# What Does a Public Option Do? Evidence from California

Evan Saltzman*

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**Abstract**

Creating a public firm to compete with private firms is an increasingly debated intervention to address inefficiency in concentrated markets. I develop a mixed oligopoly model with alternative firm objectives and estimate it with consumer-level data from the California insurance exchange, where one-third of consumers have access to a public firm. In the best-fitting model, the public firm places more weight on consumer surplus than producer surplus. Adding a public firm decreases premiums, improves welfare in concentrated markets, and increases surplus the most for disadvantaged subpopulations. Enhancing subsidies for private plans, a leading alternative intervention, increases premiums and reduces welfare.

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

*Department of Economics, Emory University, 1602 Fishburne Drive, Atlanta, GA 30322, evan.saltzman@emory.edu. I thank David Bradford, Mark Shepard, Karen Stockley, and Sebastian Tello Trillo for agreeing to serve as discussants and providing valuable feedback. I am also grateful to Stuart Craig, Atul Gupta, Chris Karbownik, John Kim, Teddy Kim, Nelson Lind, Claudio Lucarelli, Ian McCarthy, Dan Polsky, Ashley Swanson, and Pietro Tebaldi for helpful discussions. I also thank participants at the Johns Hopkins Applied Microeconomics Seminar, ASSA Annual Meetings, Southeastern Health Economics Study Group, ASHE Annual Conference, and Caribbean Health Economics Symposium. Katie Leinenbach and Amy Lim provided excellent research assistance.

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 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 that has received increased attention is the introduction of a public firm that competes directly with private firms.

The impact of introducing a public firm depends on several factors, including the public firm's objective, cost structure, 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 industries. The United Parcel Service (UPS) and FedEx Corporation (FedEx) coexist with the U.S. Postal Service 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 creating a public firm that competes with private firms. I develop a novel empirical framework for estimating a mixed oligopoly model. My framework allows for heterogeneity in consumer preferences for the public firm's products and accommodates a wide range of public firm objectives, cost structures, and design features. I apply my empirical framework to U.S. health insurance markets, which often suffer from weak competition and high premiums that limit access to health insurance for millions of Americans. My model explicitly accounts for the principal health insurance market failures, including asymmetric information, firm market power, and consumer inertia. I also incorporate key health insurance policies such as regulation on price discrimination (known as community rating), the individual mandate for purchasing insurance, premium-linked subsidies, and risk adjustment.

I study the creation of a public firm in health insurance by exploiting consumer-level enrollment data from the Affordable Care Act (ACA) exchange in California. In this setting, residents of

Los Angeles, Santa Clara, and Contra Costa counties, accounting for approximately one-third of California exchange consumers, had access to a public firm run by their county governments. The remaining two-thirds of California consumers could only choose plans from private firms. Heterogeneity in access to the public firm across county markets and time provides plausible exogenous variation for identifying consumer preferences for public firm plans. 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 combine my consumer-level enrollment data 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 firm profit. Consumers are willing to pay an average of \$39 or 8.9% more in premiums for a private firm plan relative to a public firm plan, controlling for observables. Older, higher-income, and non-Hispanic White consumers have a much higher willingness-to-pay for a private plan, whereas 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 use the best-fitting mixed oligopoly model to simulate the impact of introducing a public firm (with the same objective, cost structure, and product design as it currently exists in California) to five markets in California without a public firm. Two main results emerge: (1) adding a public firm improves social welfare most in rural markets with limited competition, but reduces social welfare in urban markets with robust competition and (2) disadvantaged subpopulations benefit most from the addition of a public firm. The introduction of a public firm reduces average premiums by 21.2% and increases annual per-capita social welfare by \$462 in a 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 firm 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 and all private firms continue to earn positive profit. Adding a public firm 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.

I apply my estimated empirical framework to evaluating proposals for a public option in health insurance. Discussion of adding a public firm in health insurance, often referred to as the "public option," featured prominently in the original debate over the Affordable Care Act (ACA) and was resurrected during the 2020 presidential campaign by President Biden. Most recently, four separate bills for a public option were proposed during the $117^{th}$ Congress. Colorado, Nevada, and Washington, have added or will add a version of a public option to their states' ACA exchanges. Design of the public option, including how it sets premiums, negotiates with providers, and determines plan quality, varies widely across policy proposals. All public option proposals share the goals of reducing premiums and expanding access to health insurance by stimulating competition. I simulate several alternative designs of a public option to understand the economic tradeoffs and welfare implications of each design. I first consider adding a profit-maximizing private firm instead of an altruistic public firm. I find substantially smaller premium reductions and less favorable shifts in welfare when adding a profit-maximizing private firm, suggesting the public firm's altruistic objective plays a key role in determining its impact. Second, I consider adding a strong public firm that can negotiate "Medicare-like" reimbursement rates and find significantly larger premium reductions. However, social welfare declines because the increased costs of subsidy payments and unreimbursed claims offset the benefits of lower premiums. The final design alternative investigates the degree to which inertia protects incumbent private firms from the public firm. I find inertia is a key source of firm market power that partially insulates private firms from entry of a public firm.

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) enhances premium subsidies available to ACA exchange consumers.[1] I use my empirical framework to simulate the impact of ARP subsidies and find ARP subsidies increase (unsubsidized) premiums and decrease annual per-capita social welfare. By comparison, adding a public firm unambiguously decreases premiums and improves social welfare in more rural markets with limited competition. Whereas adding a public firm reduces premiums because it increases supply, enhancing premium subsidies increases premiums because it increases demand. The resulting premium increases lead to government spending growth that more than offsets the gains in consumer and producer surplus.

My work makes both methodological and empirical contributions to the literature. First, I develop a framework for estimating a mixed oligopoly model with alternative objectives. The evaluation of alternative objectives contributes to the rich literature that studies regulator objectives (Wolak, 1994; Timmins, 2002; Gagnepain and Ivaldi, 2002; Abito, 2014; Lim and Yurukoglu, 2018) and nonprofit firm objectives, particularly in the hospital industry (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). I extend these literatures by estimating the non-profit-maximizing agent's objective in a mixed oligopoly setting. Second, my approach for counterfactual simulations overcomes a significant computational challenge in correctly endogenizing risk adjust-

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

ment, improving upon the approaches in Saltzman (2021) and Tebaldi (2022). Third, I provide novel evidence (to the best of my knowledge) that adding a public firm can improve social welfare in rural markets with limited competition and provide the largest consumer surplus gains to disadvantaged subpopulations. Fourth, my model provides a comprehensive framework for studying how a broad range of proposed public option design features may affect its impact, unifying many of the potential impacts of a public option considered in previous work (Blumberg et al., 2019; Shepard et al., 2020; Liu et al., 2020; Fiedler, 2020; Craig, 2022). Fifth, I show adding a public firm compares favorably with enhancing premium subsidies because subsidies create 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 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) by highlighting the relationship between competition and welfare.

This paper is organized as follows. Section 1 estimates consumer preferences for the public firm. Section 2 evaluates alternative public firm objectives. Section 3 simulates the impact of adding a public firm. Section 4 analyzes design features of public option proposals. Section 5 concludes.

# 1 Consumer Preferences for the Public Firm

My goals in this section are to (1) identify which consumer types are most likely to choose the public firm and (2) distinguish whether choice of the public firm 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 describes the data, the second subsection presents descriptive evidence, the third subsection develops a model, the fourth subsection discusses estimation, and the fifth subsection presents the results.

## 1.1 Data

My demand-side data come from two primary sources: (1) California's ACA exchange (called Covered California) and (2) the American Community Survey (ACS) (Ruggles et al., 2022). I obtain administrative data on consumer-level enrollment through a California Public Records Act (PRA) request. 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.[2] 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. My uninsured 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 insurance. I combine administrative data from Covered California with survey data from the ACS to form the universe of consumers.

When 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 (rating area 5), Santa Clara (rating area 7), East Los Angeles (rating area 15), and West Los Angeles (rating area 16). Figure 1a shows the 19 rating areas in California and Figure 1b indicates where a public firm is present. Approximately one-third of Covered California enrollees reside in the 4 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 origins and business practices. All three public firms existed long before creation of the California exchange and exclusively sell HMO plans that target low-income and disadvantaged subpopulations. L.A. Care was established in 1997 and offers plans through Medicaid/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."[3] 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."[4] 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.[5]

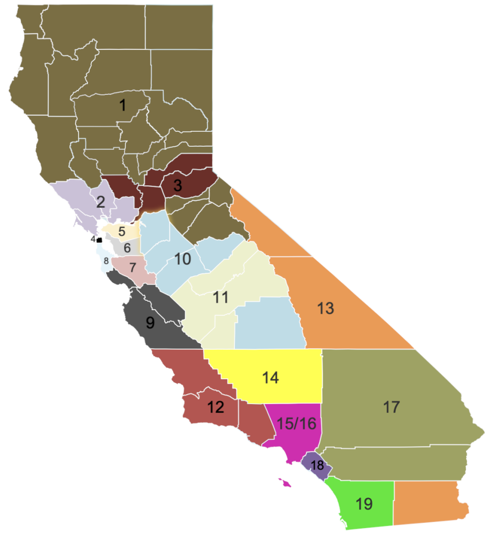
[2] The provider networks for two insurers – Contra Costa and United – are not available in the directories.

[3] https://www.lacare.org/about-us/about-la-care/mission-vision-and-values

[4] https://www.valleyhealthplan.org/about-us

[5] 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.

## 1.2 Descriptive Evidence

My data indicate important differences exist between the insurers' enrollee populations. Figure 2 summarizes enrollee characteristics in the markets where a public firm was available. The public insurers' enrollee populations disproportionately draw from low-income and disadvantaged communities, consistent with the public insurers' mission statements. 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] 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. Gender and family size differences between the insurers are relatively small.

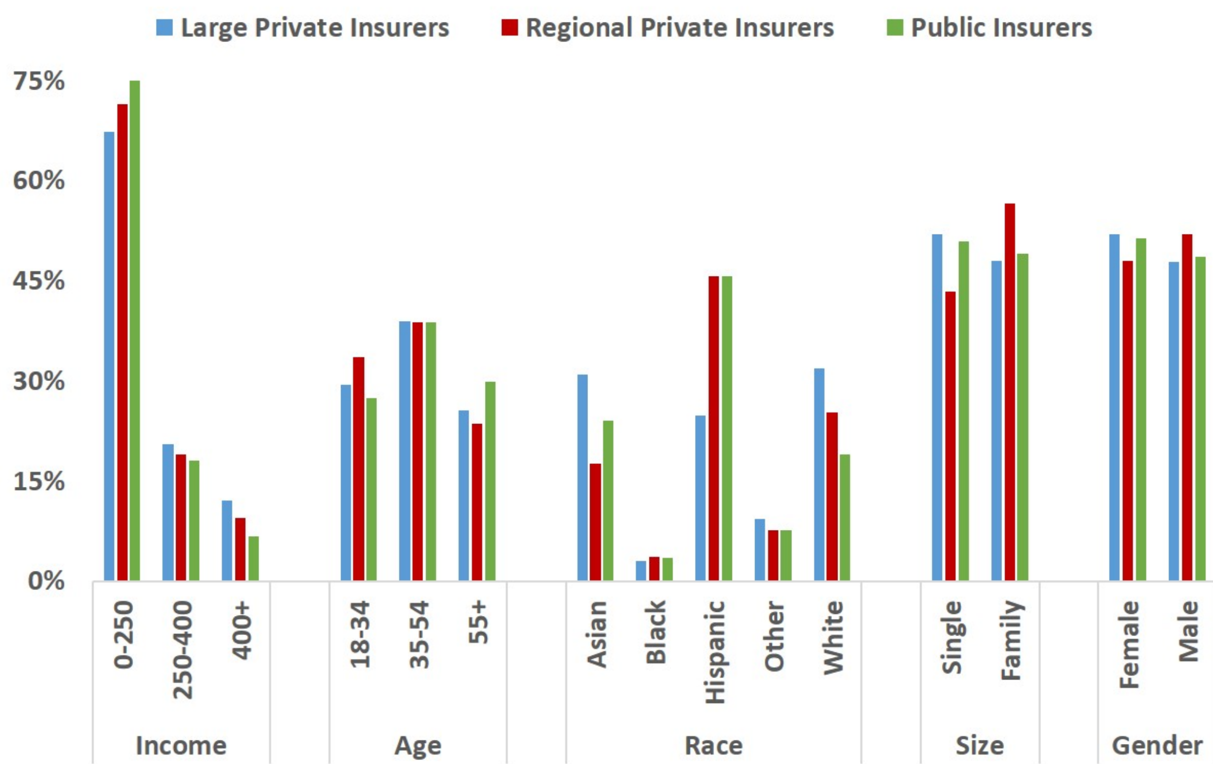
I investigate whether the public firms increase takeup of exchange coverage in disadvantaged subpopulations or simply cannibalize enrollment from the private insurers. In Table 1, I exploit the cross-sectional variation in public firm presence to determine whether availability of the public firm is associated 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 firm. Controls include the cheapest premium in the household's choice set and relevant demographic variables. I find having a public firm available 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, availability of the public firm 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

