Managing Adverse Selection: Underinsurance vs. Underenrollment

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Adverse selection in insurance markets may lead some consumers to underinsure or too few consumers to purchase insurance relative to the socially optimal level. I study whether government intervention can mitigate both underinsurance and underenrollment due to adverse selection. I establish theoretical conditions under which there exists a tradeoff in addressing underinsurance and underenrollment. I then estimate a model of the California ACA insurance exchange using consumer-level data to quantify the welfare impact of risk adjustment and the individual mandate. I find (1) risk adjustment reduces underinsurance, but reduces enrollment and (2) the mandate increases enrollment, but increases underinsurance.

Keywords: Adverse selection, individual mandate, risk adjustment, health insurance, ACA.

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Governments have increasingly intervened in insurance markets to address inefficiencies resulting from asymmetric information. A common model for government intervention is managed competition, in which insurers compete for consumers in regulated markets called exchanges (Enthoven, 1978). The exchanges established under the Affordable Care Act (ACA) are a prominent example of managed competition.

An important decision in managed competition is how to regulate price discrimination. Rules limiting price discrimination, referred to as "community rating," are pervasive in insurance markets, including Medicare Advantage and the ACA exchanges. Adverse selection may occur if insurers cannot use information on consumer risk such as health status to price discriminate. Prior work finds empirical evidence of adverse selection in both Medicare Advantage (Brown et al., 2014; Newhouse et al., 2015) and the ACA exchanges (Panhans, 2019).

Adverse selection may cause some consumers to buy too little insurance coverage (Rothschild and Stiglitz, 1976) or not insure at all (Akerlof, 1970), relative to the socially optimal level. To illustrate, suppose consumers can either (1) purchase plan L, which has a low premium and limited benefits; (2) purchase plan H, which has a high premium and comprehensive benefits; or (3) forgo insurance. Underinsurance, an intensive margin effect, arises when low-risk consumers are attracted to plan L because of the high relative premium for plan H. Underenrollment, an extensive margin effect, may occur if there is an influx of high-risk consumers into plan L, raising its premium and causing low-risk consumers to forgo insurance.

In this paper, I study whether government intervention in insurance markets can simultaneously mitigate underinsurance and underenrollment due to adverse selection. Risk adjustment is an example of a policy that addresses underinsurance. In the ACA exchanges, risk adjustment requires plans with lower-than-average risk consumers make transfer payments to plans with higher-than-average risk consumers. If plan L has lower-than-average risk consumers, risk adjustment imposes additional cost on plan L and provides cost relief to plan H, likely increasing plan L's premium and decreasing plan H's premium. Some enrollees in plan L may switch to plan H, reducing underinsurance, but others may opt to forgo insurance, reducing enrollment. A prominent example of a policy that addresses underenrollment is the individual mandate. The ACA's individual mandate incentivizes enrollment by requiring consumers to purchase insurance or pay a tax penalty. In markets with adverse selection, the mandate motivates low-risk consumers to enroll, improving the risk pool. Low-risk entrants are likely to select plan L, increasing the difference between the plan premiums and potentially leading to a reduction or even unraveling in demand for plan H.

To study the underinsurance-underenrollment tradeoff, I first develop a two-plan model. I show that the occurrence and extent of the tradeoff depends primarily on the Jacobian of the plans' average claims functions, which I refer to as the "claim slope matrix." The claim slope matrix captures the intensive and extensive margin effects of adverse selection. I show that the underinsurance-underenrollment tradeoff occurs if average claims are more responsive to changes in plan L's premium than changes in plan H's premium. Insurance markets where the premiums of cheap, limited benefit plans drive the risk level of consumers in the market and between plans are consistent with insurance markets likely to be observed in practice.

In the second part of the paper, I study whether the tradeoff between underinsurance and underenrollment exists in the ACA exchanges. The ACA setting is particularly appealing because (1) there is evidence of both underinsurance and underenrollment and (2) several policies targeting adverse selection are in place, including premium subsidies, risk adjustment, and the mandate. I extend the basic two-plan model to a differentiated products model of the ACA exchanges and estimate it using consumer-level administrative data from the California ACA exchange. My data contain 2.5 million records and account for 15% of nationwide enrollment in the ACA exchanges (Department of Health and Human Services, 2015). Detailed demographic information enables me to calculate consumer-specific plan premiums, subsidies, and penalties for forgoing coverage.

With these data, I estimate consumer-level demand using a nested logit discrete choice model. I address potential endogeneity of the premium by exploiting consumer-level variation in premiums created by exogenous ACA regulations. I estimate average claims and the claim slope matrix by combining my demand estimates with non-parametric estimates of marginal claims from the firms' first-order conditions for profit maximization. I relate these estimates to premiums to measure how marginal claims vary with premiums and find statistically significant evidence of adverse selection.

I use the estimated model to simulate the impact of risk adjustment, an important policy counterfactual given recent litigation challenging the ACA risk adjustment program.[1] I find risk adjustment compresses equilibrium premiums; the least expensive and comprehensive plans (known as bronze) become more expensive, while the most expensive and comprehensive plans (known as platinum) become less expensive. Exchange enrollment shifts from bronze to platinum plans, but total enrollment remains about the same because ACA subsidies are linked to the premium of the one of the cheaper plans. I simulate an alternative scenario where I convert the ACA's price-linked subsidies to vouchers that do not adjust to premiums and find risk adjustment decreases total enrollment.

I then simulate the impact of the mandate penalty, which was set to zero starting in 2019 according to the Tax Cuts and Jobs Act of 2017. I find the individual mandate decreases bronze premiums, but slightly increases platinum premiums. Total exchange enrollment increases, but enrollment in platinum plans declines. Consumer surplus falls because platinum enrollment is reduced and consumers do not benefit from the lower bronze plan premiums (i.e., the price-linked subsidies are reduced). I simulate an alternative scenario where I convert the price-linked subsidies to vouchers and find the mandate (1) increases total enrollment and (2) increases consumer surplus because consumers benefit from the lower bronze premiums.

