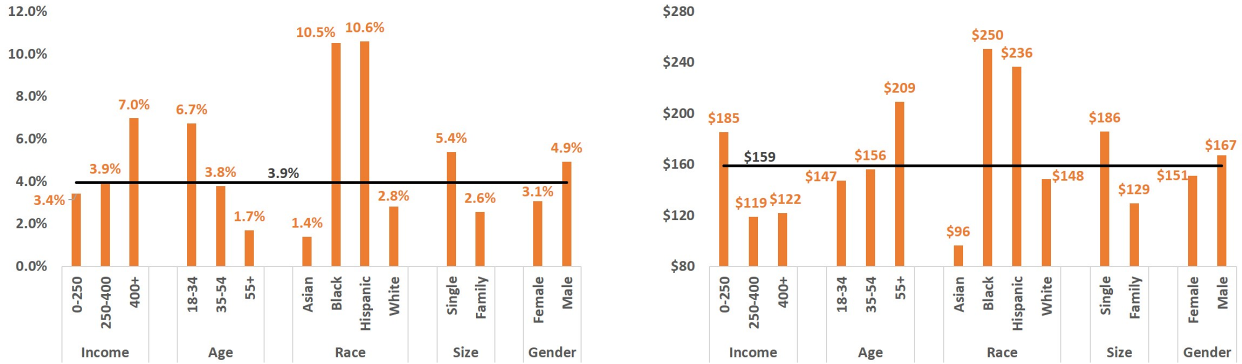
highest in Monterey, Santa Cruz, and San Benito Counties even with a public option. The impact of the public option on net government spending is mixed, depending on reductions in premium subsidy spending (because of lower premiums) and operating losses incurred by the public option. Annual per-capita net government spending falls by $779 in Monterey, Santa Cruz, and San Benito Counties because the reductions in premium subsidy spending dominate. Conversely, operating losses incurred by the public option dominate in San Diego County, resulting in annual per-capita net government spending increasing by $244. Adding a public option enhances consumer surplus. The upper bound measure of annual per-capita consumer surplus gain exceeds $100 in all five markets and the lower bound measure of annual per-capita consumer surplus gain exceeds $50 in four of the five markets. Annual per-capita consumer surplus gains are largest in Monterey, Santa Cruz, and San Benito Counties ($76-$271) and smallest in Orange County ($7-$101). The net effect of adding a public option on social welfare varies considerably by market. Annual per-capita social welfare increases $266 to $462 in Monterey, Santa Cruz, and San Benito Counties, but decreases $173 to $261 in San Diego County. Changes in annual per-capita social welfare are smaller in Alameda, Kern, and Orange Counties.

Figure 11 shows the distributional impact of adding a public option on enrollment and consumer surplus. The African American and Hispanic communities are the clear winners of adding a public option. African American enrollment increases 10.5% and Hispanic enrollment increases 10.6%. Annual per-capita consumer surplus increases $250 for African American consumers and $236 for Hispanic consumers. For consumers earning less than 250% of FPL, annual per-capita consumer surplus increases by $185 because of reduced subsidized premiums. Other demographics with relatively large gains in consumer surplus are consumers over age 55 and single consumers.

4.3 Comparing Policy Approaches

Increasing premium subsidies is an alternative policy approach used in the ARP for expanding coverage and increasing affordability. There are numerous ways to compare the two policy approaches, such as requiring net government spending to be the same or the same enrollment be achieved for both approaches. Each approach has numerous design options; the public option could adopt different objectives or provider reimbursement rates and premium subsidies could be better targeted towards certain groups (Tebaldi, 2022; Polyakova and Ryan, 2021). To avoid these complexities and gain insight into the relative welfare and policy implications of each approach, I compare two real-world policies: (1) the public option as it exists in Los Angeles and Santa Clara Counties and (2) enhanced subsidies under the ARP. I simulate ARP subsidies by (1) replacing the income-based

Figure 11: Distributional Impact of Adding the Public Option



(a) % Change in Total Exchange Enrollment (b) Change in Annual Per-Capita Consumer Surplus

Notes: Figure shows the distributional impact of adding a public option on the percentage change in the number of consumers enrolled (panel a) and the change in consumer surplus (panel b). The effects of adding a public option are summarized across five markets: Alameda County (rating area 6), Monterey, Santa Cruz, and San Benito Counties (rating area 9), Kern County (rating area 14), Orange County (rating area 18), and San Diego County (rating area 19). The distributional impacts are shown by income (as a percentage of FPL), age, race, family size, and gender. Consumer surplus is calculated using equation (16). The thick black lines indicate the average percentage change (3.9%) and average consumer surplus change ($159) in panels (a) and (b), respectively.

contribution caps in the first column of Table 2 with the ones in the second column and (2) solving for the new vector of premiums that satisfies the firms' first-order conditions.

Figure 9 summarizes the results. In contrast to adding a public option which increases supply, increasing premium subsidies under the ARP increases unsubsidized premiums because it increases demand. Average unsubsidized premiums increase 0.5% to 3.2% across the five markets. In contrast, average subsidized premiums decrease 19.6% to 26.4% across the five markets, substantially larger than the decrease from adding a public option. The percentage of consumers enrolled in the exchange increases by 4.4 to 7.5 percentage points across the five markets. Overall, enhancing premiums has a much less heterogeneous impact across markets than adding a public option.

Whereas adding a public option decreases firm profit, enhancing premiums subsidies increases firm profit. In four of the five markets, annual per-capita profit increases 15% to 20%. Consumers also benefit from enhanced premium subsidies. Annual per-capita consumer surplus increases more than $200 in four of the five markets. The gains in consumer and producer surplus are more than offset by increased spending on premium subsidies. Annual per-capita social welfare decreases in all five markets, ranging from a $198 decrease in Kern County to a $561 decrease in Alameda County. In all markets, the social welfare change from adding a public option is more beneficial than the welfare change from enhancing premium subsidies. These welfare calculations do not account for any one-time entry costs for the public option, such as setting up a provider network. They also do not reflect the cost of setting up and administering an income verification system for determining premium subsidy eligibility and levels.