[6] Large private insurers include Anthem, Blue Shield, Health Net, and Kaiser. Regional private insurers include Molina and Oscar. 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 firm 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 Firm Availability on Takeup of Exchange Coverage

| | Low-Income | Minority |
|---|---|---|
| Public Firm 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) | |

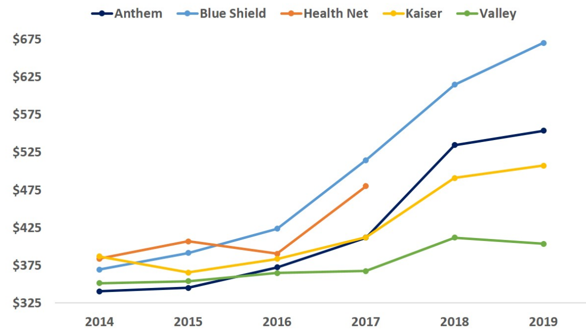
Notes: Table shows the results of binomial logit regressions at the household-year level. The dependent variable is an indicator of whether the household has exchange coverage for both specifications. In the first specification, I restrict the sample to households with income below 250% of FPL. In the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

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 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 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, Molina raised 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.

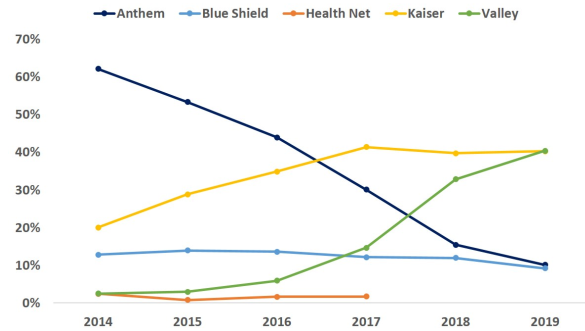
During the ACA's initial years, the public insurers set similar premiums to the private insurers. Valley sold the second-cheapest silver plan in Santa Clara in 2014, approximately 3.3% more expensive than Anthem's premium, and its market share was 2.5%. In 2014, LA Care sold the second-cheapest silver plan in East Los Angeles and third-cheapest silver plan in West Los Angeles; its silver plan market shares were 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, exceeding Kaiser's 40.2% market share. In Los Angeles, LA Care became the cheapest insurer in 2018 because of Molina's aggressive pricing in 2017. LA Care's market share increased to 18.6% in East Los Angeles and 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. 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

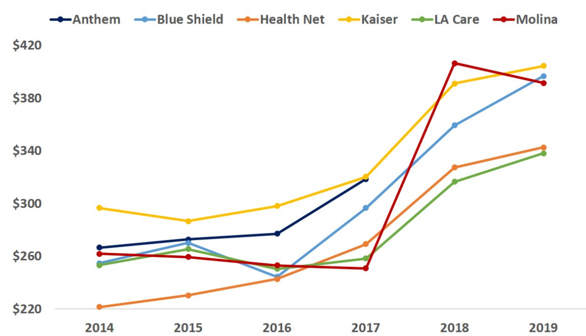
Figure 3: Average Premiums and Market Shares By Insurer and Year



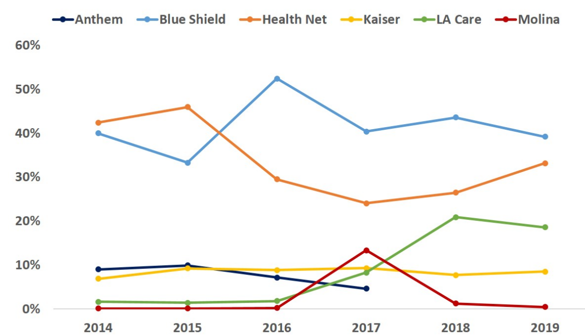

(a) Silver Premiums (Santa Clara)



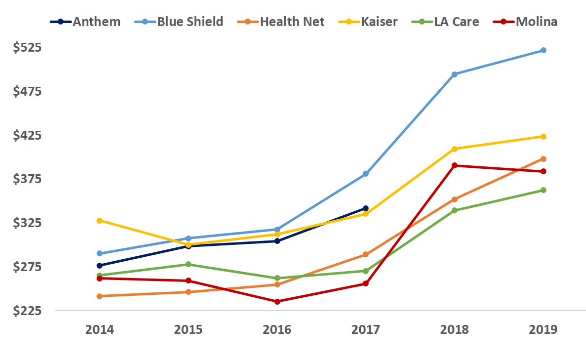

(b) Silver Market Shares (Santa Clara)



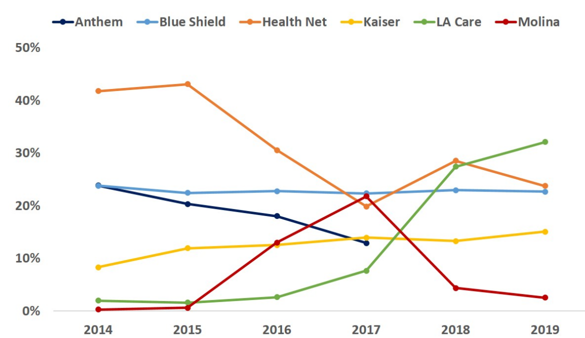

(c) Silver Premiums (East Los Angeles)




(d) Silver Market Shares (East Los Angeles)



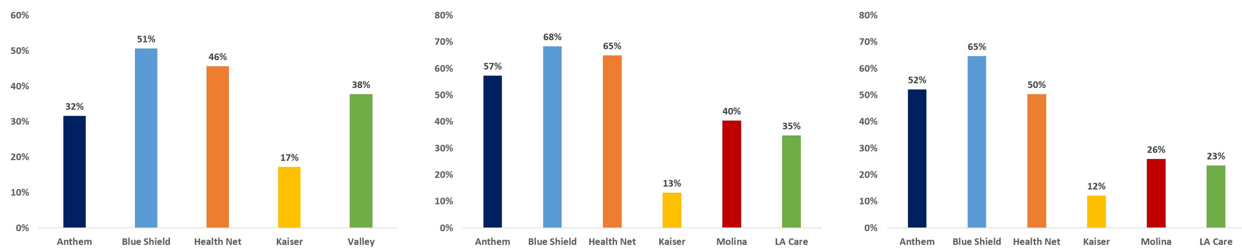

(e) Silver Premiums (West Los Angeles)




(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 (the premium for all other ages is proportional to the 40-year-old premium 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.

Figure 4: Provider Network Breadth By Insurer




(a) Santa Clara (b) East Los Angeles (c) West Los Angeles

Notes: Figure shows 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 physicians that are covered within a consumer's market.

insurer in every year except 2018.

Figure 4 compares the firms' provider networks. I calculate provider network breadth as the percentage of physicians that are covered within a consumer's 3-digit zip code. The public firm's network breadth is 38% in Santa Clara, 35% in East Los Angeles, and 23% in West Los Angeles. Blue Shield and Health Net have substantially higher network breadth than the public firms, whereas Kaiser has lower network breadth because of its vertically-integrated, staff HMO model.

## 1.3 Model

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 $U_{i0t} \equiv \beta_i^p \rho_{it} + \epsilon_{i0t}^d$. 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, $\xi_j$ is unobserved plan characteristics, $\rho_{it}$ is the household-specific penalty for not having insurance, and $\epsilon_{ijt}^d$ 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 $\beta_i^w$ represents the additional utility household $i$ obtains from choosing a private plan ceteris paribus, assuming $w_j$ is uncorrelated with unobservables $\xi_j$. 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 $\sigma_{it}$ 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 $\zeta_{it}$ 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 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 $\sigma_{it}$ 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. [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 $\zeta_{it}$. 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. Equation (2) prevents the subsidy from exceeding the premium, which could occur for certain bronze plans. This nonlinearity is an exogenous source of variation that I use to identify the premium parameter as discussed below. Before passage of the 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 by reducing contribution caps and allowing consumers with income above 400% of FPL to receive subsidies.

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

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

[9]To be subsidy eligible, consumers must (1) have income between 100% and 400% of FPL; (2) be citizens or legal residents; (3) be ineligible for Medicaid/CHIP, Medicare, etc.; and (4) lack access to an affordable health insurance offer from an employer. 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 annually.

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 ($\zeta_{it}$) 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 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, the penalty for a single person was the greater of \$95 and 1% of income exceeding the tax filing threshold. The penalty was fully 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.

## 1.4 Estimation and Identification

I assume the error term $\epsilon^d_{ijt}$ 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 (Train, 2009). I define two nests: (1) all exchange plans and (2) the outside option (i.e., forgoing insurance). The household-level choice probabilities are

$$q_{ijt}(\mathbf{p}_t) \quad = \quad \frac{e^{V_{ijt}(\mathbf{p}_t)/\lambda}\left(\sum_j e^{V_{ijt}(\mathbf{p}_t)/\lambda}\right)^{\lambda-1}}{1+\left(\sum_j e^{V_{ijt}(\mathbf{p}_t)/\lambda}\right)^{\lambda}} \tag{3}$$

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 $\lambda$ 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

$$\frac{\partial q_{ikt}(\mathbf{p}_t)}{\partial p_{jmt}} = \sum_{l \in J_{mt}} \frac{\partial q_{ikt}(\mathbf{p}_t)}{\partial p_{ilt}(\mathbf{p}_t)} \frac{\partial p_{ilt}(\mathbf{p}_t)}{\partial p_{jmt}} \tag{4}$$

for all plans $j, k$, where

$$\frac{\partial p_{ilt}(\mathbf{p}_t)}{\partial p_{jmt}} = \begin{cases} 0 & l = j, j = b \\ \sigma_{it} & l = j, j \neq b \\ -\sigma_{it} & l \neq j, j = b \\ 0 & l \neq j, j \neq b \end{cases}. \tag{5}$$

Except for the benchmark plan, a dollar increase in a plan's base premium results in consumers paying $\sigma_{it}$ additional dollars for that plan and does not affect what consumers pay for any other plan. However, a dollar increase in the benchmark premium increases the subsidy by $\sigma_{it}$ dollars; consumers pay the same amount for the benchmark plan, but now pay less for all other plans. Firms may be able to exploit the benchmark plan premium to increase profit, particularly in a monopoly market. My model explicitly accounts for this potential gaming behavior in equation (5).