The primary contribution of this paper is to illustrate the underinsurance-underenrollment tradeoff and its existence in the ACA exchanges. This tradeoff is relevant not only for the ACA exchanges, but also other community-rated markets such as Medicare Advantage and Medicare Part D. Most work studying the effects of adverse selection in insurance markets considers either the intensive or

[1]The decision in *New Mexico Health Connections v. U.S. Department of Health and Human Services* case challenged the ACA's risk adjustment transfer formula. On July 7, 2018, the Trump Administration responded by suspending risk adjustment transfers for the 2017 plan year totaling \$10.4 billion. The Trump Administration announced on July 24, 2018 that it would restore the risk adjustment program.

extensive margin, but not both simultaneously. Azevedo and Gottlieb (2017) show in a theoretical model of perfect competition how the individual mandate can have the unintended consequence of increasing underinsurance. In concurrent work, Geruso et al. (2019) construct a novel graphical framework to illustrate the underinsurance-underenrollment tradeoff in the spirit of Einav, Finkelstein, and Cullen (2010). My work complements these studies by showing the tradeoff analytically and its dependence on the claim slope matrix. I develop a novel empirical strategy for estimating the claim slope matrix. The approach can be implemented in markets with a large number of products such as the California exchange, where about 75 different plans offered by 11 different firms are available and the claim slope matrix is therefore 75×75. The estimated claim slope matrix captures selection effects between plans sold by the same insurer and plans sold by other insurers.

This paper also augments the extensive literature on risk adjustment and the individual mandate. Considerable research examines how well risk adjustment programs equalize firm risk (Brown et al., 2014; Newhouse et al., 2015; Geruso et al., 2016), but less work has studied its impact on coverage and social welfare. Handel, Hendel, and Whinston (2015) and Layton (2017) find that risk adjustment can yield welfare gains by reducing underinsurance, while Mahoney and Weyl (2017) show that risk adjustment can reduce total enrollment. While there is little empirical work on the intensive margin effects of the mandate, previous studies have found the mandate has a beneficial, but small impact on total enrollment and welfare (Hackmann, Kolstad, and Kowalski, 2015; Frean, Gruber, and Sommers, 2017; Sacks, 2017). I build on these studies by considering how risk adjustment and the mandate affect both underinsurance and underenrollment in a single framework.

I also contribute to the broader economic literature on health insurance. Recent work has considered the economic tradeoffs between "price-linked" subsidies that adjust to premium changes and "fixed" subsidies or vouchers that are set independently of premiums (Jaffe and Shepard, 2017; Tebaldi, 2017). I extend this literature by studying the interaction of the subsidy design with the individual mandate and risk adjustment. My analysis links to the empirical literature that examines the welfare impact of adverse selection in health insurance markets (Cutler and Reber, 1998; Pauly and Herring, 2000; Cardon and Hendel, 2001; Einav et al., 2013; Handel, 2013). This study also adds to the economic literature studying the early experience of the ACA exchanges (Tebaldi, 2017; Abraham et al., 2017; Domurat, 2017; Drake, 2019).

The remainder of this paper is organized as follows. Section 1 presents a theoretical model illustrating the underinsurance-underenrollment tradeoff. Section 2 adapts the model to the ACA setting. Section 3 describes the data. Section 4 details how I estimate the model. Section 5 simulates the impact of risk adjustment and the individual mandate. Section 6 concludes.

1 Basic Model

I first develop a tractable model[2] to illustrate the underinsurance-underenrollment tradeoff and understand when it occurs. Consider a competitive market with two firms L and H that each sell one plan with premiums p_L and p_H, respectively. Let $q_f \equiv q_f(p_L, p_H)$ be firm f's demand for $f \in \{L, H\}$ with negative own-price partial derivatives $\frac{\partial q_L}{\partial p_L}, \frac{\partial q_H}{\partial p_H} < 0$ and positive cross-price partial derivatives $\frac{\partial q_L}{\partial p_H}, \frac{\partial q_H}{\partial p_L} > 0$. Denote $c_f \equiv c_f(p_L, p_H)$ as average claims, where $c_L \leq c_H$, and $D(\mathbf{c})$ as the corresponding claim slope matrix

$$D(\mathbf{c}) = \begin{bmatrix} \frac{\partial c_L}{\partial p_L} & \frac{\partial c_L}{\partial p_H} \\ \frac{\partial c_H}{\partial p_L} & \frac{\partial c_H}{\partial p_H} \end{bmatrix}$$

Assume adverse selection is present such that the own-price partial derivatives satisfy $0 < \frac{\partial c_L}{\partial p_L}, \frac{\partial c_H}{\partial p_H} < 1$ and the cross-price partial derivatives satisfy $-1 < \frac{\partial c_L}{\partial p_H}, \frac{\partial c_H}{\partial p_L} < 0$. Further assume higher total enrollment $q \equiv q_L + q_H$ reduces market average claims $c \equiv (q_L c_L + q_H c_H)/(q_L + q_H)$. That is, $q(p'_L, p'_H) < q(p''_L, p''_H)$ if and only if $c(p'_L, p'_H) > c(p''_L, p''_H)$ for any premium vectors $p' = (p'_L, p'_H)$ and $p'' = (p''_L, p''_H)$. Individual consumers make the same claims regardless of which plan they choose (i.e., there is no moral hazard). Firm profit $\pi_f(p_L, p_H) = [p_f - c_f]q_f$. In equilibrium, the

[2] To this end, I make several assumptions that I relax in the next section, where I allow for more than two firms selling heterogeneous products, imperfect competition, imperfect risk adjustment, the divergence of average claims and risk, and moral hazard.

firms earn zero profit such that $p_L = c_L$ and $p_H = c_H$. Below I illustrate how risk adjustment and the individual mandate affect this competitive equilibrium.

1.1 Risk Adjustment

Risk adjustment transfers money from the firm with lower-than-average risk (firm L) to the firm with higher-than-average risk (firm H) such that each firm is exposed to the same risk. Assume average claims perfectly represent firm risk exposure. Under risk adjustment, each firm is exposed to market average claims c, so the risk adjustment transfer per consumer paid by firm L is $t_L \equiv c - c_L$ and the transfer per consumer received by firm H is $t_H \equiv c_H - c$. The equilibrium conditions are

$$\begin{aligned} p_L &= c'_L \equiv c_L + \psi t_L = (1-\psi)c_L + \psi c \\ p_H &= c'_H \equiv c_H - \psi t_H = (1-\psi)c_H + \psi c \end{aligned} \tag{1}$$

where $\psi \in [0,1]$ is the level of risk adjustment. Without risk adjustment, $\psi = 0$ and the firms set premiums equal to their average claims in equilibrium (i.e., $p_L = c_L$ and $p_H = c_H$). Full risk adjustment corresponds to $\psi = 1$ and the firms set premiums equal to the market average claims in equilibrium (i.e., $p_L = p_H = c$). Partial risk adjustment occurs when $0 < \psi < 1$.