5 Alternative Designs of the Public Option

In this section, I evaluate alternative designs of the public option on two dimensions: (1) the weight ω that the public firm places on consumer surplus in its objective function $MW(\mathbf{p}_t, \omega)$ and (2) the percentage of claims that the public firm reimburses providers. I simulate alternative objectives by solving for the new vector of premiums that satisfies the private firms' equilibrium conditions in equation (9) and the public firm's equilibrium condition in equation (12a) with weights $\omega = 0\%$ (profit maximization) and $\omega = 75\%$.[16] Figure 12 indicates that the firm's objective has the expected impact on equilibrium premiums. Decreasing the weight ω on consumer surplus from 63% to 0% increases average unsubsidized premiums by 2.1%, whereas increasing ω from 63% to 75% decreases average unsubsidized premiums by 4.5%. The percentage of consumers enrolled in the exchange remains unchanged when ω is reduced to 0%, but increases by 1.4 percentage points when ω is increased to 75%. Annual per-capita net government spending increases by \$112 when ω is reduced to 0% because the government spends more on premium subsidies when premiums rise. When ω is increased to 75%, annual per-capita net government spending increases by \$215 due to losses incurred by the public firm. Overall, annual per-capita social welfare is highest in the Base case when the public firm puts 63% weight on consumer surplus.[17]

The public option as it currently exists in LA and Santa Clara Counties has little apparent advantage over the private firms to negotiate lower reimbursement rates. Some advocates of the public option have suggested it can negotiate lower, "Medicare-like" reimbursement rates. The previous literature has generally found that Medicare reimbursement is approximately between 45% and 85% of private firm reimbursement (Lopez et al., 2020; Cooper et al., 2019; White and Whaley, 2019; Selden, 2020; Pelech, 2018; Ginsburg, 2010). I simulate reduced provider reimbursement rates by first multiplying the public firm's claims by 50% or 80% and then solving for the new vector of premiums that satisfies the firms' equilibrium conditions. Reducing the public option's reimbursement

[16] I choose 75% instead of 100% (pure consumer surplus maximization) because there is no budget constraint in the model and high values of ω can lead to economically nonsensical results (e.g., negative premiums).

[17] Note that the public firm operates at the local level and its objective does not include federal expenditures (e.g., premium subsidy spending). Hence, it is not obvious that the weight $\omega = 50\%$ would generate the highest net social welfare.

level has a substantial impact on the equilibrium. Average subsidized premiums fall by 2.8% when reimbursement is reduced to 80% and by 10.1% when reimbursement is reduced to 50%. These premium reductions are significantly lower than the reductions in reimbursement levels, indicating that the public firm has limited ability to exert pressure on the private firms. The percentage of consumers enrolled in the exchange increases by 1.2 percentage points when reimbursement is reduced to 80% and by 3.9 percentage points when reimbursement is reduced to 50%. To compute social welfare, I include unreimbursed claims as a cost to the government (that would likely be paid through provider tax write-offs or disproportionate share payments as is done for Medicare).[18] Annual per-capita net government spending including the cost of unreimbursed claims increases by $189 when reimbursement is reduced to 80% and by $666 when reimbursement is reduced to 50%. Annual per-capita social welfare decreases by $227 when reimbursement is reduced to 80% and by $788 when reimbursement is reduced to 50%. Therefore, lower reimbursement rates benefit consumers through lower premiums, but the cost to taxpayers more than offsets these welfare gains.

6 Conclusion

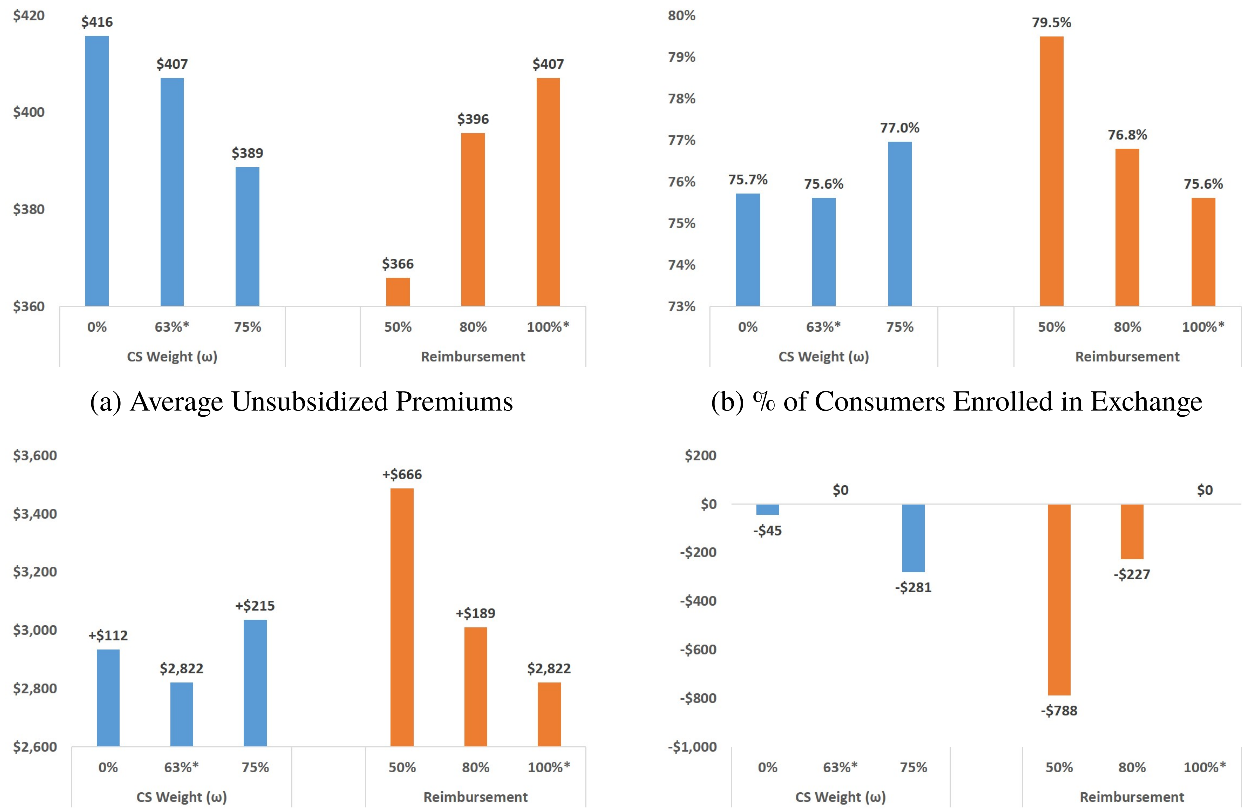
Governments often have to decide if and how to intervene in markets that are perceived to undersupply a socially consequential good or service such as health insurance. I study the equilibrium and social welfare implications of one such intervention: introducing a public option that competes with private firms. I estimate a mixed oligopoly model with alternative objectives using data from the California ACA exchange, where approximately one-third of consumers in three different counties had access to a public option. In the best-fitting mixed oligopoly model, the public option places 63% weight on consumer surplus and 37% weight on producer surplus. I also find consumers from disadvantaged subpopulations have stronger preferences for the public option.