My analysis of consumer plan choices requires credible identification of the premium parameter $\beta_i^p$ and the private parameter $\beta_i^w$. Most plan characteristics are observed, but 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 time-invariant unobserved plan characteristics. Key institutional details of the ACA setting also generate plausibly exogenous variation in premiums that I can exploit with consumer-level data. First, the phase-in of the mandate penalty between 2014 and 2016 and elimination of the penalty in 2019 creates exogenous variation in household premiums relative to the outside option. Second, exogenous age rating factors ($\sigma_{it}$) are used to translate premiums set by insurers to household premiums, creating variation in premiums across households and plans. To leverage this variation for identification, I allow the premium parameter in equation (1) to vary by age group and assume premium sensitivity does not vary within each age group (but premiums do vary within age groups). Third, the ACA's nonlinear subsidy formula in equation (2) creates exogenous variation between plans in each household's choice set. Some households have access to "free" bronze plans if the household's subsidy exceeds the full premium. The set of "free" plans varies across markets, time, and exogenously-determined household characteristics. In previous work, I also estimated the demand parameters using the control function of Petrin and Train (2010) with geographic cost factors as instruments, finding minimal differences in the estimated parameters (Saltzman, 2019). I do not use the control function approach here because the first stage imposes a hedonic pricing model, precluding me from evaluating alternative public firm objectives.

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 and other neighboring counties, who only have access to the large firms. Consumers may view the public firm as another regional firm. I address this concern by comparing consumer choices in Los Angeles County, where all firm categories are present, with those in Orange County and San Bernardino County, where only the large and regional firms are present. CCHP departed after 2014 due to regulatory changes, allowing me to compare the choices of the same consumers across time. A final concern is that entry of the public firms or regional private firms is correlated with unobserved ACA exchange consumer characteristics. The formation of all three public firms long preceded creation of the ACA exchanges in 2014 and targeted a different population than ACA exchange consumers. It is therefore unlikely that entry of a public firm in Los Angeles, Santa Clara, and Contra Costa Counties is endogenous. Many of the local private insurers in the California exchange, including Chinese Community in the Bay Area, Western Health in Sacramento, and Sharp in San Diego, were also founded in their communities long before creation of the ACA exchanges.

## 1.5 Results

Parameter estimates of $\beta$ are available in Appendix C.[10] 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

[10] Appendix C includes specifications with provider network breadth and without provider network breadth. Provider network breadth data are unavailable for Contra Costa and United, which requires eliminating those insurers' plans when estimating the specification with provider network breadth. The premium and private parameters are largely unchanged across specifications. I use the specification without provider network breadth in the analysis below.

Table 3: Mean Own-Plan and Coverage Elasticities

| | Own-Premium | Exchange Coverage |
|---|---|---|
| Overall | -6.13 | -0.90 |
| Age | | |
| 0-17 | -5.98 | -0.80 |
| 18-34 | -9.25 | -1.22 |
| 35-54 | -6.82 | -0.91 |
| 55+ | -4.10 | -0.56 |
| Gender | | |
| Female | -6.00 | -0.88 |
| Male | -6.28 | -0.92 |
| Race/Ethnicity | | |
| Asian | -7.01 | -0.98 |
| Black | -6.49 | -0.91 |
| Hispanic | -7.68 | -1.07 |
| Other | -5.59 | -0.80 |
| Non-Hispanic White | -5.28 | -0.76 |
| Household Size | | |
| Single | -5.96 | -0.88 |
| Family | -6.64 | -0.97 |

Notes: Table reports mean plan elasticities by demographic group. The first column indicates how a plan's demand responds to a change in its own premium before subsidies. The second column indicates how total exchange enrollment responds to a change in all exchange 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."

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 "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. 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. Hence, the public firm expands the market to disadvantaged subpopulations, consistent with their mission statements.

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.

# 2 Public Firm Objectives

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

## 2.1 Data

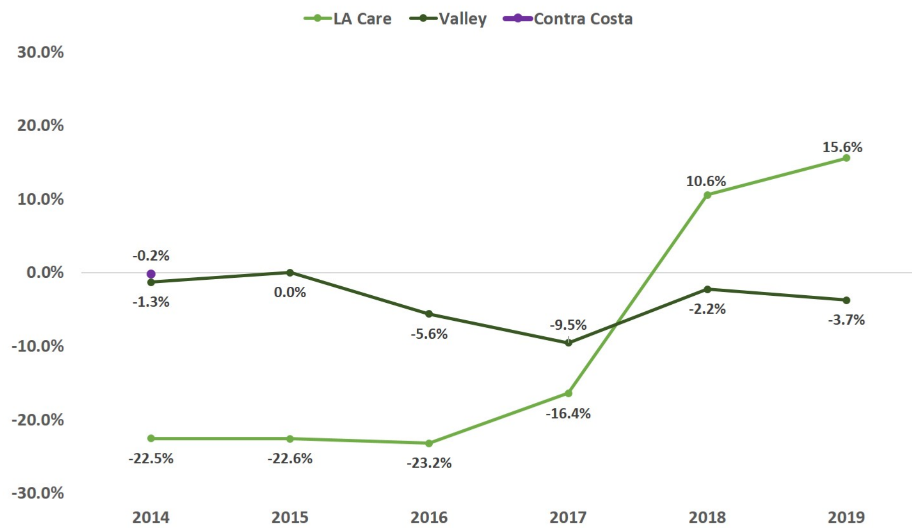
To estimate the supply-side of the model, I need data on the firms' cash flows in profit equation (6), including premium revenue collected, medical claims incurred, risk adjustment received or paid, reinsurance received, variable administrative costs, and fixed costs. I obtain most of these data from insurer rate filings (Department of Managed Health Care, 2016), which all insurers participating in the ACA exchanges must complete to justify their premiums. The rate filings provide plan-market-year level financial information on premium revenue collected, incurred medical claims, risk adjustment received or paid, and reinsurance received. I supplement the rate filings with data from the CMS medical loss ratio (MLR) reports to obtain the firms' variable administrative costs (e.g., taxes, fees, commissions) and fixed costs (e.g., building overhead, salaries). All insurers are required to submit MLR reports to show that they are spending at least 80% of collected premiums on medical claims. To endogenize risk adjustment in the model, I also require data on risk scores and geographic cost factors (defined in detail below). I obtain risk scores at the plan-year-market level from California's supplement rate review template (SRRT). The geographic cost factors are from CMS and provided in Appendix D (Centers for Medicare and Medicaid Services, 2022).

## 2.2 Descriptive Evidence

Figure 6 plots profit margins for the public insurers over time as reported in the MLR data. Overall, the data indicate that the public insurers were willing to sustain fairly substantial losses during the study timeframe. Valley operated at a loss in every year except 2015 and had nearly a -10% profit margin in 2017. LA Care sustained losses of more than 16% through 2017, peaking at 23.2% in 2016. In 2018 and 2019, LA Care earned positive profit, recouping some of the losses in the preceding years. This empirical evidence suggests the public insurers (1) either did not operate with a budget constraint or were only constrained to earn zero profit over a long time horizon and (2) may have objectives that diverge from profit maximization.

I assess whether the public firm puts competitive pressure on private firms to reduce premiums

Figure 6: Public Insurer Profit Margins By Year




Notes: Figure shows profit margins by year for the public insurers, including LA Care (Los Angeles County), Valley (Santa Clara County), and Contra Costa (Contra Costa County). Contra Costa only operated in the California exchange in 2014. Profit margins are calculated from the MLR data and include administrative costs.

by constructing least squares regressions at the household-year level. These regressions leverage geographic variation in public firm availability to evaluate the public firm'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 firm 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 firm puts competitive pressure on private firms.

## 2.3 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 1. I first discuss the private firm's objective and then propose alternative specifications of the public firm's objective.

Table 5: Effect of Public Firm Availability on Exchange Premiums

| | Benchmark Premium | Cheapest Premium |
|---|---|---|
| Public Firm 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. Both specifications include market and year fixed effects.

### 2.3.1 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

$$\pi_{ft}(\mathbf{p}_t) \quad = \quad R_{ft}(\mathbf{p}_t) - C_{ft}(\mathbf{p}_t) + RA_{ft}(\mathbf{p}_t) + RI_{ft}(\mathbf{p}_t) - V_{ft}(\mathbf{p}_t) - FC_{ft}. \tag{6}$$

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 all terms in (6) are in Appendix A. The formulas for premium revenue, medical claims, reinsurance (a temporary ACA program in effect through 2016 that provided "insurance to insurers" for their highest-cost enrollees), and variable administrative cost are straightforward. Below I discuss the risk adjustment formula.

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 risk adjustment transfer received by a plan is

$$
\begin{aligned}
ra_{jmt}(\mathbf{p}_t) &= \widehat{c}_{jmt}(\mathbf{p}_t) - \widetilde{c}_{jmt}(\mathbf{p}_t) \\
&= \frac{\widehat{h}_{jmt}(\mathbf{p}_t)}{\sum_{n \in M, l \in J_{nt}} \widehat{h}_{lnt}(\mathbf{p}_t) s_{lnt}(\mathbf{p}_t)} \nu \overline{p} - \frac{\widetilde{h}_{jmt}(\mathbf{p}_t)}{\sum_{n \in M, l \in J_{nt}} \widetilde{h}_{lnt}(\mathbf{p}_t) s_{lnt}(\mathbf{p}_t)} \nu \overline{p}
\end{aligned} \tag{7}
$$

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 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 $\nu$.[11] The cost factor $\widehat{h}_{jmt}(\mathbf{p}_t) \equiv \mathrm{IDF}_j \mathrm{GCF}_{mt} r_{jmt}(\mathbf{p}_t)$ is the product of the plan's induced demand factor, geographic cost factor, and risk score. The cost factor $\widetilde{h}_{jmt}(\mathbf{p}_t) \equiv \mathrm{AV}_j \mathrm{IDF}_j \mathrm{GCF}_{mt} a_{jmt}(\mathbf{p}_t)$ is the product of the plan's AV, induced demand factor, geographic cost factor, and average ACA age rating factor $a_{jmt}(\mathbf{p}_t)$ across the plan's enrollees. The induced demand factor accounts for expected moral hazard associated with lower cost sharing when enrolled in a more generous plan. CMS sets $\mathrm{IDF}_j$ equal to 1 for bronze plans, 1.03 for silver plans, 1.08 for gold plans, and 1.15 for platinum plans. The geographic cost factors account for regional differences in the cost of doing business (e.g., input prices, provider market power, etc.) Appendix D summarizes the CMS geographic cost factors by market and year in California. CMS uses a regression-based procedure that calculates the ACA risk score, a measure of ex-ante enrollee risk (not ex-post spending on health care), as a function of plan generosity and enrollee characteristics, including age, gender, and diagnosed medical conditions (Kautter et al., 2014). I write the plan risk score $r_{jmt}(\mathbf{p}_t)$ as

$$
\ln r_{jmt}(\mathbf{p}_t) = \sum_{d \in D} \gamma^d s_{djmt}(\mathbf{p}_t) + MT_j' \gamma^{MT} + \epsilon^r_{jmt} \tag{8}
$$

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 $\epsilon^r_{jmt}$ is an error term. I discuss estimation of the risk score parameters $\boldsymbol{\gamma} = (\gamma^d, \gamma^{MT})$ below.