Appendix A shows that differentiating (1) with respect to the level of risk adjustment ψ yields

$$\begin{aligned} \frac{\partial p_L}{\partial \psi} &= \frac{t_L\left(1 - \frac{\partial c'_H}{\partial p_H}\right) - t_H \frac{\partial c'_L}{\partial p_H}}{\left(1 - \frac{\partial c'_L}{\partial p_L}\right)\left(1 - \frac{\partial c'_H}{\partial p_H}\right) - \frac{\partial c'_H}{\partial p_L}\frac{\partial c'_L}{\partial p_H}} \\ \frac{\partial p_H}{\partial \psi} &= \frac{-t_H\left(1 - \frac{\partial c'_L}{\partial p_L}\right) + t_L \frac{\partial c'_H}{\partial p_L}}{\left(1 - \frac{\partial c'_L}{\partial p_L}\right)\left(1 - \frac{\partial c'_H}{\partial p_H}\right) - \frac{\partial c'_H}{\partial p_L}\frac{\partial c'_L}{\partial p_H}} \end{aligned} \tag{2}$$

Appendix A establishes risk adjustment increases firm L's premium ($\frac{\partial p_L}{\partial \psi} > 0$) and decreases firm H's premium ($\frac{\partial p_H}{\partial \psi} < 0$). These premium changes may reduce underinsurance if some of firm L's consumers shift to firm H and reduce enrollment if firm L's marginal buyers forgo insurance. Proposition 1.1 gives sufficient conditions on the claim slope matrix for the tradeoff to occur.

Proposition 1.1. *Suppose (i)* $\frac{\partial c'_L}{\partial p_L} > \frac{\partial c'_H}{\partial p_H}$*; (ii)* $\frac{\partial c'_L}{\partial p_L} > |\frac{\partial c'_L}{\partial p_H}|$*; (iii)* $|\frac{\partial c'_H}{\partial p_L}| \geq \frac{\partial c'_H}{\partial p_H}$*; (iv)* $|\frac{\partial c}{\partial p_L}| > |\frac{\partial c}{\partial p_H}|$*; and (v)* $t_L \frac{\partial c}{\partial p_L} > t_H \frac{\partial c}{\partial p_H}$.[3] *Then risk adjustment decreases total enrollment* ($\frac{\partial q}{\partial \psi} < 0$) *and decreases underinsurance* ($\frac{\partial q_H}{\partial \psi} > 0$).

Proof. See Appendix A. □

The sufficient conditions in Proposition 1.1 imply that changes in firm L's premium have a greater impact on average claims in the market and between plans than changes in firm H's premium. These sufficient conditions are plausible in insurance markets where the willingness-to-pay distribution for an insurance plan is proportional to the long-tailed distribution of consumer claims (Agency for Healthcare Research and Quality, 2019). Such a market is consistent with the "vertical preferences" assumption made by Geruso et al. (2019), but contradicts their assumption that willingness-to-pay follows the uniform distribution. In this market environment, firm L's average claims are highly sensitive to consumers on the margin between L and the outside option, but relatively less sensitive to consumers on the margin between L and H where the willingness-to-pay distribution thins. Firm H's average claims are relatively insensitive to plan switching because the long tail of the willingness-to-pay distribution drives its claims. Firm L therefore faces greater own-price effects than firm H (condition 1), firm L's average claims are more responsive to its own premium than its competitor's premium (condition 2), firm L's premium has a bigger impact on market average claims than changes in firm H's premium (condition 4), and firm L's premium scaled by the average transfer t_L has a greater effect on market average claims than firm H's premium scaled by the average transfer t_H (condition 5). The third sufficient condition is likely to hold as an equality if consumers have vertical preferences or few consumers are on the margin between H and the outside option; it would hold as a strict inequality if consumers on the margin between L and H have higher claims than those on the margin between H and the outside option.

[3] I could replace the assumptions on c and c' with analogous assumptions on the more primitive c_L and c_H, but instead make assumptions on c and c' for expositional clarity.

The sufficient conditions in Proposition 1.1 may not hold in all insurance markets. If the willingness-to-pay distribution were uniform instead of long-tailed, both firms' average claims would be more sensitive to switching between L and H, offsetting the effect of firm L's low-risk marginal buyers switching between L and the outside option. Firm H may face greater own-price effects than firm L, violating the first sufficient condition. Firm L's average claims may be more sensitive to firm H's premium than its own premium, violating the second sufficient condition.

1.2 Individual Mandate

The individual mandate assesses a penalty ρ on consumers who forgo insurance. Assume average claims are decreasing in the penalty such that $\frac{\partial c_L}{\partial \rho}, \frac{\partial c_H}{\partial \rho} < 0$ for a given price vector (p_L, p_H). The equilibrium conditions are

$$\begin{aligned} p_L &= c_L(p_L, p_H, \rho) \\ p_H &= c_H(p_L, p_H, \rho) \end{aligned} \tag{3}$$

In Appendix A, I show that differentiating equilibrium conditions (3) with respect to the penalty yields

$$\begin{aligned} \frac{\partial p_L}{\partial \rho} &= \frac{\frac{\partial c_L}{\partial \rho}\left(1 - \frac{\partial c_H}{\partial p_H}\right) + \frac{\partial c_H}{\partial \rho}\frac{\partial c_L}{\partial p_H}}{\left(1 - \frac{\partial c_L}{\partial p_L}\right)\left(1 - \frac{\partial c_H}{\partial p_H}\right) - \frac{\partial c_H}{\partial p_L}\frac{\partial c_L}{\partial p_H}} \\ \frac{\partial p_H}{\partial \rho} &= \frac{\frac{\partial c_H}{\partial \rho}\left(1 - \frac{\partial c_L}{\partial p_L}\right) + \frac{\partial c_L}{\partial \rho}\frac{\partial c_H}{\partial p_L}}{\left(1 - \frac{\partial c_L}{\partial p_L}\right)\left(1 - \frac{\partial c_H}{\partial p_H}\right) - \frac{\partial c_H}{\partial p_L}\frac{\partial c_L}{\partial p_H}} \end{aligned} \tag{4}$$

In general, these partial derivatives cannot be signed. The penalty is likely to decrease firm L's premium ($\frac{\partial p_L}{\partial \rho} < 0$) and increase firm H's premium ($\frac{\partial p_H}{\partial \rho} > 0$) if the underinsurance-underenrollment exists. Proposition 1.2 gives sufficient conditions on the claim slope matrix for the tradeoff to occur.