I use my best-fitting model to simulate the impact of adding a public option to five different markets in the California ACA exchange. I find a public option reduces premiums by up to 21.2%, improves social welfare in rural markets with more limited competition, and increases consumer surplus most for disadvantaged subpopulations. Adding a public option compares favorably with a prominent alternative intervention, enhancing premium subsidies. I find enhancing subsidies under the ARP increases (unsubsidized) premiums by shifting the demand curve to the right and reduces social welfare in all markets. Finally, my simulations indicate the impact of the public option is quite sensitive to its design.

My analysis has several limitations. The model does not endogenize firm entry or exit. In

[18] Unreimbursed claims are likely to have many general equilibrium impacts that are beyond the scope of this paper.

Figure 12: Impact of Public Option Design on Premiums, Enrollment, and Welfare



(a) Average Unsubsidized Premiums

(b) % of Consumers Enrolled in Exchange

(c) Annual Per-Capita Net Government Spending

(d) Change in Annual Per-Capita Social Welfare

Notes: Figure shows the impact of public option design on average unsubsidized premiums (panel a), the percentage of consumers enrolled in the exchange (panel b), annual per-capita net government spending (panel c), and the change in annual per-capita social welfare (panel d). I simulate the effect of changing the weight on consumers surplus in the public firm's objective from $\omega = 63\%$ in the base case to $\omega = 0\%$ (profit maximization) and $\omega = 75\%$. I also simulate the effect of changing the provider reimbursement rate from 100% in the base case to 50% and 80%.

four of the five markets I simulate, firm profit falls by less than 20% when adding a public option, making it unlikely that private firms would exit because of a public option. For the most part, firm exits are minimal in the California exchange and one firm (Oscar) even entered Los Angeles County where the public option was present. Anthem exited most California markets in 2018, but one of the three it remained in was Santa Clara County. The model also does not endogenize the formation of provider networks as considered in Gowrisankaran et al. (2015); Ho et al. (2017); Ho and Lee (2019); Ghili (2022); Shepard (2022). Endogenizing formation of the public option's provider network would be a fruitful extension of my work. I also do not model forward-looking behavior. The public option may have a longer time horizon and be willing to sustain short-run losses. Modeling forward-looking behavior in health insurance markets is particularly challenging and would require significant compromises on key institutional details (Fleitas, 2017; Miller, 2019) given existing empirical approaches (e.g., Aguirregabiria and Mira (2007); Bajari et al. (2007)).

My study has important policy implications. Introducing a public option that competes with private firms can be an effective intervention in rural markets with limited competition. The public option may also be an important vehicle for expanding access to health care in disadvantaged subpopulations. Adding a public option compares favorably to enhancing subsidies for purchasing plans from private firms, a leading alternative intervention that was adopted in the ARP. When ARP subsidies come up for renewal in 2025, policymakers should consider whether an alternative approach such as a public option would be a more efficient use of taxpayer funds. The empirical framework advanced in this paper can illuminate the tradeoffs involved with alternative intervention approaches.

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ELECTRONIC APPENDICES – NOT FOR PRINT PUBLICATION

A Mathematical Formulas in the Model

This appendix details all of the model formulas. In the "Risk Adjustment" section below, I detail how I endogenize risk adjustment and allow local market premiums to vary without restriction.

Demand:

The (k, j) element of the Jacobian matrix of the household choice probability in equation (4) is

$$\frac{\partial q_{ikt}(\mathbf{p}_t)}{\partial p_{ijt}} = \begin{cases} \beta_i^p q_{ijt}(\mathbf{p}_t)\left[\frac{1}{\lambda} + \frac{\lambda-1}{\lambda} q'_{ijt}(\mathbf{p}_t) - q_{ijt}(\mathbf{p}_t)\right] & k = j \\ \beta_i^p q_{ijt}(\mathbf{p}_t)\left[\frac{\lambda-1}{\lambda} q'_{ikt}(\mathbf{p}_t) - q_{ikt}(\mathbf{p}_t)\right] & k \neq j \end{cases} \tag{19}$$

where $q'_{ijt}(\mathbf{p}_t)$ is the probability of choosing j, conditional on choosing a plan. Household i's demand partial derivative with respect to the firm's base plan premium p_{jmt} is

$$\frac{\partial q_{ikt}(\mathbf{p}_t)}{\partial p_{jmt}} = \sum_{l \in J_{mt}} \frac{\partial q_{ikt}(\mathbf{p}_t)}{\partial p_{ilt}(\mathbf{p}_t)} \frac{\partial p_{ilt}(\mathbf{p}_t)}{\partial p_{jmt}}$$

where $\frac{\partial p_{ilt}(\mathbf{p}_t)}{\partial p_{jmt}}$ is given in equation (6). Total plan demand $q_{jmt}(\mathbf{p}_t) = \sum_{i \in I} (\mathbb{I}_{i,m,t})\, q_{ijt}(\mathbf{p}_t)$ and firm demand $q_{ft}(\mathbf{p}_t) = \sum_{k \in J_f} q_{kmt}(\mathbf{p}_t)$. The plan and firm demand partial derivatives are

$$\frac{\partial q_{kmt}(\mathbf{p}_t)}{\partial p_{jmt}} = \sum_{i \in I} (\mathbb{I}_{i,m,t}) \frac{\partial q_{ikt}(\mathbf{p}_t)}{\partial p_{jmt}}$$

$$\frac{\partial q_{ft}(\mathbf{p}_t)}{\partial p_{jmt}} = \sum_{k \in J_{ft}} \frac{\partial q_{kmt}(\mathbf{p}_t)}{\partial p_{jmt}}$$

Risk Scores:

The (k, j)-element of the Jacobian matrix of the plan risk score in equation (3) equals

$$\frac{\partial r_{kmt}(\mathbf{p}_t)}{\partial p_{jmt}} = \frac{r_{kmt}(\mathbf{p}_t)}{q_{kmt}(\mathbf{p}_t)} \sum_{d \in D} \gamma^d \left[\frac{\partial q_{dkmt}(\mathbf{p}_t)}{\partial p_{jmt}} - s_{dkmt}(\mathbf{p}_t) \frac{\partial q_{kmt}(\mathbf{p}_t)}{\partial p_{jmt}}\right] \tag{20}$$

Age Rating Factors:

The average plan age rating factor and the (k, j)-element of its Jacobian matrix are

$$a_{jmt}(\mathbf{p}_t) = \frac{\sum_{i \in I} (\mathbb{I}_{i,m,t})\, a_{it} q_{ijt}(\mathbf{p}_t)}{q_{jmt}(\mathbf{p}_t)}$$

$$\frac{\partial a_{kmt}(\mathbf{p}_t)}{\partial p_{jmt}} = (q_{kmt}(\mathbf{p}_t))^{-1} \left[\sum_{i \in I} (\mathbb{I}_{i,m,t})\, a_{it} \frac{\partial q_{ikt}(\mathbf{p}_t)}{\partial p_{jmt}} - a_{kmt}(\mathbf{p}_t) \frac{\partial q_{kmt}(\mathbf{p}_t)}{\partial p_{jmt}}\right]$$

Revenue:

Total premium revenue earned by the firm and its partial derivative are

$$R_{ft}(\mathbf{p}_t) = \sum_{i\in I,m\in M,k\in J_{fmt}} \mathbb{I}_{i,m,t}\sigma_{it}p_{kmt}q_{ikt}(\mathbf{p}_t)$$

$$\frac{\partial R_{ft}(\mathbf{p}_t)}{\partial p_{jmt}} = \sum_{i\in I,k\in J_{fmt}} \mathbb{I}_{i,m,t}\sigma_{it}\left(q_{ijt}(\mathbf{p}_t) \ + p_{kmt}\frac{\partial q_{ikt}(\mathbf{p}_t)}{\partial p_{jmt}}\right) \tag{21}$$

Total market revenue and its partial derivative are

$$R_{mt}(\mathbf{p}_t) = \sum_{i\in I,f\in F,k\in J_{fmt}} \mathbb{I}_{i,m,t}\sigma_{it}p_{kmt}q_{ikt}(\mathbf{p}_t)$$

$$\frac{\partial R_{mt}(\mathbf{p}_t)}{\partial p_{jmt}} = \sum_{i\in I,f\in F,k\in J_{fmt}} \mathbb{I}_{i,m,t}\sigma_{it}\left(q_{ijt}(\mathbf{p}_t) \ + p_{kmt}\frac{\partial q_{ikt}(\mathbf{p}_t)}{\partial p_{jmt}}\right) \tag{22}$$

Claims:

Average claims and the (k, j)-element of its Jacobian are

$$\begin{aligned} c_{jmt}(\mathbf{p}_t) = \widehat{c}_{jmt}(\mathbf{p}_t) + \zeta_{jmt} &= \left(\frac{\widehat{h}_{jmt}(\mathbf{p}_t)}{\sum_{n\in M,l\in J_{nt}}\widehat{h}_{lnt}(\mathbf{p}_t)q_{lnt}(\mathbf{p}_t)}\right)\nu R_t(\mathbf{p}_t) + \zeta_{jmt} \\ &= \nu CF_{jmt}(\mathbf{p}_t)R_t(\mathbf{p}_t) + \zeta_{jmt} \end{aligned}$$

$$\frac{\partial c_{kmt}(\mathbf{p}_t)}{\partial p_{jmt}} = \nu\left[CF_{kmt}(\mathbf{p}_t)\frac{\partial R_t(\mathbf{p}_t)}{\partial p_{jmt}} + R_t(\mathbf{p}_t)\left(\frac{\partial CF_{kmt}(\mathbf{p}_t)}{\partial p_{jmt}}\right)\right] \tag{23}$$

where $\frac{\partial R_t(\mathbf{p}_t)}{\partial p_{jmt}} = \sum_{f\in F}\frac{\partial R_{ft}(\mathbf{p}_t)}{\partial p_{jmt}}$, $CF_{jmt}(\mathbf{p}_t) \equiv \left(\frac{\widehat{h}_{jmt}(\mathbf{p}_t)}{\sum_{n\in M,l\in J_{nt}}\widehat{h}_{lnt}(\mathbf{p}_t)q_{lnt}(\mathbf{p}_t)}\right)$, and

$$\begin{aligned} \frac{\partial CF_{kmt}(\mathbf{p}_t)}{\partial p_{jmt}} &= \left(\sum_{n\in M,l\in J_{nt}}\widehat{h}_{lnt}(\mathbf{p}_t)q_{lnt}(\mathbf{p}_t)\right)^{-1}\left[\frac{\partial\widehat{h}_{kmt}(\mathbf{p}_t)}{\partial p_{jmt}}\right. \\ &\quad \left. - \ CF_{kmt}(\mathbf{p}_t)\sum_{l\in J_{mt}}\left(\widehat{h}_{lmt}(\mathbf{p}_t)\frac{\partial q_{lmt}(\mathbf{p}_t)}{\partial p_{jmt}} + q_{lmt}(\mathbf{p}_t)\frac{\partial\widehat{h}_{lmt}(\mathbf{p}_t)}{\partial p_{jmt}}\right)\right] \end{aligned}$$

$$\frac{\partial\widehat{h}_{kmt}(\mathbf{p}_t)}{\partial p_{jmt}} = \mathrm{IDF}_k\mathrm{GCF}_{mt}\frac{\partial r_{kmt}(\mathbf{p}_t)}{\partial p_{jmt}}$$

Total firm claims and its partial derivative are

$$C_{ft}(\mathbf{p}_t) = \sum_{m\in M,k\in J_{fmt}} c_{kmt}(\mathbf{p}_t)q_{kmt}(\mathbf{p}_t)$$

$$\frac{\partial C_{ft}(\mathbf{p}_t)}{\partial p_{jmt}} = \sum_{k\in J_{fmt}}\left[c_{kmt}(\mathbf{p}_t)\frac{\partial q_{kmt}(\mathbf{p}_t)}{\partial p_{jmt}} + q_{kmt}(\mathbf{p}_t)\frac{\partial c_{kmt}(\mathbf{p}_t)}{\partial p_{jmt}}\right] \tag{24}$$