Average transfer formula (7) 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 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 <u>not</u> 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

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

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 7 does not compensate plans for these cost differences or any other efficiencies that plans may realize.

Differentiating equation (6) 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 $\iota_{ft}$ 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.

Equation (6) does not allow firms to consider how consumer inertia affects future year profits. Firms anticipating inertia may engage in an "invest-and-harvest" strategy, setting lower initial premiums to capture market share and raising premiums in future years. Given existing empirical tools (e.g., Aguirregabiria and Mira (2007); Bajari et al. (2007)), it is challenging to estimate heterogeneous firm objectives along with the complex institutional detail of the ACA.

### 2.3.2 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. Timmins (2002) and Lim and Yurukoglu (2018) consider regulator objectives. A parallel literature considers nonprofit objectives in the hospital industry (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 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

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

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 2.2 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

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

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

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

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

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 $\omega$ and objective family. The vector of premiums that solve these equilibrium conditions define a Nash-in-premiums equilibrium.

[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.

## 2.4 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 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

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

As shown in Appendix A, I can compute every term in (13) using my data and estimates of demand and plan risk scores except for average claims $c_{kmt}(\mathbf{p}_t)$ and its partial derivative $\frac{\partial c_{kmt}(\mathbf{p}_t)}{\partial p_{jmt}}$. On the right-hand side of (13), the estimated choice probabilities are computed using equation (3) and the corresponding Jacobians are computed using equation (19). On the left-hand side of (13), the formula for the revenue partial derivative $\frac{\partial R_{ft}(\mathbf{p}_t)}{\partial p_{jmt}}$ in equation (21) is a function of the observed premiums, as well as the estimated choice probabilities and corresponding Jacobian. The formula for the risk adjustment partial derivative $\frac{\partial RA_{ft}(\mathbf{p}_t)}{\partial p_{jmt}}$ in equation (27) is a function of the observed premiums, the estimated choice probabilities and corresponding Jacobian, the estimated risk scores in equation (8) and corresponding Jacobian in equation (20), and the age rating factors, geographic cost factors, and induced demand factors published by CMS. The formula for variable administrative cost partial derivative $\frac{\partial V_{ft}(\mathbf{p}_t)}{\partial p_{jmt}}$ in equation (29) is a function of the observed variable administrative costs in the MLR data and the estimated Jacobian of the choice probabilities. The reinsurance factors are $\iota_{ft}$ are calculated from the insurer rate filings.

Now I develop an approach for computing the average claims partial derivative $\frac{\partial c_{kmt}(\mathbf{p}_t)}{\partial p_{jmt}}$ so that average claims $c_{kmt}(\mathbf{p}_t)$ is the only unknown term remaining in equation (13). 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 $\frac{\partial c_{kmt}(\mathbf{p}_t)}{\partial p_{jmt}} > 0$. To identify average claims, I assume the functional form

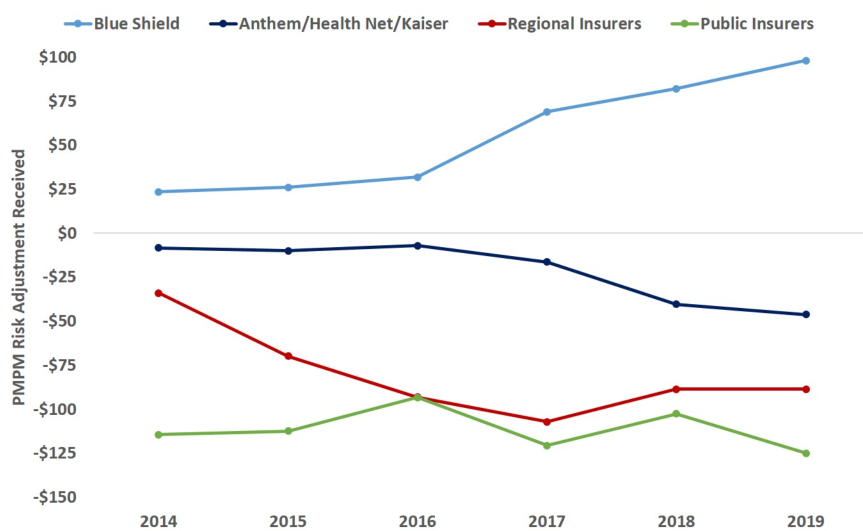
$$c_{jmt}(\mathbf{p}_t) = \widehat{c}_{jmt}(\mathbf{p}_t)+\zeta_{jmt} \tag{14}$$

where $\widehat{c}_{jmt}(\mathbf{p}_t)$ is expected average claims with adverse selection from equation (7) and $\zeta_{jmt}$ captures factors such as the provider network that result in average claims diverging from $\widehat{c}_{jmt}(\mathbf{p}_t)$. 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 1 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 $\zeta_{jmt}$.

Equation (14) makes one strong assumption: ACA risk adjustment accurately captures selection. Geruso and Layton (2020) find private plans engage in upcoding and generate 6-16% higher enrollee risk scores than they would under traditional Medicare. Although I have no evidence of upcoding in my setting, Figure 7 indicates the private firms reported that their enrollees were substantially less healthy than the public firms' enrollees, particularly Blue Shield. Upcoding implies that the private firms can take advantage of any adverse selection that is unaccounted for in equation (14). Private firms would be at a competitive disadvantage if instead the public firm attracts unobservably healthy patients. Early critics of the ACA risk adjustment formula also thought it overcompensated firms with higher-than-average risk enrollees. In response, CMS reduced $\nu$ 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.

Figure 7: Average Risk Adjustment Received




Notes: Figure shows the statewide average or per-member per-month risk adjustment transfer received. Transfers are positive if a transfer was received and negative if a transfer was paid. I group insurers into the following categories: (1) Blue Shield; (2) other large private insurers (Anthem, Health Net, Kaiser); (3) regional private insurers (Chinese Community, Molina, Oscar, Sharp, United, Western); and (4) public insurers (LA Care, Valley, Contra Costa).

To obtain credible estimates of average claims, I need unbiased estimates of the risk score parameters $\boldsymbol{\gamma}$ in equation (8). The main identification challenge is that I do not observe diagnosed medical conditions, potentially biasing estimates of $\gamma^d$. I address this potential source of omitted variable bias by computing predicted demographic shares using the estimated consumer-level choice probabilities from equation (3) instead of the observed demographic shares in my data, which may be endogenous. My identifying assumption is that predictions of the demographic shares are based on exogenous determinants of consumer-level demand, whereas the observed shares may be a function of unobserved medical conditions. Intuitively, 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). Estimates of $\boldsymbol{\gamma}$ are available in Appendix C.

## 2.5 Results

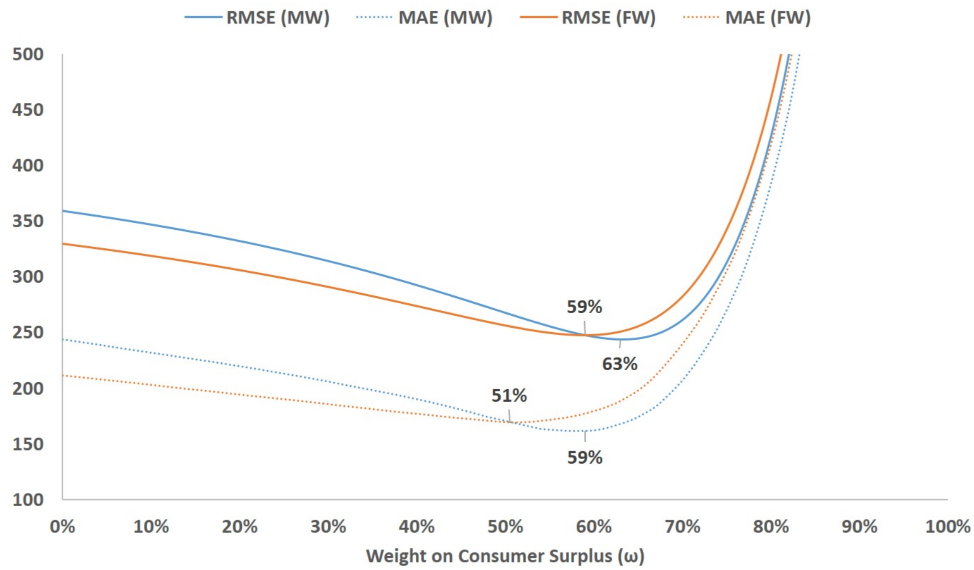
For each family of public firm objectives, I obtain 200 sets of average claims estimates corresponding to the model with weight $\omega \in \left\{0, \frac{1}{200}, \frac{2}{200}, \frac{3}{200}, \ldots, \frac{198}{200}, \frac{199}{200}\right\}$. I compute the root mean square error (RMSE) and mean absolute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

Figure 8a 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).

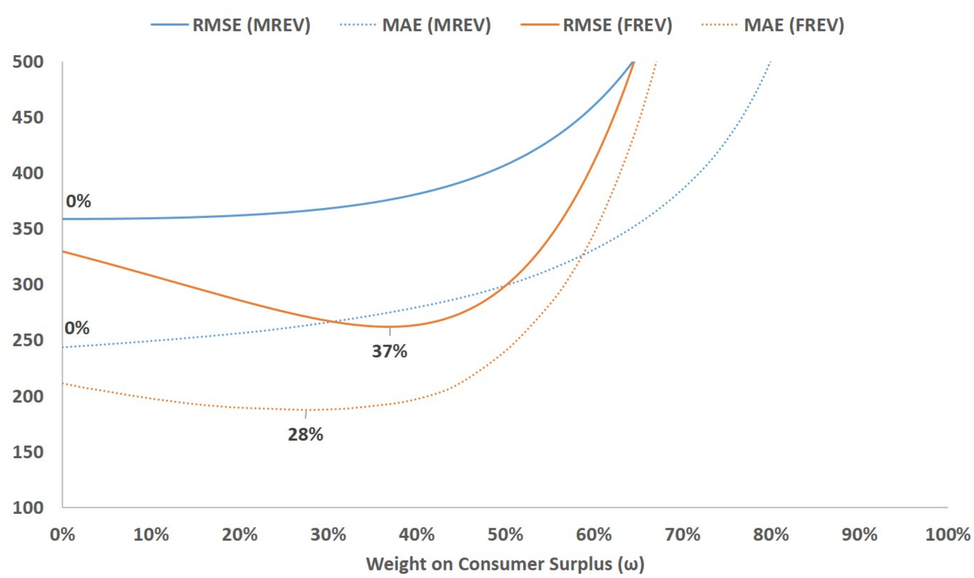
Figure 8b indicates that objective family (10c) is a poor fit. The objective that results in the smallest RMSE and MAE places 100% weight on market profit and 0% weight on market revenue. Objective family (10d) performs better than (10c), but not as well as objective families (10a) and (10b). The objective 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.

[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 8: 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.

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

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

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 assumption that the ACA risk adjustment formula accurately captures selection. First, I vary the expected percentage $\nu$ of collected premiums that is spent on claims from 80% (the MLR limit) to 100%. Figure 9a 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 9b 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.

# 3 Impact of Adding a Public Firm

In this section, I use the best fitting model from Section 2 ($MW(\mathbf{p}_t, 0.63)$) to simulate the impact of adding a public firm. Several key stories emerge: (1) adding a public firm decreases premiums and increases enrollment, although there is substantial heterogeneity in the magnitude of the change across markets; (2) disadvantaged subpopulations benefit most from the addition of a public firm; (3) adding a public firm improves social welfare in rural markets. The first subsection explains my simulation methodology and the second subsection summarizes my results.