Proposition 1.2. *Suppose (i)* $\frac{\partial c_L}{\partial p_L} > \frac{\partial c_H}{\partial p_H}$*; (ii)* $|\frac{\partial c_H}{\partial p_L}| \geq |\frac{\partial c_L}{\partial p_H}|$*; (iii)* $\frac{\partial c}{\partial p_L} > \frac{\partial c}{\partial p_H}$*; (iv)* $|\frac{\partial c_L}{\partial \rho}| > |\frac{\partial c_H}{\partial \rho}|$*; (v)* $\frac{\partial c_L}{\partial p_L} + |\frac{\partial c_H}{\partial p_L}| > 1$ *and* $\frac{\partial c_H}{\partial p_H} + |\frac{\partial c_L}{\partial p_H}| < 1$*. Then the individual mandate increases total enrollment* ($\frac{dq}{d\rho} > 0$) *and increases underinsurance* ($\frac{dq_H}{d\rho} < 0$).

Proof. See Appendix A. □

As I establish in the proof of Proposition 1.2, the mandate reduces firm L's premium and increases firm H's premium. These premium changes occur because (1) low-risk consumers motivated to enroll by the mandate disproportionately choose the cheaper plan L and reduce its premium relative to firm H's plan and (2) marginal buyers of firm H's plan shift to firm L's plan, increasing firm H's premium. Consequently, firm L's enrollment increases and firm H's enrollment decreases.

The sufficient conditions in Proposition 1.2 are very similar to those in Proposition 1.1 for risk adjustment. They imply changes in firm L's premium have a greater impact on consumer risk in the market and between plans than changes in firm H's premiums. The sufficient conditions are plausible in markets where the willingness-to-pay distribution is long-tailed. In such markets, firm L faces greater own-price effects than firm H (condition 1), firm L's premium has a bigger impact on market average claims than changes in firm H's premium (condition 3), and firm L's average claims are more responsive to the mandate penalty than firm H's average claims (condition 4). The second sufficient condition primarily concerns consumers on the margin between L and H and is more likely to hold when enrollment in L exceeds enrollment in H. The fifth sufficient condition, which is only used to sign the partial derivatives in equation (1.2), imposes a lower bound for firm L's own-price effect and an upper bound for firm H's own-price effect.

The basic model shows the underinsurance-underenrollment tradeoff can occur in realistic markets. I now turn to the ACA setting to examine whether the tradeoff occurs in practice.

2 ACA Exchange Model

I extend the basic model to study the tradeoff between underinsurance and underenrollment in the ACA setting. The objective is to develop an estimable model that captures the important market features of the exchanges. Consider a two-stage model where (1) insurers set premiums simultaneously to maximize their expected profit and (2) consumers then select a plan to maximize their expected utility. Below I detail how I model household plan choice and firm premium-setting. I then discuss how the omission of certain market features may bias my empirical results.

2.1 Household Plan Choice

Exchange consumers can choose a plan from on the four actuarial value (AV) or "metal" tiers, including bronze (60% AV), silver (70% AV), gold (80% AV), and platinum (90% AV). Individuals under age 30 can buy a basic catastrophic plan. Silver is the most common choice because eligible consumers must choose silver in order to receive cost sharing reductions (CSRs) that reduce deductibles, copays, etc. CSRs increase the AV of silver plans as discussed in Appendix D. In California, plans within a metal tier are standardized to have the same cost sharing parameters.

In the model, households choose the plan that maximizes their utility function

$$U_{ij} \equiv \alpha_i p_{ij}(\mathbf{p}) + x_j'\beta + d_i'\varphi + \xi_j + \epsilon_{ij} \tag{5}$$

where $\mathbf{p}$ is the vector of plan base premiums, $p_{ij}(\mathbf{p})$ is household i's premium for plan j, d_i is a vector of demographic characteristics, x_j is a vector of observed product characteristics including the plan AV, ξ_j is a vector of unobserved product characteristics, ϵ_{ij} is an error term, and the household i's premium parameter $\alpha_i = \alpha + d_i'\gamma$. CSRs enter equation (5) through the plan AV and premium subsidies reduce the household's premium $p_{ij}(\mathbf{p})$. The household's premium is calculated as

$$p_{ij}(\mathbf{p}) = \max\left\{ \underbrace{r_{ij}p_j}_{\substack{\text{full}\\ \text{premium}}} - \underbrace{\max\{r_{ij}p_b - c_i, 0\}}_{\text{premium subsidy}}, 0 \right\} \tag{6}$$

where r_{ij} is the household's rating factor, p_j is the base premium of plan j, p_b is the base premium of the benchmark plan, and c_i is the household's income contribution cap. The product of the rating factor and the plan's base premium equals the unsubsidized premium. The ACA limits variation in the rating factor to the age, smoking status, and geographic residence of the household's members. Insurers can charge a 64-year-old up to 3 times as much as a 21-year-old. Smokers can be charged 50% more than non-smokers, but some states including California prohibit tobacco rating. Each state also defines geographic rating areas where an insurer's premiums must be the same for consumers of the same age and smoking status. Figure 1 shows the California rating area partition.