Total market claims and its partial derivative are

$$C_{mt}(\mathbf{p}_t) = \sum_{f\in F,k\in J_{fmt}} c_{kmt}(\mathbf{p}_t)q_{kmt}(\mathbf{p}_t)$$
$$\frac{\partial C_{mt}(\mathbf{p}_t)}{\partial p_{jmt}} = \sum_{f\in F,k\in J_{fmt}} \left[c_{kmt}(\mathbf{p}_t)\frac{\partial q_{kmt}(\mathbf{p}_t)}{\partial p_{jmt}} + q_{kmt}(\mathbf{p}_t)\frac{\partial c_{kmt}(\mathbf{p}_t)}{\partial p_{jmt}}\right] \tag{25}$$

Risk Adjustment:

The firm's risk adjustment transfer and its partial derivative are

$$\begin{aligned} RA_{ft}(\mathbf{p}_t) &= \sum_{m\in M,k\in J_{fmt}} q_{kmt}\left[\widehat{c}_{kmt}(\mathbf{p}_t) - \widetilde{c}_{kmt}(\mathbf{p}_t)\right] \\ &= \sum_{m\in M,k\in J_{fmt}} \left(\frac{\widehat{h}_{kmt}(\mathbf{p}_t)q_{kmt}(\mathbf{p}_t)}{\sum_{n\in M,l\in J_{nt}}\widehat{h}_{lnt}(\mathbf{p}_t)q_{lnt}(\mathbf{p}_t)} - \frac{\widetilde{h}_{kmt}(\mathbf{p}_t)q_{kmt}(\mathbf{p}_t)}{\sum_{n\in M,l\in J_{nt}}\widetilde{h}_{lnt}(\mathbf{p}_t)q_{lnt}(\mathbf{p}_t)}\right)\nu R_t(\mathbf{p}_t) \\ &= \sum_{m\in M,k\in J_{fmt}} \left(rs_{kmt}(\mathbf{p}_t) - us_{kmt}(\mathbf{p}_t)\right)\nu R_t(\mathbf{p}_t) \end{aligned}$$

$$\begin{aligned} \frac{\partial RA_{ft}(\mathbf{p}_t)}{\partial p_{jmt}} &= \nu \sum_{k\in J_{fmt}} \left[\frac{\partial R_t(\mathbf{p}_t)}{\partial p_{jmt}}\left(rs_{kmt}(\mathbf{p}_t) - us_{kmt}(\mathbf{p}_t)\right)\right. \\ &\quad + \left. R_t(\mathbf{p}_t)\left(\frac{\partial rs_{kmt}(\mathbf{p}_t)}{\partial p_{jmt}} - \frac{\partial us_{kmt}(\mathbf{p}_t)}{\partial p_{jmt}}\right)\right] \end{aligned} \tag{26}$$

where

$$\begin{aligned} \frac{\partial rs_{kmt}(\mathbf{p}_t)}{\partial p_{jmt}} &= \left(\sum_{n\in M,l\in J_{nt}} \widehat{h}_{lnt}(\mathbf{p}_t)q_{lnt}(\mathbf{p}_t)\right)^{-1}\left[\left(\widehat{h}_{kmt}(\mathbf{p}_t)\frac{\partial q_{kmt}(\mathbf{p}_t)}{\partial p_{jmt}} + q_{kmt}(\mathbf{p}_t)\frac{\partial \widehat{h}_{kmt}(\mathbf{p}_t)}{\partial p_{jmt}}\right)\right. \\ &\quad - \left. rs_{kmt}(\mathbf{p}_t)\sum_{l\in J_{mt}}\left(\widehat{h}_{lmt}(\mathbf{p}_t)\frac{\partial q_{lmt}(\mathbf{p}_t)}{\partial p_{jmt}} + q_{lmt}(\mathbf{p}_t)\frac{\partial \widehat{h}_{lmt}(\mathbf{p}_t)}{\partial p_{jmt}}\right)\right] \\ \frac{\partial us_{kmt}(\mathbf{p}_t)}{\partial p_{jmt}} &= \left(\sum_{n\in M,l\in J_{nt}} \widetilde{h}_{lnt}(\mathbf{p}_t)q_{lnt}(\mathbf{p}_t)\right)^{-1}\left[\left(\widetilde{h}_{kmt}(\mathbf{p}_t)\frac{\partial q_{kmt}(\mathbf{p}_t)}{\partial p_{jmt}} + q_{kmt}(\mathbf{p}_t)\frac{\partial \widetilde{h}_{kmt}(\mathbf{p}_t)}{\partial p_{jmt}}\right)\right. \\ &\quad - \left. us_{kmt}(\mathbf{p}_t)\sum_{l\in J_{mt}}\left(\widetilde{h}_{lmt}(\mathbf{p}_t)\frac{\partial q_{lmt}(\mathbf{p}_t)}{\partial p_{jmt}} + q_{lmt}(\mathbf{p}_t)\frac{\partial \widetilde{h}_{lmt}(\mathbf{p}_t)}{\partial p_{jmt}}\right)\right] \end{aligned}$$

$$\frac{\partial \widetilde{h}_{kmt}(\mathbf{p}_t)}{\partial p_{jmt}} = \mathrm{AV}_k\mathrm{IDF}_k\mathrm{GCF}_{mt}\frac{\partial a_{kmt}(\mathbf{p}_t)}{\partial p_{jmt}}$$