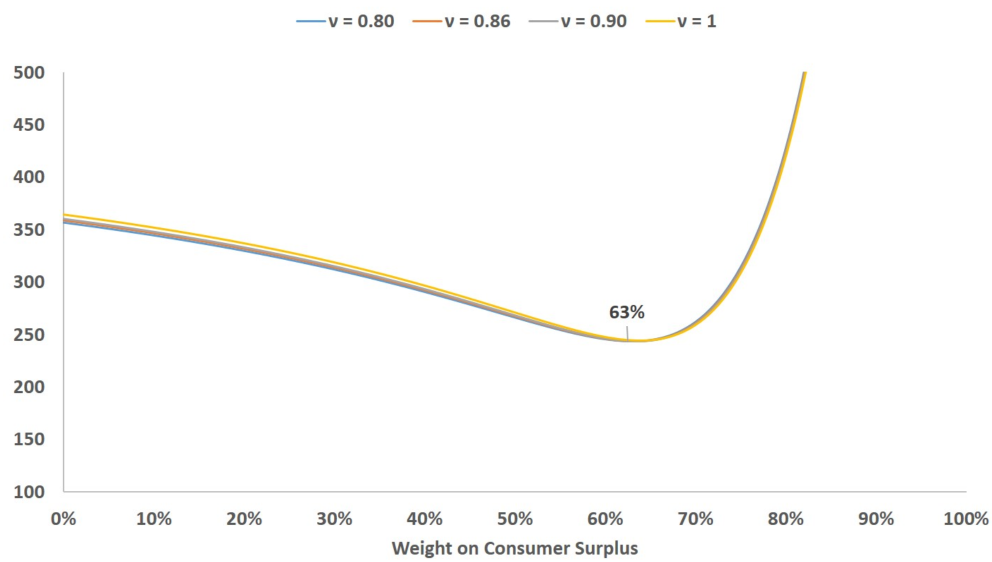
## 3.1 Simulation Methodology

I simulate the impact of adding a public firm 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 Valley expanded to San Benito in 2020 and Monterey in 2021.

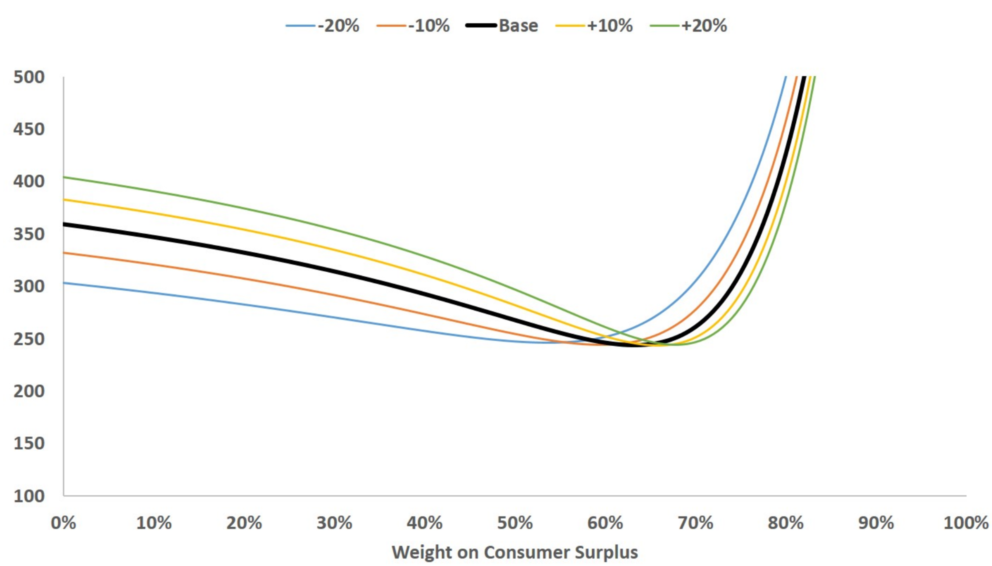
To simulate adding a public firm in a local market, I perform the following steps: (1) I add four plans (bronze, silver, gold, and platinum) to each consumer's choice set that have the same plan characteristics as the existing public firm plans in California; (2) I allow a multiproduct public firm to set the premiums of the four plans to maximize the objective $MW(\mathbf{p}_t, 0.63)$, assuming plan average costs equal plan average costs of the existing public firms adjusted by the local market's CMS geographic cost factor; 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). The new vector of premiums satisfying the first-order conditions may not be unique; I tested several different starting points for each simulation and obtained the same premium vector.

Correctly simulating ACA risk adjustment in counterfactuals poses a significant computational challenge because there is dependency between local markets. Solving for the new vector of premiums in all 19 markets simultaneously is computationally infeasible with as many as 40 plans per market. Saltzman (2021) addresses this challenge by endogenizing risk adjustment at the state

Figure 9: 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 $\nu$ in equation 7). The value of $\nu$ 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 firm is 20% lower (-20%), 10% lower (-10%), 10% higher (+10%), and 20% higher (+20%).

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 counterfactuals. I develop a computationally feasible method that endogenizes risk adjustment and allows local market premiums to vary without restriction. The key insight 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, $\pi_t$ is profit earned by the private firms, and $GS_t$ is net government spending adjusted by the deadweight loss of taxation $\delta$ 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

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

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

Total Profit $\pi_t$ is computed as the sum of firm profits using equation (6). Note that the fixed cost term drops out in the firms' first-order conditions, but is included in equation (6). I compute firm-level fixed costs by year from the MLR reports.

Net government spending $GS_t$ is calculated as

$$GS_t \;=\; PS_t + CSR_t + UC_t - PEN_t - \pi_t^{PUB} \tag{18}$$

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 $\pi_t^{PUB}$ is profit earned by the public firm. 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. I also include any operating gains or losses incurred by the public firm in government spending. I do not include any one-time entry costs that the public firm may incur.

## 3.2 Results

Figure 10 summarizes the impact of adding a public firm on premiums and enrollment. Adding a public firm reduces premiums and increases enrollment with considerable heterogeneity across markets. Average unsubsidized premiums decline by 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

[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).

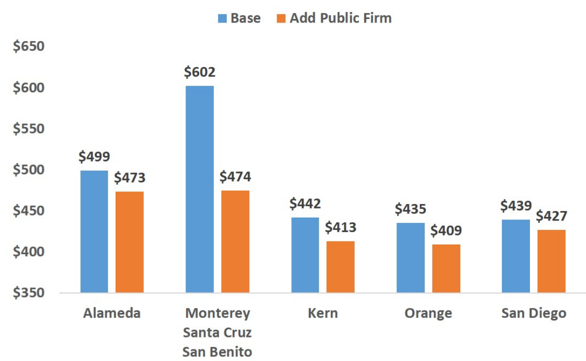
consumers enrolled in the exchange increases by 6.3 percentage points in Monterey, San Benito, and Santa Cruz Counties, but by only 1.9 percentage points in Orange County. Across the five markets, the public firm captures 11.9% market share. The private plans retain significant market share and remain viable in the presence of a public firm.

Figure 11 summarizes the welfare impact of adding a public firm. Adding a public firm reduces annual per-capita profit. 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 firm 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. The impact on government spending is mixed, depending on reductions in premium subsidy spending (because of lower premiums) and operating losses incurred by the public firm. 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. Operating losses incurred by the public firm dominate in San Diego County, resulting in annual per-capita net government spending increasing by $244. Adding a public firm enhances consumer surplus. The upper bound measure of the annual per-capita consumer surplus gain exceeds $100 in all five markets; the lower bound measure of the 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 firm 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 per-capita social welfare are smaller in Alameda, Kern, and Orange Counties.

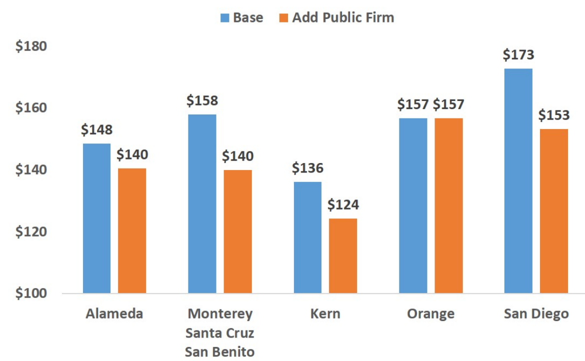
Figure 12 shows the distributional impact of adding a public firm. The African American and Hispanic communities benefit most. African American enrollment increases 10.5% and Hispanic enrollment increases 10.6%. Annual per-capita consumer surplus increases $250 for African American consumers and $236 for Hispanic consumers. For consumers earning less than 250% of FPL, annual per-capita consumer surplus increases by $185 because of reduced subsidized premiums. Single consumers and those over age 55 also have relatively large consumer surplus gains.

My model precludes the possibility that private firms exit when a public firm is added. Although my simulations indicate all private insurers continue to earn positive profits when a public firm is added, some may find better uses of their factors of production. Figure A1 in Appendix B considers a counterfactual scenario where I add a public firm and remove the private insurer earning the least profit in each of the five markets. For the most part, I find the results are qualitatively similar to introducing a public firm without the loss of a private insurer. Average (unsubsidized)

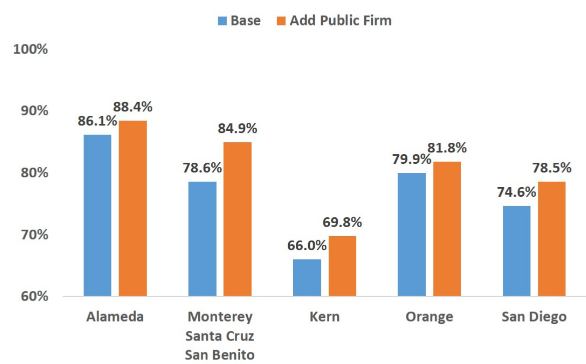
Figure 10: Impact of Adding Public Firm on Premiums and Enrollment



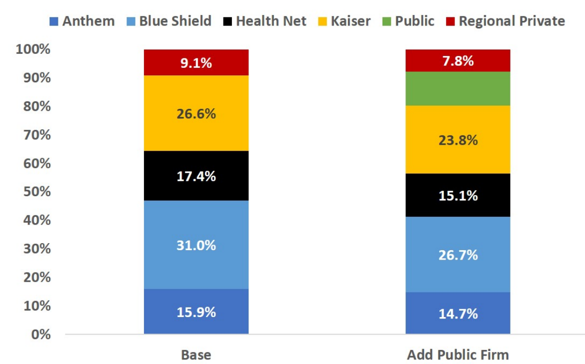

(a) Average Unsubsidized Premiums




(b) Average Subsidized Premiums



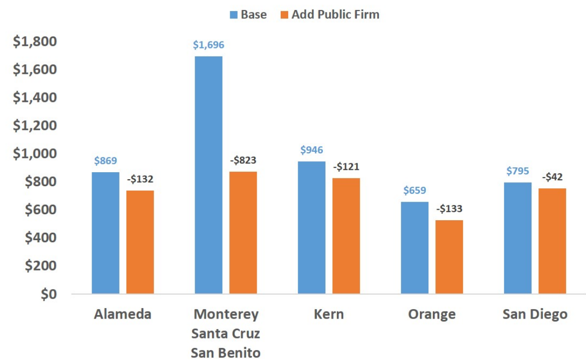

(c) % of Consumers Enrolled in Exchange



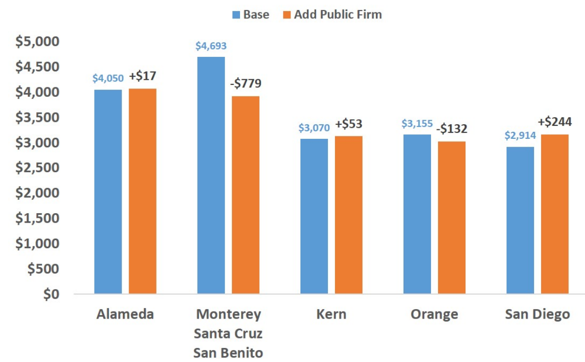

(d) Firm Market Share

Notes: Figure shows the impact of adding a public firm 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 firm 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.