The household's premium subsidy equals the difference between what the household would pay for the benchmark plan ($r_{ij}p_b$) and the household's income contribution cap c_i. The benchmark plan is the second-cheapest silver plan available and varies between consumers because of heterogeneous firm entry. The income contribution cap ranged from 2% of annual income for consumers earning 100% of the federal poverty level (FPL) and 9.5% of annual income for consumers earning 400% of FPL in 2014. Subsidies can be applied to any plan except a catastrophic plan. For some low-income consumers, the premium subsidy may exceed the full premium of certain bronze plans. The subsidy is reduced in these cases to ensure nonnegativity of the premium. Premium subsidies are available to consumers who (1) have income between 100% and 400% of FPL; (2) are citizens or legal residents; (3) are ineligible for public insurance such as Medicare or Medicaid[4]; and (4) lack access to an "affordable plan offer" through employer-sponsored insurance.[5]

The utility of the outside option $U_{i0} = \alpha_i \rho_i + \epsilon_{i0}$, where ρ_i is the household's penalty for forgoing insurance. The penalty was phased in between 2014 and 2016. The penalty for a single person was the greater of $\$95$ and 1% of income exceeding the filing threshold in 2014 and the greater of $\$695$ and 2.5% of income in 2016. Exemptions from the ACA's individual mandate are made for certain groups, including (1) those with income below the tax filing threshold and (2) individuals who lack access to a health insurance plan that is less than 8% of their income in 2014 (8.05% in 2015).

Let the household demand function $q_{ij}(\mathbf{p})$ be the probability household i chooses plan j. The effect of a premium change on a subsidized consumer's demand is given by

[4]In Medicaid expansion states, most households with income below 138% of FPL are eligible for Medicaid. Low-income recent immigrants may be ineligible for Medicaid, but eligible to receive exchange subsidies.

[5]A plan is defined as affordable if the employee's contribution to the employer's single coverage plan is less than 9.5% of the employee's household income in 2014 and 9.56% of income in 2015.

$$\frac{\partial q_{ik}(\mathbf{p})}{\partial p_j} = \sum_{l \in J} \frac{\partial q_{ik}(\mathbf{p})}{\partial p_{il}(\mathbf{p})} \frac{\partial p_{il}(\mathbf{p})}{\partial p_j}$$

for all plans j, k in the set of available plans J. Assuming a strictly positive subsidy that does not exceed the full, unsubsidized premium, it follows from equation (6) that

$$\frac{\partial p_{il}(\mathbf{p})}{\partial p_j} = \begin{cases} 0 & l = j, j = b \\ r_{ij} & l = j, j \neq b \\ -r_{ib} & l \neq j, j = b \\ 0 & l \neq j, j \neq b \end{cases} \tag{7}$$

For a non-benchmark plan, an infinitesimal premium increase results in consumers paying more for that plan only. An infinitesimal increase in the benchmark premium does not affect what subsidized consumers pay for the benchmark plan, but reduces what consumers pay for all other plans because of the larger subsidy. The complex relationship between insurer and consumer premiums, endogenous determination of the benchmark premium, and variation in the benchmark plan across consumers due to heterogeneous entry create significant computational challenges. I carefully model the endogenous subsidy design despite the high computational cost because of the critical role premium subsidies play in addressing adverse selection.

2.2 Firm Premium-Setting

A risk-neutral profit-maximizing firm sets the base premium for each plan that it sells to maximize

$$\pi_f(\mathbf{p}) \quad = \quad R_f(\mathbf{p}) - C_f(\mathbf{p}) + RA_f(\mathbf{p}) + RI_f(\mathbf{p}) - V_f - FC_f \tag{8}$$

where $R_f(\mathbf{p})$ is total premium revenue, $C_f(\mathbf{p})$ is total claims, $RA_f(\mathbf{p})$ is risk adjustment received, $RI_f(\mathbf{p})$ is reinsurance received, V_f is variable administrative cost (e.g., commissions or fees), and FC_f is fixed cost. Firm premium revenue $R_f(\mathbf{p}) = \sum_{i \in I, j \in J_f} r_{ij} p_j q_{ij}(\mathbf{p})$, where J_f is the set of plans sold by firm f. Firm claims $C_f(\mathbf{p}) = c_f(\mathbf{p}) \sum_{i \in I, j \in J_f} q_{ij}(\mathbf{p})$, where $c_f(\mathbf{p})$ is average claims.

Pope et al. (2014) derive the ACA risk adjustment transfer formula. Plans with lower-than-average risk make payments to plans with higher-than-average risk such that $\sum_f RA_f = 0$. The ACA design contrasts with the one used in Medicare Advantage, where risk adjustment payments are benchmarked to the risk of those choosing the outside option (i.e., traditional Medicare) and do not necessarily sum to zero. Under the ACA's single risk pool provisions, risk adjustment occurs at the state level for all firms participating in the individual market, including firms offering plans off the exchanges. Risk adjustment reduces firm incentives to market in favorable geographic regions of the state or off the exchanges. Risk adjustment also discourages strategic variation in premiums by plan generosity, but does not explicitly restrict such variation.

Appendix C shows how the risk adjustment transfer formula in Pope et al. (2014) can be aggregated to the firm's risk adjustment transfer

$$RA'_f(\mathbf{p}) \;=\; \left(\omega_f(\mathbf{p}) \sum_{i\in I, j\in J_f} q_{ij}(\mathbf{p}) - rs_f(\mathbf{p}) \sum_{i\in I, j\in J} q_{ij}(\mathbf{p})\right) \overline{p} \tag{9}$$

where $\omega_f(\mathbf{p})$ is the firm's risk score, $rs_f(\mathbf{p})$ is the firm's risk-adjusted share of total claims, and $\overline{p}$ is the share-weighted average premium. The risk score $\omega_f(\mathbf{p}) \equiv \frac{c'_f(\mathbf{p})}{c'(\mathbf{p})}$, where $c'_f(\mathbf{p})$ is the firm's predicted average claims and $c'(\mathbf{p})$ is the predicted average claims weighted across all firms. Kautter et al. (2014) detail how demographics and diagnosed conditions are used to predict average claims. Firms with higher-than-average risk have risk score $\omega_f(\mathbf{p}) > 1$, firms with lower-than-average risk have $\omega_f(\mathbf{p}) < 1$, and firms with average risk have $\omega_f(\mathbf{p}) = 1$. The risk-adjusted share equals

$$rs_f(\mathbf{p}) = \frac{\sum_{i\in I, j\in J_f} h_j q_{ij}(\mathbf{p})}{\sum_{i\in I, j\in J} h_j q_{ij}(\mathbf{p})}$$

where h_j is an exogenous utilization factor that accounts for the plan AV and expected moral hazard. The firm's risk-adjusted share equals its market share if its enrollees have an average distribution across the plan metal tiers.