The market risk adjustment transfer and its partial derivative are

$$
\begin{aligned}
RA_{mt}(\mathbf{p}_t) &= \sum_{k\in J_{mt}} q_{kmt}\left[\widehat{c}_{kmt}(\mathbf{p}_t)-\widetilde{c}_{kmt}(\mathbf{p}_t)\right]\\
&= \left(\frac{\sum_{k\in J_{mt}}\widehat{h}_{kmt}(\mathbf{p}_t)q_{kmt}(\mathbf{p}_t)}{\sum_{n\in M,l\in J_{nt}}\widehat{h}_{lnt}(\mathbf{p}_t)q_{lnt}(\mathbf{p}_t)}-\frac{\sum_{k\in J_{mt}}\widetilde{h}_{kmt}(\mathbf{p}_t)q_{kmt}(\mathbf{p}_t)}{\sum_{n\in M,l\in J_{nt}}\widetilde{h}_{lnt}(\mathbf{p}_t)q_{lnt}(\mathbf{p}_t)}\right)\nu R_t(\mathbf{p}_t)\\
&= \left(mrs_{kmt}(\mathbf{p}_t)-mus_{kmt}(\mathbf{p}_t)\right)\nu R_t(\mathbf{p}_t)
\end{aligned}
$$

$$
\begin{aligned}
\frac{\partial RA_{mt}(\mathbf{p}_t)}{\partial p_{jmt}} &= \nu\sum_{k\in J_{fmt}}\left[\frac{\partial R_t(\mathbf{p}_t)}{\partial p_{jmt}}\left(mrs_{kmt}(\mathbf{p}_t)-mus_{kmt}(\mathbf{p}_t)\right)\right.\\
&\quad\left.+\ R_t(\mathbf{p}_t)\left(\frac{\partial mrs_{kmt}(\mathbf{p}_t)}{\partial p_{jmt}}-\frac{\partial mus_{kmt}(\mathbf{p}_t)}{\partial p_{jmt}}\right)\right]
\end{aligned}
\tag{27}
$$

where

$$
\begin{aligned}
\frac{\partial mrs_{kmt}(\mathbf{p}_t)}{\partial p_{jmt}} &= \left(\sum_{n\in M,l\in J_{nt}}\widehat{h}_{lnt}(\mathbf{p}_t)q_{lnt}(\mathbf{p}_t)\right)^{-1}\left[\sum_{k\in J_{fmt}}\left(\widehat{h}_{kmt}(\mathbf{p}_t)\frac{\partial q_{kmt}(\mathbf{p}_t)}{\partial p_{jmt}}+q_{kmt}(\mathbf{p}_t)\frac{\partial\widehat{h}_{kmt}(\mathbf{p}_t)}{\partial p_{jmt}}\right)\right.\\
&\quad\left.-\ mrs_{kmt}(\mathbf{p}_t)\sum_{l\in J_{mt}}\left(\widehat{h}_{lmt}(\mathbf{p}_t)\frac{\partial q_{lmt}(\mathbf{p}_t)}{\partial p_{jmt}}+q_{lmt}(\mathbf{p}_t)\frac{\partial\widehat{h}_{lmt}(\mathbf{p}_t)}{\partial p_{jmt}}\right)\right]\\
\frac{\partial mus_{kmt}(\mathbf{p}_t)}{\partial p_{jmt}} &= \left(\sum_{n\in M,l\in J_{nt}}\widetilde{h}_{lnt}(\mathbf{p}_t)q_{lnt}(\mathbf{p}_t)\right)^{-1}\left[\sum_{k\in J_{fmt}}\left(\widetilde{h}_{kmt}(\mathbf{p}_t)\frac{\partial q_{kmt}(\mathbf{p}_t)}{\partial p_{jmt}}+q_{kmt}(\mathbf{p}_t)\frac{\partial\widetilde{h}_{kmt}(\mathbf{p}_t)}{\partial p_{jmt}}\right)\right.\\
&\quad\left.-\ mus_{kmt}(\mathbf{p}_t)\sum_{l\in J_{mt}}\left(\widetilde{h}_{lmt}(\mathbf{p}_t)\frac{\partial q_{lmt}(\mathbf{p}_t)}{\partial p_{jmt}}+q_{lmt}(\mathbf{p}_t)\frac{\partial\widetilde{h}_{lmt}(\mathbf{p}_t)}{\partial p_{jmt}}\right)\right]
\end{aligned}
$$

As discussed in Section 4, risk adjustment transfers in market m depend on consumer choices in other markets, but those choices do not depend on premiums in market m. Hence, it is only necessary to hold in memory consumer choices in other markets when simulating a change in market m. To see this, write the risk share $rs_{kmt}(\mathbf{p}_t)$ as

$$
\begin{aligned}
rs_{kmt}(\mathbf{p}_t) &\equiv \frac{\widehat{h}_{kmt}(\mathbf{p}_t)q_{kmt}(\mathbf{p}_t)}{\sum_{n\in M,l\in J_{nt}}\widehat{h}_{lnt}(\mathbf{p}_t)q_{lnt}(\mathbf{p}_t)}\\
&= \frac{\widehat{h}_{kmt}(\mathbf{p}_t)q_{kmt}(\mathbf{p}_t)}{\widehat{h}_{lmt}(\mathbf{p}_t)q_{lmt}(\mathbf{p}_t)+\sum_{n\in M,,n\neq m,l\in J_{nt}}\widehat{h}_{lnt}(\mathbf{p}_t)q_{lnt}(\mathbf{p}_t)}
\end{aligned}
\tag{28}
$$

The summation in the denominator of equation (28) depends on consumer choices in other markets, but neither the cost factor $\widehat{h}_{lnt}(\mathbf{p}_t)$ nor plan demand $q_{lnt}(\mathbf{p}_t)$ depend on premiums in market m. Hence, I only need to hold in memory the summation $\sum_{n\in M,,n\neq m,l\in J_{nt}}\widehat{h}_{lnt}(\mathbf{p}_t)q_{lnt}(\mathbf{p}_t)$ when simulating market m. The same reasoning applies for the utilization share $us_{kmt}(\mathbf{p}_t)$, the market risk share $mrs_{kmt}(\mathbf{p}_t)$, and the market utilization share $mus_{kmt}(\mathbf{p}_t)$.