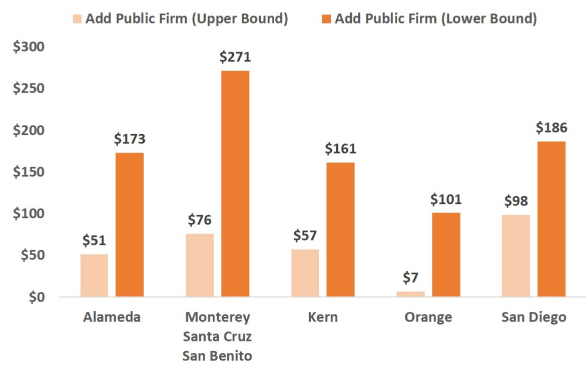
Figure 11: Impact of Adding Public Firm on Social Welfare



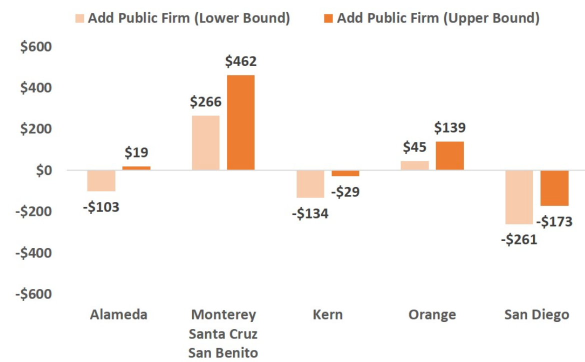

(a) Annual Per-Capita Profit




(b) Annual Per-Capita Net Government Spending



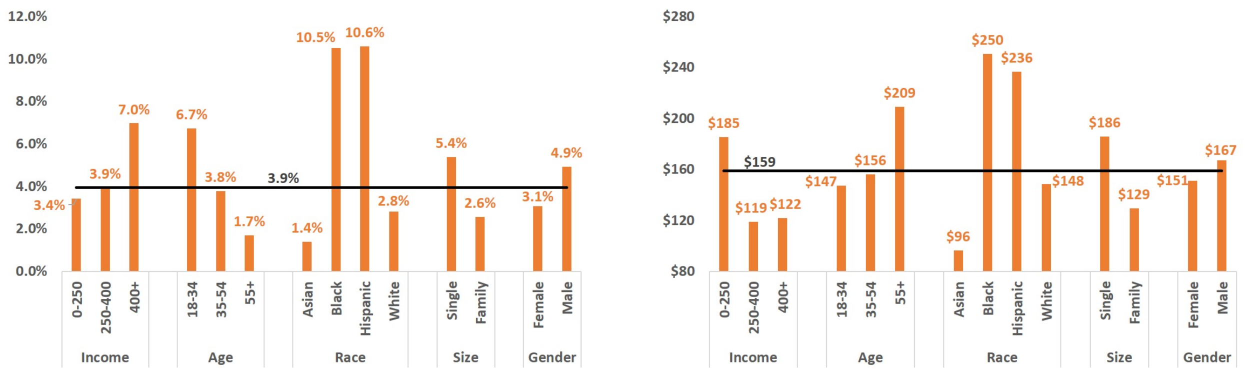

(c) Change in Annual Per-Capita Consumer Surplus




(d) Change in Annual Per-Capita Social Welfare

Notes: Figure shows the impact of adding a public firm 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 firm 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 Firm (Lower Bound)" uses equation (17) to compute consumer surplus and the scenario "Add Public Firm (Upper Bound)" uses equation (16) to compute consumer surplus.

Figure 12: Distributional Impact of Adding Public Firm




(a) % Change in Total Exchange Enrollment

(b) Change in Annual Per-Capita Consumer Surplus

Notes: Figure shows the distributional impact of adding a public firm 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 firm 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.

premiums fall substantially, particularly in Monterey, Santa Cruz, and San Benito. As before, annual per-capita social welfare increases in Monterey, Santa Cruz, and San Benito, but falls in San Diego. The remaining private insurers largely benefit from the exit of the lowest-profit private insurer, particularly Anthem and Kaiser. Total coverage, however, declines in Alameda and Orange Counties. My results are therefore largely robust to the loss of the lowest-profit private insurer.

# 4 Proposed Policy Interventions

I now use my estimated empirical framework to evaluate proposed alternatives for a public option in health insurance. The objective of this section is to understand the economic tradeoffs and welfare implications of alternative policy designs. The first subsection provides institutional background on the public option. The second subsection evaluates alternative design features of the public option. The third subsection compares the public option to enhancing subsidies for private plans.

## 4.1 What is the Public Option in Health Insurance?

The term "public option" has been used to describe a broad range of proposed policy reforms. The 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 idea of a public option 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. President Biden proposed including a public option in the ACA exchanges during the 2020 presidential campaign. Most recently, four separate bills for a public option were proposed during the $117^{th}$ Congress.[16] As in the California setting, these proposals add public plans to the existing state exchanges that are structured largely the same as private firm plans.[17] The proposals diverge on how to reimburse providers. Two of the bills allow the public firm to negotiate directly with providers; negotiated rates must be no less than reimbursement rates paid by Medicare and no more than the average reimbursement rate paid by the private firms on the exchange. The public firm sets reimbursement rates unilaterally at Medicare levels or slightly above under the other two bills. All four proposals require providers that take Medicare to also accept the public firm. At the state level, Washington, Colorado, and Nevada have adopted legislation to implement reforms similar to a public option in their state exchanges. The state legislation differs from the federal proposals by having private firms administer the public plans using public financing (Nevada) or requiring private firms to offer certain public plans using their own financing (Washington and Colorado).[18]

[16] These include the CHOICE Act, the Public Option Deficit Reduction Act, the Medicare-X Choice Act of 2021, and the Choose Medicare Act of 2021 (Monahan and Lucia, 2022).

[17] The Medicare-X Choice Act and Choose Medicare Act of 2021 also add public plans to the employer-sponsored insurance market.

[18] These plans must meet stronger cost containment, quality, and network breadth requirements compared to the private plans.

## 4.2 Evaluating Alternative Design Features of the Public Option

In this section, I evaluate three alternative policy scenarios for the public option, including (1) adding a profit-maximizing private firm instead of a public firm with an altruistic objective; (2) adding a public firm that can negotiate "Medicare-like" reimbursement rates; and (3) adding a public firm in a market without inertia. The first scenario compares the relative importance of competition versus firm objectives, the second asks whether a public firm that negotiates lower, "Medicare-like" reimbursement rates can achieve welfare gains, and the third investigates whether inertia protects incumbent private firms from entry of a public firm. There are other design features, such as administrative cost savings and plan quality requirements, that I considered using my model, but omit for brevity. For each simulation, I add four plans (bronze, silver, gold, and platinum) to each consumer's choice set in Alameda, Monterey/San Benito/Santa Cruz, Kern, Orange, and San Diego. The reported results in Figures 13 and 14 are enrollee-weighted across the five simulated markets. The results for the scenarios "Base" and "Add Public Firm" are the same as in Figures 10 and 11, but reported as an enrollee-weighted average across the five simulated markets.

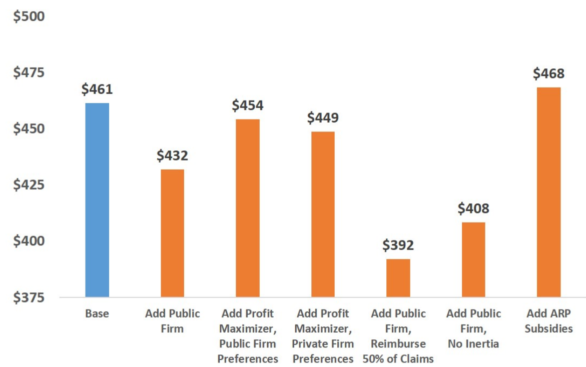
Figures 13 and 14 show there is a substantial difference between adding an altruistic public firm and a profit-maximizing firm. This difference occurs regardless of whether consumers view the profit-maximizing firm as a public firm (i.e., the private dummy $w_j = 0$) or as a private firm (i.e., the private dummy $w_j = 1$). Average unsubsidized premiums decline 1.5% with $w_j = 0$ and 2.7% with $w_j = 1$ when adding a profit-maximizer, far smaller than the 6.4% reduction when adding a public firm. Average subsidized premiums decline 12.8% with $w_j = 0$ and 13.5% with $w_j = 1$ when adding a profit-maximizer, greater than the 6.2% reduction when adding a public firm. Total enrollment growth is similar, but adding a profit-maximizer results in substantially less redistribution in market share between the private firms. The profit-maximizer takes 4.7% market share with $w_j = 0$ and 2.2% market share with $w_j = 1$, compared to 11.9% market share for the altruistic public firm. Not surprisingly, firm profits remain substantially higher when adding a profit maximizer. Although adding a profit-maximizer results in lower average subsidized premiums, the additional spending on premium-linked subsidies results in annual per-capita government spending increasing \$140 with $w_j = 0$ and \$117 with $w_j = 1$, compared to a decrease in annual per-capita government spending of \$24 when adding a public firm. Consumer surplus is higher when adding a profit maximizer compared to adding a public firm because of lower average subsidized premiums. Overall, annual per-capita social welfare decreases \$73 with $w_j = 0$ and \$44 with $w_j = 1$ when adding a profit-maximizer, but increases \$34 when adding a public firm. These results indicate that the public firm's altruistic objective plays a key role in determining the public option's impact.

Introducing a strong public option that can negotiate Medicare-like reimbursement rates would have a substantially different impact. 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 "Medicare-like" reimbursement rates by multiplying claims paid by the public firm by 50% and solving for the premiums satisfying the firms' first-order conditions. Adding a strong public option results in average unsubsidized premiums declining by 15.0% and average subsidized premiums declining by 18.3%. The percentage of consumers enrolled in the exchange increases by 5.9 percentage points and the public firm captures 25.1% market share. Annual per-capita government spending, including the cost of subsidies and unreimbursed claims,[19] increases substantially and more than offsets the gains in consumer surplus. As a result, the change in annual per-capita social welfare is negative when introducing a strong public option.