ACA risk adjustment formula (9) assumes firms price at average claims, which could introduce error if there are administrative costs or markups. If average claims are used instead of the average premium and the firm's risk-adjusted share equals its market share, then formula (9) reduces to

$$RA'_f(\mathbf{p}) \;\; = \;\; \left[c'_f(\mathbf{p}) - c'(\mathbf{p})\right] \sum_{i\in I, j\in J_f} q_{ij}(\mathbf{p}) = t_f \sum_{i\in I, j\in J_f} q_{ij}(\mathbf{p})$$

where $t_f \equiv c'_f(\mathbf{p}) - c'(\mathbf{p})$ is the average transfer received by firm f as in the basic model.

Because data on diagnosed conditions are unavailable, I cannot implement formula (9). Instead, I set the risk score $\omega_f(\mathbf{p}) = \phi_f \frac{c_f(\mathbf{p})}{c(\mathbf{p})}$, where ϕ_f is the firm's imperfection score, $c_f(\mathbf{p})$ is the firm's actual average claims, and $c(\mathbf{p})$ is the actual average claims weighted across all firms. The imperfection score is a parameter that captures all *unobserved* factors that may cause predicted and actual claims to diverge, including imprecision in the risk adjustment formula or variation in firm efficiency, bargaining power with providers, and ability to exploit the risk adjustment formula. These factors cannot be separately identified. Differences in plan generosity are captured in the risk-adjusted share $rs_f(\mathbf{p})$ and do not affect the imperfection score. The transfer becomes

$$RA_f(\mathbf{p}) \;\; = \;\; \left[\phi_f \frac{c_f(\mathbf{p})}{c(\mathbf{p})} \left(\sum_{i\in I, j\in J_f} q_{ij}(\mathbf{p})\right) - rs_f(\mathbf{p}) \left(\sum_{i\in I, j\in J} q_{ij}(\mathbf{p})\right)\right] \overline{p} \qquad (10)$$

Reinsurance was a temporary program in effect through 2016 that helped to offset the realized claims of high-utilization consumers. Let τ_f be the AV of the reinsurance contract (i.e., the expected percentage of claims paid by the reinsurer). Reinsurance received $RI_f(\mathbf{p}) = \tau_f c_f(\mathbf{p}) \sum_{i\in I, j\in J_f} q_{ij}(\mathbf{p})$. Substituting the risk adjustment and reinsurance formulas into equation (8) yields

$$\pi_f(\mathbf{p}) \;\; = \;\; R_f(\mathbf{p}) + \left[\phi_f \frac{C_f(\mathbf{p})}{C(\mathbf{p})} - rs_f(\mathbf{p})\right] R(\mathbf{p}) - (1-\tau_f) C_f(\mathbf{p}) - V_f - FC_f \qquad (11)$$

where $R(\mathbf{p}) = \sum_f R_f(\mathbf{p})$ and $C(\mathbf{p}) = \sum_f C_f(\mathbf{p})$. The corresponding first-order conditions are

$$MR_j(\mathbf{p}) \;\; = \;\; \overline{MR}_j(\mathbf{p}) - \phi_f \widetilde{MC}_j(\mathbf{p}) + (1-\tau_f) MC_j(\mathbf{p}) + v_f \frac{\partial q_f(\mathbf{p})/\partial p_j}{\partial q_j(\mathbf{p})/\partial p_j} \qquad (12)$$

for all plans offered by the firm, where $q_j(\mathbf{p})$ is plan demand, $q_f(\mathbf{p})$ is total firm demand, v_f is per-consumer variable administrative cost, and formulas for marginal revenue $MR_j(\mathbf{p}) \equiv \frac{\partial R_f(\mathbf{p})}{\partial q_j(\mathbf{p})}$, marginal claims $MC_j(\mathbf{p}) \equiv \frac{\partial C_f(\mathbf{p})}{\partial q_j(\mathbf{p})}$, "average" marginal revenue $\overline{MR}_j(\mathbf{p}) \equiv \frac{\partial [rs_f(\mathbf{p})R(\mathbf{p})]}{\partial q_j(\mathbf{p})}$, and $\widetilde{MC}_j(\mathbf{p}) = \frac{\partial [C_f(\mathbf{p})R(\mathbf{p})/C(\mathbf{p})]}{\partial q_j(\mathbf{p})}$ are given in Appendix B.

First-order conditions (12) are difficult to interpret. Suppose average claims had been used in formula (10) instead of the average premium, there is no reinsurance ($\tau_f = 0$) or administrative costs ($v_f = 0$), and the imperfection score $\phi_f = 1$. Then the firm's first order conditions are

$$MR_j(\mathbf{p}) \;\; = \;\; \overline{MC}_j(\mathbf{p}) \tag{13}$$

where $\overline{MC}_j(\mathbf{p}) \equiv \frac{\partial (rs_f(\mathbf{p})C(\mathbf{p}))}{\partial q_j(\mathbf{p})}$ is "average" marginal claims. Average marginal claims vary by plan and represent what plan j's marginal claims would have been if its enrollees had average risk (not an average of marginal claims across plans). In this case, risk adjustment replaces the firm's own marginal claims with average marginal claims. Risk adjustment raises marginal cost for firms with lower-than-average risk and reduces marginal cost for firms with higher-than-average risk.

Appendix B shows how every variable in equation (13) can be written in terms of four variables, including: (1) the household choice probabilities $q_{ij}(\mathbf{p})$; (2) the $J \times J$ household demand sensitivity matrix $D_i(\mathbf{q})$; (3) the firm's average claims function $c_f(\mathbf{p})$; and (4) the $J \times J$ claim slope matrix $D(\mathbf{c})$. The (k, j)-element of household i's demand sensitivity matrix equals the partial derivative $\frac{\partial q_{ik}(\mathbf{p})}{\partial p_{ij}(\mathbf{p})}$. The (k, j)-element of the claim slope matrix equals the partial derivative $\frac{\partial c_f(\mathbf{p})}{\partial p_j}$.