Variable Administrative Cost:
Let v_{ft} be variable administrative cost per-member per-month. Firm variable administrative cost $V_{ft}(\mathbf{p}_t) = v_{ft} q_{ft}(\mathbf{p}_t)$ and its partial derivative is

$$\frac{\partial V_{ft}(\mathbf{p}_t)}{\partial p_{jmt}} = v_{ft} \frac{\partial q_{ft}(\mathbf{p}_t)}{\partial p_{jmt}} \tag{29}$$

Market variable administrative cost $V_{mt}(\mathbf{p}_t) = \sum_{f \in F, k \in J_{fmt}} v_{ft} q_{jmt}(\mathbf{p}_t)$ and its partial derivative

$$\frac{\partial V_{mt}(\mathbf{p}_t)}{\partial p_{jmt}} = \sum_{f \in F, k \in J_{fmt}} v_{ft} \frac{\partial q_{jmt}(\mathbf{p}_t)}{\partial p_{jmt}} \tag{30}$$

Consumer Surplus:
Total market consumer surplus and its partial derivative are

$$\begin{aligned} CS_{mt}(\mathbf{p}_t) &= -\sum_{i \in I} \left(\mathbb{I}_{i,m,t}\right) \frac{1}{\beta_i^p} \ln \left(\left(\sum_{l \in J} \exp\left(V_{ilt}(\mathbf{p}_t)/\lambda\right) \right)^{\lambda} + \exp\left(\beta_i^p \rho_{it}\right) \right) \\ &+ \sum_{i \in I, l \in J} \left[\left(\mathbb{I}_{i,m,t}\right) q_{ilt}(\mathbf{p}_t) * \frac{\beta_{il}^y * y_{il(t-1)}}{\beta_i^p} \right] \end{aligned}$$

$$\begin{aligned} \frac{\partial CS_{mt}(\mathbf{p}_t)}{\partial p_{jmt}} &= -\sum_{i \in I} \left[\frac{\left(\mathbb{I}_{i,m,t}\right) \left[\sum_{l \in J} \exp\left(V_{ilt}(\mathbf{p}_t)/\lambda\right)\right]^{\lambda-1} \sum_{l \in J} \left[\exp\left(V_{ilt}(\mathbf{p}_t)/\lambda\right) \frac{\partial p_{ilt}(\mathbf{p}_t)}{\partial p_{jmt}}\right]}{\left(\sum_{l \in J} \exp\left(V_{ilt}(\mathbf{p}_t)/\lambda\right)\right)^{\lambda} + \exp\left(\beta_i^p \rho_{it}\right)} \right] \\ &+ \sum_{i \in I, l \in J} \left[\left(\mathbb{I}_{i,m,t}\right) \frac{\partial q_{ilt}(\mathbf{p}_t))}{\partial p_{jmt}} \frac{\beta_{il}^y * y_{il(t-1)}}{\beta_i^p} \right] \end{aligned}$$

B Model Parameter Estimates

Table A1: Estimated Parameters

Demand Parameters ($\widehat{\beta}_t$)

	$\widehat{\boldsymbol{\theta}}_{2016}$	$\widehat{\boldsymbol{\theta}}_{2017}$	$\widehat{\boldsymbol{\theta}}_{2018}$	$\widehat{\boldsymbol{\theta}}$
Monthly Premium (\$100) ×	-0.544^{***}	-0.574^{***}	-0.566^{***}	-0.544^{***}
	(0.008)	(0.007)	(0.006)	(0.005)
250% to 400% of FPL	0.188^{***}	0.213^{***}	0.201^{***}	0.183^{***}
	(0.006)	(0.006)	(0.005)	(0.004)
> 400% of FPL	0.303^{***}	0.351^{***}	0.360^{***}	0.357^{***}
	(0.007)	(0.006)	(0.005)	(0.005)
Ages 0 to 17	-0.279^{***}	-0.242^{***}	-0.236^{***}	-0.202^{***}
	(0.018)	(0.015)	(0.013)	(0.011)
Ages 18 to 34	-0.857^{***}	-0.861^{***}	-0.835^{***}	-0.794^{***}
	(0.008)	(0.007)	(0.006)	(0.005)
Ages 35 to 54	-0.374^{***}	-0.386^{***}	-0.382^{***}	-0.373^{***}
	(0.006)	(0.005)	(0.005)	(0.004)
Male	-0.147^{***}	-0.153^{***}	-0.144^{***}	-0.134^{***}
	(0.006)	(0.005)	(0.004)	(0.004)
Family	0.009	−0.011	-0.026^{***}	-0.032^{***}
	(0.005)	(0.004)	(0.004)	(0.003)
Asian	-0.195^{***}	-0.185^{***}	-0.187^{***}	-0.175^{***}
	(0.007)	(0.006)	(0.006)	(0.005)
Black	-0.295^{***}	-0.308^{***}	-0.319^{***}	-0.315^{***}
	(0.015)	(0.014)	(0.012)	(0.011)
Hispanic	-0.544^{***}	-0.544^{***}	-0.522^{***}	-0.478^{***}
	(0.008)	(0.007)	(0.006)	(0.005)
Other race	0.065^{***}	0.058^{***}	0.048^{***}	0.045^{***}
	(0.010)	(0.009)	(0.008)	(0.007)
AV	3.202^{***}	3.190^{***}	3.150^{***}	3.088^{***}
	(0.028)	(0.025)	(0.022)	(0.020)
Silver	0.578^{***}	0.658^{***}	0.720^{***}	0.739^{***}
	(0.008)	(0.007)	(0.007)	(0.006)
HMO	0.404^{***}	0.514^{***}	-0.015^{*}	-0.106^{***}
	(0.016)	(0.016)	(0.008)	(0.007)
Anthem	1.198^{***}	1.238^{***}	0.563^{***}	0.444^{***}
	(0.021)	(0.019)	(0.010)	(0.009)
Blue Shield	1.174^{***}	1.259^{***}	0.584^{***}	0.489^{***}
	(0.021)	(0.019)	(0.010)	(0.008)
Kaiser	0.854^{***}	0.790^{***}	0.674^{***}	0.629^{***}
	(0.011)	(0.008)	(0.007)	(0.006)
Health Net	0.522^{***}	0.403^{***}	0.159^{***}	0.102^{***}
	(0.010)	(0.008)	(0.007)	(0.006)
Anthem × HMO	-1.206^{***}	-1.452^{***}	-0.979^{***}	-0.955^{***}
	(0.022)	(0.022)	(0.015)	(0.014)
Nesting Parameter	0.554^{***}	0.618^{***}	0.649^{***}	0.694^{***}
	(0.005)	(0.005)	(0.004)	(0.004)