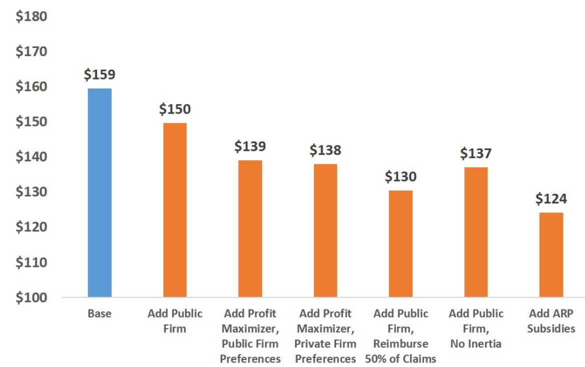
Finally, Figures 13 and 14 suggest that consumer inertia protects incumbent private firms from entry of the public option. I simulate the elimination of inertia by setting the inertia variable $y_{ij(t-1)}$ equal to zero and solving for the premiums satisfying the firms' first-order conditions. Average unsubsidized premiums decrease by 11.5% when adding a public firm without inertia, nearly double the 6.4% decrease when adding a public firm with inertia. Average subsidized premiums decrease by 14.1% when adding a public firm without inertia, more than double the 6.2% decrease when adding a public firm with inertia. Total enrollment is largely unchanged when adding a public firm without inertia because of two offsetting forces: (1) an enrollment increase due to lower premiums and (2) an enrollment decrease because some consumers elect to forgo coverage when inertia is eliminated. Annual per-capita profit plummets by 50.7% when adding a public firm without inertia, compared to a decline of 18.6% when adding a public firm with inertia. This result indicates that inertia is a key source of firm market power that insulates private firms from entry of a public option. Annual per-capita government spending declines by about $200 because the lower premiums reduce spending on premium-linked subsidies. To compute the change in annual per-capita consumer surplus, I assume that inertia represents a choice error (e.g., inattention) as in equation (16) rather than a true switching cost. Adding a public option without inertia increases annual per-capita consumer surplus by $689 and annual per-capita social welfare by $527 if inertia is the result of a choice error. These changes are smaller if inertia represents a true switching cost.

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

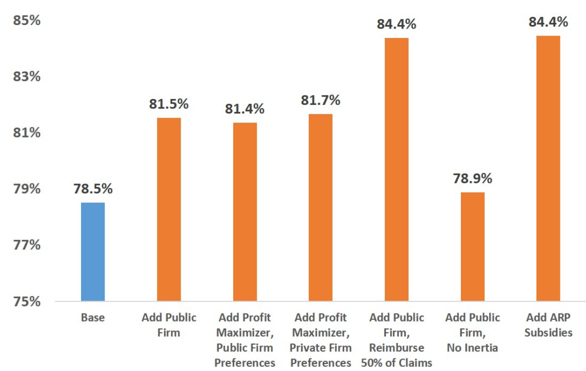
Figure 13: Impact of Policy Interventions on Premiums and Enrollment



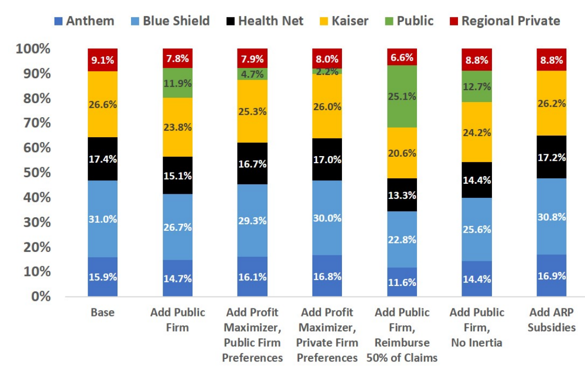

(a) Average Unsubsidized Premiums




(b) Average Subsidized Premiums



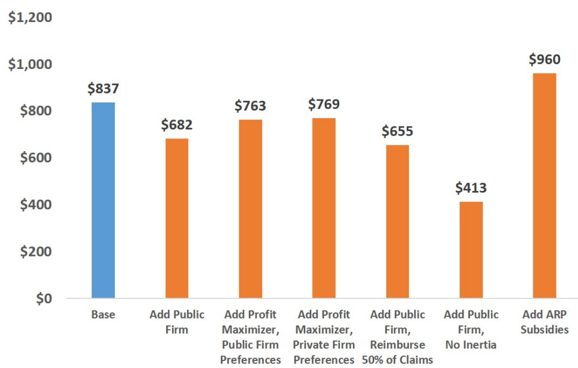

(c) % of Consumers Enrolled in Exchange



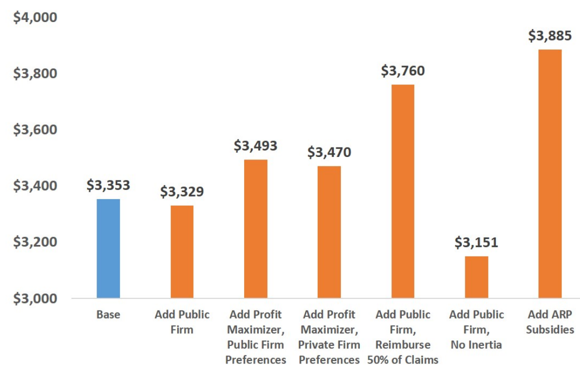

(d) Firm Market Share

Notes: Figure shows the impact of policy interventions on average unsubsidized premiums (panel a), average subsidized premiums (panel b), the percentage of consumers enrolled in the exchange, and firm market share (panel d). I consider six interventions: (1) adding a public firm as it currently exists in California (same as Figure 10); (2) adding a firm that maximizes profit but consumers perceive as a public firm; (3) adding a public firm that maximizes profit and consumers perceive as a private firm; (4) adding a public firm that reimburses 50% of medical claims; (5) adding a public firm in a market where there is no consumer inertia; and (6) enhancing premium subsidies according to the ARP. The reported results are enrollee-weighted across the five simulated markets (Alameda, Monterey/San Benito/Santa Cruz, Kern, Orange, and San Diego).

Figure 14: Impact of Policy Interventions 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 policy interventions design 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). I consider six interventions: (1) adding a public firm as it currently exists in California (same as Figure 10); (2) adding a firm that maximizes profit but consumers perceive as a public firm; (3) adding a public firm that maximizes profit and consumers perceive as a private firm; (4) adding a public firm that reimburses 50% of medical claims; (5) adding a public firm in a market where there is no consumer inertia; and (6) enhancing premium subsidies according to the ARP. The reported results are enrollee-weighted across the five simulated markets (Alameda, Monterey/San Benito/Santa Cruz, Kern, Orange, and San Diego). I compute consumer surplus using equation (16).

### 4.3 Enhancing Premium Subsidies for Private Firm Plans

Enhancing premium subsidies for private firm plans is an alternative policy intervention to a public option for expanding coverage and increasing affordability. There are numerous ways to allocate premium subsidies that may have different welfare implications, such as targeting subsidies to certain groups (Tebaldi, 2022; Polyakova and Ryan, 2021). I focus on enhanced subsidies under the ARP here because they have been implemented in practice. I simulate ARP subsidies by (1) replacing the income-based 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.

Figures 13 and 14 summarize the results. In contrast to adding a public firm which increases supply, enhancing premium subsidies under the ARP increases demand. Consequently, average unsubsidized premiums increase 1.5% when adding ARP subsidies, but decrease 6.4% when adding a public firm. In contrast, the larger subsidies imply that average subsidized premiums decrease 22.1%, compared to a 6.2% decrease from adding a public firm. The substantial reduction in subsidized premiums results in a 5.9 percentage point increase in total exchange coverage, compared to a 3.0 percentage point increase in total exchange coverage from adding a public firm.

Whereas adding a public firm decreases profit, enhancing premium subsidies increases annual per-capita profit 14.7%. Consumers also benefit; annual per-capita consumer surplus increases \$209 when adding ARP subsidies, compared to an increase of \$53 when adding a public firm. These gains are more than offset by spending on premium subsidies. Annual per-capita social welfare decreases \$362 when adding ARP subsidies, but increases \$34 when adding a public firm.[20]

## 5 Conclusion

Governments often have to decide if and how to intervene in markets that are perceived to undersupply a socially consequential good or service. I study the equilibrium and social welfare implications of one such intervention: introducing a public firm 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 firm. In the best-fitting model, the public firm places 63% weight on consumer surplus and 37% weight on producer surplus and consumers from disadvantaged subpopulations have stronger preferences for the public firm. I use the model to simulate the impact of adding a public firm to five different

[20]These welfare calculations do not account for any one-time entry costs for the public firm or the cost of setting up and administering an income verification system for determining premium subsidy eligibility and levels.

markets in the California ACA exchange. Adding a public firm reduces premiums by up to 21.2%, improves social welfare in rural markets with limited competition, and increases consumer surplus most for disadvantaged subpopulations. Adding a public firm compares favorably with a prominent alternative intervention, enhancing premium subsidies. Enhancing subsidies under the ARP increases (unsubsidized) premiums by increasing demand and reduces social welfare in all markets. My simulations also indicate the potential impact of public option proposals in health insurance is quite sensitive to its design, including the public firm's objective and reimbursement levels.

The analysis in this paper can be extended in several directions. First, it would be informative to endogenize firm entry or exit. In four of the five markets I simulate, I find firm profit falls by less than 20% when adding a public firm and all firms continue to earn positive profit, making it unlikely that private firms would exit. For the most part, firm exits are minimal in the California exchange and one firm (Oscar) even entered Los Angeles County where a public firm was present. Anthem exited most California markets in 2018, but one of the three it remained in was Santa Clara County. Another useful extension would be to endogenize formation of the public firm's provider network. Previous work has considered network formation in other contexts assuming firms maximize profit (Gowrisankaran et al., 2015; Ho et al., 2017; Ho and Lee, 2019; Ghili, 2022; Shepard, 2022).

My study has important policy implications. Introducing a public firm that competes with private firms can be an effective intervention in rural markets with limited competition and may be an important vehicle for expanding health care access in disadvantaged subpopulations. Adding a public firm 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 interventions.

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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 (3) 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 (5). 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 (8) 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

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

**Risk Adjustment**:

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

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

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

where

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

The market risk adjustment transfer and its partial derivative are

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

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

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 3, 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

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

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**:

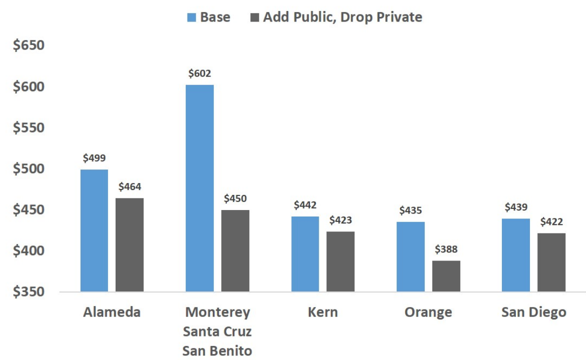
Total market consumer surplus and its partial derivative are

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

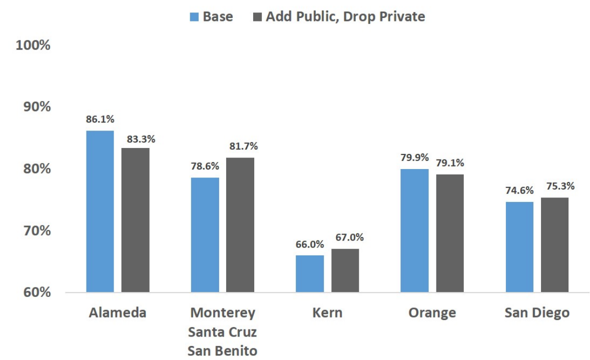
$$\begin{aligned} \frac{\partial CS_{mt}(\mathbf{p}_t)}{\partial p_{jmt}} &= -\sum_{i\in I}\left[\frac{\left(\mathbb{I}_{i,m,t}\right)\left[\sum_{l\in J}\exp\left(V_{ilt}(\mathbf{p}_t)/\lambda\right)\right]^{\lambda-1}\sum_{l\in J}\left[\exp\left(V_{ilt}(\mathbf{p}_t)/\lambda\right)\frac{\partial p_{ilt}(\mathbf{p}_t)}{\partial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

# B Robustness Checks

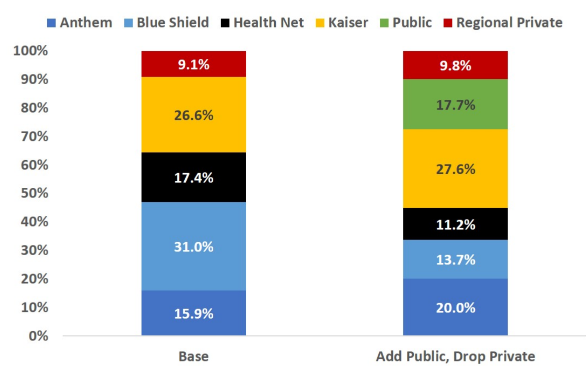
Figure A1: Impact of Adding the Public Option and Dropping the Lowest-Profit Private Insurer



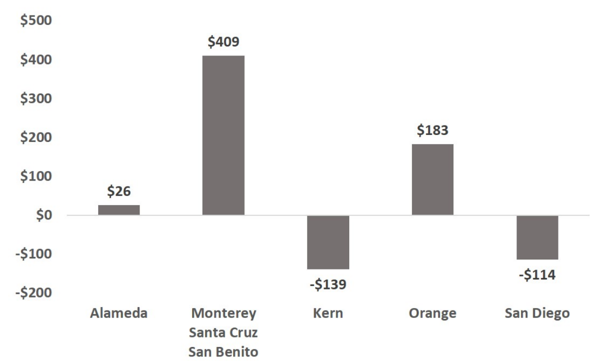

(a) Average Unsubsidized Premiums




(b) % of Consumers Enrolled in Exchange




(c) Firm Market Share




(d) Change in Annual Per-Capita Social Welfare

Notes: Figure shows the impact of adding a public option and removing the private insurer earning the least profit on average subsidized premiums (panel a), the percentage of consumers enrolled in the exchange (panel b), firm market share (panel c), and the change in annual per-capita social welfare (panel d). The impact is shown for five markets without a public option in the ACA/Base scenario. 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.