2.3 Model Limitations

Although I model many of the key features of the ACA exchanges, I am unable to model some policy details. I lack demand data on individual plans sold outside the ACA exchanges. Only unsubsidized consumers are likely to consider off-exchange plans, which are ineligible for subsidies. Off-exchange plans have to comply with ACA regulations and are rated together with exchange plans as part of a single risk pool. On average, California exchange plans paid a per-consumer risk adjustment transfer to off-exchange plans of only $0.80 in 2014 (compared to average claims of

\$314) and \$1.10 in 2015 (compared to average claims of \$338) (Department of Managed Health Care, 2016). Hence, selection between exchange and off-exchange plans is negligible.

Data on claims, risk adjustment, and reinsurance are not available at the rating area level. Consequently, I am unable to model how firms adjust geographic rating factors (i.e., ratio of premium in a rating area to the plan base premium) when computing equilibrium base premiums in alternative scenarios. Assuming the geographic rating factors are exogenous could downward bias my estimates of risk adjustment's impact if insurers risk select across rating areas. In practice, geographic rating factors are closely reviewed by California regulators and must be supported with cost data.

Because modeling the ACA's endogenous subsidy imposes significant computational challenges, I make compromises elsewhere. I do not permit insurer entry and exit in the model. Although elimination of policies targeting adverse selection could prompt some insurers to exit, no California insurers exited any rating areas in 2019 when the mandate penalty was set to zero. Ignoring insurer entry and exit does not preclude the possibility that specific plans offered by an insurer could unravel. I also assume that products sets and characteristics are exogenous. This assumption is not particularly onerous because of the ACA's metal tier structure and strict regulations on minimum essential benefits. California has standardized cost sharing parameters and requires insurers to offer a plan in each metal tier. Firms could use narrow provider networks and restrictive formularies to attract low-risk consumers in the absence of risk adjustment. Ignoring provider networks and formularies could bias the magnitude of my estimates, but is unlikely to have a bearing on my central research question of whether there is tradeoff between underinsurance and underenrollment.

3 Data

To estimate the model, I use detailed consumer-level enrollment data from the California ACA exchange. There are approximately 2.5 million records across the 2014 and 2015 plan years. Table II indicates that the California exchange has robust firm participation. Four firms – Anthem, Blue

Shield, Centene, and Kaiser – have 95% of the market share. The data indicate every enrollee's selected plan and demographic information such as age, county of residence, income, and subsidy eligibility. These demographic characteristics and rating factors from insurer rate filings (Department of Managed Health Care, 2016) enable me to (1) define the household's complete menu of plan choices and (2) calculate the household-specific premium from the base premium. I also use the American Community Survey (ACS) to obtain data on uninsured consumers (Ruggles et al., 2016). I exclude undocumented immigrants and any consumers eligible for another source of insurance coverage. Table III presents summary statistics on exchange enrollees and the uninsured. Silver is the most commonly selected option because consumers must choose a silver plan to receive CSRs. The modest enrollment in gold and platinum plans suggests there is underinsurance, while the large number of uninsured indicates there is also underenrollment.

Data on firm costs come from the medical loss ratio (MLR) reports (Centers for Medicare and Medicaid Services, 2017) and other CMS reports (Centers for Medicare and Medicaid Services, 2015, 2016). These data provide state-level information on risk adjustment, reinsurance, firm claims, variable administrative cost, and fixed administrative cost. Table IV summarizes average claims, risk adjustment transfers, and reinsurance recoveries. The utilization factors used in calculating risk-adjusted shares come directly from the formula used by CMS (Pope et al., 2014). Although I do not directly observe the imperfection scores, I solve for them in ACA risk adjustment transfer formula (10) using data on risk adjustment transfers, claims, and risk-adjusted shares.

4 Estimation

In this section, I explain how I estimate (1) the household choice probabilities $q_{ij}(\mathbf{p})$; (2) the household demand sensitivity matrix $D_i(\mathbf{q})$; (3) the firm's average claims function $c_f(\mathbf{p})$; and (4) the claim slope matrix $D(\mathbf{c})$. I first discuss how I estimate demand and then how I estimate claims.

4.1 Estimating Demand

To estimate demand, I model equation (5) as a nested logit at the consumer level, where the vector of error terms ϵ_i has the generalized extreme value distribution. I create a nest containing all exchange plans and a nest containing only the outside option. This two-nest structure captures the key observed substitution pattern between the silver tier and the outside option resulting from the ACA's linkage of CSRs to the purchase of silver plans. The household choice probabilities are

$$q_{ij}(\mathbf{p};\boldsymbol{\theta}) \quad = \quad \frac{e^{V_{ij}/\lambda}\left(\sum_j e^{V_{ij}/\lambda}\right)^{\lambda-1}}{1+\left(\sum_j e^{V_{ij}/\lambda}\right)^{\lambda}} \tag{14}$$

where $\boldsymbol{\theta}$ is the vector of parameters in equation (5), $V_{ij} \equiv \alpha_i p_{ij}(\mathbf{p}) + x_j'\beta + d_i'\varphi + \xi_j$, and λ is the nesting parameter. The (k, j) element of the demand sensitivity matrix is given by

$$\frac{\partial q_{ik}(\mathbf{p},\boldsymbol{\theta})}{\partial p_{ij}} = \begin{cases} \alpha q_{ij}(\mathbf{p})\left[\frac{1}{\lambda} + \frac{\lambda-1}{\lambda} q'_{ij}(\mathbf{p}) - q_{ij}(\mathbf{p})\right] & k = j \\ \alpha q_{ij}(\mathbf{p})\left[\frac{\lambda-1}{\lambda} q'_{ij}(\mathbf{p}) - q_{ij}(\mathbf{p})\right] & k \neq j \end{cases} \tag{15}$$

where $q'_{ij}(\mathbf{p})$ is the probability of choosing j, conditional on choosing a plan. I use the base estimates of parameter vector $\boldsymbol{\theta}$ directly from Saltzman (2019). These parameter estimates are summarized in Appendix E. Table V shows the implied (unsubsidized) premium elasticities and semi-elasticities of demand. My estimates are consistent with other estimates of premium sensitivity in the California exchange (Tebaldi, 2017; Domurat, 2017; Drake, 2019).