	$\widehat{\boldsymbol{\theta}}_{2016}$	$\widehat{\boldsymbol{\theta}}_{2017}$	$\widehat{\boldsymbol{\theta}}_{2018}$	$\widehat{\boldsymbol{\theta}}$
Previous Choice ×	1.979^{***}	2.006^{***}	1.804^{***}	1.608^{***}
	(0.089)	(0.068)	(0.056)	(0.050)
250% to 400% of FPL	0.310^{***}	0.331^{***}	0.329^{***}	0.266^{***}
	(0.026)	(0.019)	(0.015)	(0.014)
> 400% of FPL	0.642^{***}	0.713^{***}	0.680^{***}	0.642^{***}
	(0.040)	(0.029)	(0.023)	(0.020)
Ages 0 to 17	-0.143^{**}	-0.125^{**}	-0.149^{***}	-0.219^{***}
	(0.070)	(0.051)	(0.040)	(0.035)
Ages 18 to 34	0.007	0.011	0.072^{***}	0.064^{***}
	(0.029)	(0.022)	(0.017)	(0.015)
Ages 35 to 54	−0.005	−0.004	0.011	0.016
	(0.026)	(0.019)	(0.015)	(0.013)
Male	0.139^{***}	0.172^{***}	0.188^{***}	0.198^{***}
	(0.028)	(0.021)	(0.017)	(0.015)
Family	-0.211^{***}	-0.277^{***}	-0.310^{***}	-0.304^{***}
	(0.020)	(0.015)	(0.012)	(0.011)
Asian	-0.200^{***}	-0.259^{***}	-0.279^{***}	-0.290^{***}
	(0.025)	(0.019)	(0.015)	(0.013)
Black	0.038	-0.092^{*}	0.018	0.057
	(0.078)	(0.055)	(0.048)	(0.043)
Hispanic	0.114^{***}	0.033^{*}	0.027^{*}	0.037^{***}
	(0.027)	(0.019)	(0.016)	(0.014)
Other race	-0.164^{***}	-0.171^{***}	-0.135^{***}	-0.153^{***}
	(0.040)	(0.030)	(0.025)	(0.022)
Anthem	-0.483^{***}	-0.380^{***}	−0.005	0.568^{***}
	(0.060)	(0.046)	(0.037)	(0.033)
Blue Shield	-0.128^{**}	−0.009	0.349^{***}	1.043^{***}
	(0.065)	(0.050)	(0.040)	(0.035)
Kaiser	-0.340^{***}	-0.273^{***}	−0.023	0.267^{***}
	(0.050)	(0.037)	(0.028)	(0.019)
Health Net	-0.846^{***}	-0.914^{***}	-0.510^{***}	0.164^{***}
	(0.050)	(0.038)	(0.028)	(0.021)
HMO	0.458^{***}	0.429^{***}	0.615^{***}	0.746^{***}
	(0.043)	(0.034)	(0.030)	(0.030)
AV	1.461^{***}	1.840^{***}	1.729^{***}	1.519^{***}
	(0.096)	(0.073)	(0.059)	(0.053)
Silver	-0.637^{***}	-0.734^{***}	-0.781^{***}	-0.930^{***}
	(0.023)	(0.017)	(0.015)	(0.013)

Risk Score Parameters ($\widehat{\gamma}_t$)

	$\widehat{\boldsymbol{\theta}}_{2016}$	$\widehat{\boldsymbol{\theta}}_{2017}$	$\widehat{\boldsymbol{\theta}}_{2018}$	$\widehat{\boldsymbol{\theta}}$
Silver	0.814^{***}	0.825^{***}	0.789^{***}	0.764^{***}
	(0.062)	(0.042)	(0.033)	(0.028)
Gold	0.882^{***}	0.915^{***}	0.863^{***}	0.852^{***}
	(0.071)	(0.044)	(0.034)	(0.029)
Platinum	1.084^{***}	1.252^{***}	1.288^{***}	1.293^{***}
	(0.077)	(0.047)	(0.036)	(0.031)
Share Ages 18 to 25	-1.647^{**}	-1.347^{***}	-0.666^{*}	-0.903^{***}
	(0.802)	(0.488)	(0.366)	(0.336)
Share Ages 26 to 44	-1.330^{***}	-0.873^{***}	-0.963^{***}	-0.913^{***}
	(0.395)	(0.217)	(0.160)	(0.143)
Share Male	−0.350	−0.047	0.106	-0.339^{*}
	(0.653)	(0.299)	(0.214)	(0.193)
Share Hispanic	−0.234	-0.348^{***}	-0.652^{***}	-0.741^{***}
	(0.184)	(0.130)	(0.097)	(0.085)
(Intercept)	0.243^{**}			
	(0.115)			
Silver	0.771^{***}			
	(0.016)			
Gold	0.841^{***}			
	(0.020)			
Platinum	1.085^{***}			
	(0.020)			
Share Ages 18 to 25	-3.533^{***}			
	(0.316)			
Share Ages 26 to 34	-1.140^{***}			
	(0.085)			
Share Ages 35 to 44	−0.119			
	(0.249)			
Share Male	−0.230			
	(0.250)			
Share Special Enrollment	0.104			
	(0.107)			

Average Claims Parameters ($\widehat{\boldsymbol{\mu}}_t$)

	$\widehat{\boldsymbol{\theta}}_{2016}$	$\widehat{\boldsymbol{\theta}}_{2017}$	$\widehat{\boldsymbol{\theta}}_{2018}$	$\widehat{\boldsymbol{\theta}}$
HMO	0.013	0.036	-0.130^{***}	-0.160^{***}
	(0.064)	(0.022)	(0.010)	(0.010)
Log risk score	1.075^{***}	1.053^{***}	1.045^{***}	1.059^{***}
	(0.009)	(0.004)	(0.003)	(0.004)
Trend	-0.026^{***}	-0.006^{**}	0.022^{***}	0.021^{***}
	(0.007)	(0.003)	(0.002)	(0.002)
Anthem	0.125^{*}	0.087^{***}	0.117^{***}	0.116^{***}
	(0.069)	(0.025)	(0.018)	(0.020)
Blue Shield	0.027	0.060^{*}	-0.053^{*}	-0.092^{***}
	(0.083)	(0.034)	(0.029)	(0.033)
Health Net	−0.030	−0.044	0.085^{**}	0.134^{***}
	(0.095)	(0.047)	(0.036)	(0.038)
Kaiser	-0.128^{***}	-0.086^{***}	−0.010	0.060^{***}
	(0.045)	(0.016)	(0.015)	(0.017)

Notes: Robust standard errors are in parentheses (*** indicates statistical significance at the 1% level, ** at the 5% level, and * at the 10% level). Parameter estimates for the market fixed effects in equations (1) and (14) are omitted.