# C Model Parameter Estimates

Table A1: Demand Parameter Estimates

| | (1) | (2) |
|---|---|---|
| Monthly Premium ($100) × | $-0.409^{***}$ | $-0.406^{***}$ |
| | (0.003) | (0.004) |
| Ages 0 to 17 | $-0.271^{***}$ | $-0.241^{***}$ |
| | (0.012) | (0.013) |
| Ages 18 to 34 | $-0.718^{***}$ | $-0.712^{***}$ |
| | (0.005) | (0.005) |
| Ages 35 to 54 | $-0.380^{***}$ | $-0.382^{***}$ |
| | (0.004) | (0.004) |
| Male | $-0.039^{***}$ | $-0.039^{***}$ |
| | (0.004) | (0.004) |
| Family | $-0.094^{***}$ | $-0.101^{***}$ |
| | (0.003) | (0.004) |
| Asian | $-0.240^{***}$ | $-0.250^{***}$ |
| | (0.005) | (0.005) |
| Black | $-0.167^{***}$ | $-0.165^{***}$ |
| | (0.011) | (0.011) |
| Hispanic | $-0.332^{***}$ | $-0.336^{***}$ |
| | (0.005) | (0.005) |
| Other race | $-0.043^{***}$ | $-0.047^{***}$ |
| | (0.007) | (0.008) |
| Private Insurer × | $0.477^{***}$ | $0.509^{***}$ |
| | (0.024) | (0.026) |
| Ages 0 to 17 | $0.302^{***}$ | $0.268^{***}$ |
| | (0.033) | (0.034) |
| Ages 18 to 34 | $-0.407^{***}$ | $-0.419^{***}$ |
| | (0.013) | (0.013) |
| Ages 35 to 54 | $-0.251^{***}$ | $-0.251^{***}$ |
| | (0.013) | (0.013) |
| Male | $-0.341^{***}$ | $-0.347^{***}$ |
| | (0.010) | (0.011) |
| Family | $0.261^{***}$ | $0.275^{***}$ |
| | (0.009) | (0.009) |
| Asian | $0.310^{***}$ | $0.338^{***}$ |
| | (0.014) | (0.015) |
| Black | $-0.811^{***}$ | $-0.832^{***}$ |
| | (0.024) | (0.025) |
| Other race | $0.543^{***}$ | $0.566^{***}$ |
| | (0.023) | (0.024) |
| Hispanic | $-0.822^{***}$ | $-0.835^{***}$ |
| | (0.010) | (0.011) |
| 250% to 400% of FPL | $0.343^{***}$ | $0.338^{***}$ |
| | (0.010) | (0.010) |
| > 400% of FPL | $0.420^{***}$ | $0.408^{***}$ |
| | (0.013) | (0.013) |
| AV | $2.940^{***}$ | $2.726^{***}$ |
| | (0.020) | (0.021) |
| Silver | $0.749^{***}$ | $0.824^{***}$ |
| | (0.006) | (0.006) |
| HMO | $-0.353^{***}$ | 0.003 |
| | (0.005) | (0.007) |
| Network Breadth | | $1.989^{***}$ |
| | | (0.019) |
| Anthem | $0.166^{***}$ | $0.292^{***}$ |
| | (0.007) | (0.008) |
| Blue Shield | $0.347^{***}$ | $0.142^{***}$ |
| | (0.007) | (0.008) |
| Kaiser | $0.689^{***}$ | $1.116^{***}$ |
| | (0.006) | (0.009) |
| Health Net | $0.107^{***}$ | $-0.124^{***}$ |
| | (0.007) | (0.007) |
| Nesting Parameter | $0.710^{***}$ | $0.763^{***}$ |
| | (0.004) | (0.004) |
| Previous Choice × | $2.364^{***}$ | $2.446^{***}$ |
| | (0.045) | (0.047) |
| Ages 0 to 17 | $-0.405^{***}$ | $-0.425^{***}$ |
| | (0.032) | (0.034) |
| Ages 18 to 34 | $0.159^{***}$ | $0.172^{***}$ |
| | (0.014) | (0.015) |
| Ages 35 to 54 | $0.077^{***}$ | $0.078^{***}$ |
| | (0.012) | (0.013) |
| Male | $0.248^{***}$ | $0.263^{***}$ |
| | (0.013) | (0.014) |
| Family | $-0.335^{***}$ | $-0.362^{***}$ |
| | (0.010) | (0.011) |
| Asian | $-0.289^{***}$ | $-0.287^{***}$ |
| | (0.012) | (0.013) |
| Black | $0.216^{***}$ | $0.243^{***}$ |
| | (0.040) | (0.042) |
| Hispanic | $0.197^{***}$ | $0.207^{***}$ |
| | (0.013) | (0.014) |
| Other race | $-0.173^{***}$ | $-0.184^{***}$ |
| | (0.020) | (0.021) |
| 250% to 400% of FPL | $0.302^{***}$ | $0.319^{***}$ |
| | (0.012) | (0.013) |
| > 400% of FPL | $1.171^{***}$ | $1.232^{***}$ |
| | (0.021) | (0.022) |
| Anthem | $-0.144^{***}$ | $-0.122^{***}$ |
| | (0.027) | (0.028) |
| Blue Shield | $0.287^{***}$ | $0.313^{***}$ |
| | (0.028) | (0.029) |
| Kaiser | 0.010 | 0.021 |
| | (0.016) | (0.018) |
| Health Net | $0.046^{**}$ | $-0.055^{***}$ |
| | (0.018) | (0.019) |
| HMO | $0.218^{***}$ | $0.277^{***}$ |
| | (0.024) | (0.024) |
| AV | $1.470^{***}$ | $1.615^{***}$ |
| | (0.048) | (0.052) |
| Silver | $-0.906^{***}$ | $-0.984^{***}$ |
| | (0.012) | (0.013) |

Notes: Robust standard errors are in parentheses ($^{***}$ indicates statistical significance at the 1% level, $^{**}$ at the 5% level, and $^{*}$ at the 10% level). Specification (1) omits the network breadth variable and Specification (2) network breadth variable. In Specification (2), I exclude United and Contra Costa plans from consumers' choice sets because network data are unavailable for these two insurers. Contra Costa was only in the market in 2014 and United was only in the market in 2016. Parameter estimates for the market fixed effects in equation (1) are omitted.

Table A2: Estimated Risk Score Parameters

| | | | |
|---|---|---|---|
| Silver | $0.771^{***}$ | Share Ages 26 to 34 | $-1.140^{***}$ |
| | (0.016) | | (0.085) |
| Gold | $0.841^{***}$ | Share Ages 35 to 44 | $-0.119$ |
| | (0.020) | | (0.249) |
| Platinum | $1.085^{***}$ | Share Male | $-0.230$ |
| | (0.020) | | (0.250) |
| Share Ages 18 to 25 | $-3.533^{***}$ | Share Special Enrollment | 0.104 |
| | (0.316) | | (0.107) |

Notes: Robust standard errors are in parentheses ($^{***}$ indicates statistical significance at the 1% level, $^{**}$ at the 5% level, and $^{*}$ at the 10% level). Specification (1) omits the network breadth variable and specification (2) network breadth variable. Network breadth data are unavailable for Contra Costa and United. Parameter estimates for the market fixed effects in equation (1) are omitted.

# D CMS Geographic Cost Factors

Table A3: CMS Geographic Cost Factors

| Rating Area | Counties | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 |
|---|---|---|---|---|---|---|---|
| 1 | Northern Counties | 1.04 | 1.04 | 1.14 | 1.16 | 1.35 | 1.38 |
| 2 | North Bay Area | 1.20 | 1.20 | 1.22 | 1.21 | 1.21 | 1.19 |
| 3 | Greater Sacramento | 1.15 | 1.14 | 1.19 | 1.18 | 1.13 | 1.12 |
| 4 | San Francisco | 0.92 | 1.23 | 1.24 | 1.26 | 1.24 | 1.25 |
| 5 | Contra Costa | 1.15 | 1.15 | 1.19 | 1.18 | 1.17 | 1.16 |
| 6 | Alameda | 1.17 | 1.15 | 1.16 | 1.16 | 1.15 | 1.15 |
| 7 | Santa Clara | 1.19 | 1.15 | 1.19 | 1.19 | 1.15 | 1.12 |
| 8 | San Mateo | 1.19 | 1.29 | 1.34 | 1.34 | 1.30 | 1.30 |
| 9 | Monterey, Santa Cruz, San Benito | 1.24 | 1.23 | 1.31 | 1.42 | 1.43 | 1.53 |
| 10 | Central Valley | 1.03 | 0.96 | 1.02 | 1.00 | 1.13 | 1.10 |
| 11 | Fresno, Kings, Madera | 0.99 | 0.96 | 0.95 | 0.93 | 0.88 | 0.84 |
| 12 | Central Coast | 1.09 | 1.10 | 1.10 | 1.10 | 1.02 | 1.02 |
| 13 | Eastern Counties | 1.34 | 1.30 | 1.12 | 1.02 | 1.11 | 1.03 |
| 14 | Kern | 0.95 | 0.94 | 0.96 | 0.93 | 0.91 | 0.91 |
| 15 | Los Angeles Easst | 0.83 | 0.81 | 0.79 | 0.80 | 0.80 | 0.81 |
| 16 | Los Angeles West | 0.93 | 0.93 | 0.91 | 0.92 | 0.94 | 0.95 |
| 17 | Inland Empire | 0.90 | 0.89 | 0.86 | 0.84 | 0.88 | 0.88 |
| 18 | Orange | 0.96 | 0.96 | 0.94 | 0.95 | 0.95 | 0.96 |
| 19 | San Diego | 1.01 | 1.02 | 1.01 | 0.99 | 0.99 | 0.95 |

Notes: Figure shows the geographic cost factors published by CMS by rating area and year. Rating areas with higher-than-average cost have a geographic cost factor greater than 1 and those with lower-than-average cost have a geographic cost factor less than 1.