Exogenous sources of variation in absolute premiums (i.e., relative to the outside option) are required to identify the effect of premiums on households' extensive margin decision to purchase an exchange plan. The phase-in of the penalty between 2014 and 2016 and time-varying kinks in the penalty formula create substantial temporal and cross-sectional variation in absolute premiums. I also exploit several discontinuities in absolute premiums, including (1) the 57% increase in the government's age rating curve between ages 20 and 21; (2) the subsidy eligibility threshold at 400% of FPL; and (3) exemptions from the mandate. Regression discontinuity design plots in Figure 2 indicate the subsidy eligibility threshold and tax filing threshold exemption have a large impact on the probability of enrolling in the exchange. A potential concern with income-based thresholds is that consumers may manipulate their incomes to reduce their absolute premiums.

Identification of the intensive margin decision between alternative exchange plans requires exogenous variation in choice sets and relative premiums (i.e., between plans). In addition to the significant variation in choice sets across California's 19 rating areas, the age 30 limit for purchasing a catastrophic plan creates exogenous within-market variation in choice sets. Subsidized consumers face different relative premiums for catastrophic plans because subsidies cannot be used to purchase a catastrophic plan. Kinks in premium formula (6) create variation in relative premiums. Formula (6) implies that some low-income consumers may receive a smaller subsidy for certain bronze plans if the subsidy exceeds the full premium. For these bronze plans, the consumer premium $p_{ij} = 0$.[6]

Unobservables such as provider networks and formularies may be correlated with premiums across insurers and markets. I address this concern by estimating equation (5) with insurer-market fixed effects. Ho and Pakes (2014) and Tebaldi (2017) follow a similar approach. My estimates are very similar when including insurer-market fixed effects. I also estimate $\boldsymbol{\theta}$ with the control function approach of Petrin and Train (2010). Table I in Appendix E indicates that the magnitude of the premium parameter is only slightly larger using the control function approach.

4.2 Estimating Claims

I estimate each firm's average claims function and the claim slope matrix at the plan level by combining my demand estimates with firm-level cost data. I specify the average claims function

$$c_f(\mathbf{p}) = \sum_{k \in J_f} \left[b_1 \log(q_k(\mathbf{p})) + b_2 x_k q_k(\mathbf{p}) \right] + d_f \tag{16}$$

where b_1, b_2, and d_f are parameters to be estimated. Each firm's claims are a function of the demand

[6] A bronze plan is free to the consumer if the subsidy exceeds its premium. In my data, over one-third of consumers had access to at least one free bronze plan.

for its plans and the plans of its competitors. Firms perceive how the premiums of their plans affect their claims relative to the outside option and relative to their competitors. The logarithmic form of equation (16), in contrast to a linear form, allows the marginal consumer to have a greater impact on average claims at low levels of demand than at high levels of demand. The total differential is

$$dc_f(\mathbf{p}) = \sum_{k \in J_f} \frac{\partial c_f(\mathbf{p})}{\partial q_k(\mathbf{p})} dq_k(\mathbf{p}) = \sum_{k \in J_f} \left[b_1 [q_k(\mathbf{p})]^{-1} + b_2 x_k \right] dq_k(\mathbf{p}) \tag{17}$$

where for each plan k, the *claim demand slope* $\frac{\partial c_f(\mathbf{p})}{\partial q_k(\mathbf{p})} \equiv b_1[q_k(\mathbf{p})]^{-1} + b_2 x_k$ is linear in inverse plan demand $[q_k(\mathbf{p})]^{-1}$ and plan characteristics x_k.[7]

I estimate the claims function parameters b_1 and b_2 by regressing the claim demand slope on inverse plan demand and plan characteristics according to the linear form of equation (17). This regression occurs at the plan level, where plans vary by actuarial value, network type, and insurer. I pool the plan observations across time. I recover the claims function intercept d_f for each firm using the observed average claims and the predicted claim demand slopes as the initial condition.

There are two important empirical challenges with this approach. First, base premiums (and hence demand) may be endogenous in equation (17), potentially biasing the estimate of parameter b_1. I include insurer fixed effects in equation (17) to control for unobserved plan characteristics that vary across insurers, such as customer service, provider networks, and formularies. I argue that variation in premiums between plans offered by the same insurer is either exogenous (e.g., the regulated metal tier structure) or observable (e.g., the plan network type). The magnitude of parameter b_1 is likely to be downward-biased if my identification argument fails. I would underestimate the impact of policy changes and be less likely to observe the underinsurance-underenrollment tradeoff.

The second challenge is that I do not directly observe the claim demand slopes. To estimate them, I assume that the exchanges are in equilibrium and invert first-order conditions (12) to obtain

[7] I refer to the partial derivative $\frac{\partial c_f(\mathbf{p})}{\partial p_k}$ as the "claim slope" and the partial derivative $\frac{\partial c_f(\mathbf{p})}{\partial q_k(\mathbf{p})}$ as the "claim demand slope." The two partial derivatives are related according to equation (18).

non-parametric estimates of marginal claims. Inversion of the first-order conditions is possible because I have carefully written the model so that the system of first-order conditions is full rank. I then solve for the claim demand slopes in (12). Assuming that the exchanges are in equilibrium in the early years of the ACA could be dubious. To determine how this assumption biases my estimates, I compute the firms' prediction error (predicted minus realized average claims) using data from rate filings. I find a Pearson correlation coefficient of -0.39 between the insurers' prediction error and the estimated claim demand slopes. This negative correlation indicates that if the insurers' predictions had been accurate, there would be more variance in my estimates of the claim demand slopes according to marginal claims formula (28) (i.e., larger claim demand slope values become larger, while smaller values become smaller). Hence, the estimated magnitude of parameter b_1 would be larger. The likely effect of the equilibrium assumption is to underestimate the impact of policy changes and reduce the likelihood of observing the underinsurance-underenrollment tradeoff.

Table VI presents the estimated parameters. The negative value of b_1 is consistent with a market where adverse selection is present; increases in demand reduce average claims, given the plan actuarial value and any associated moral hazard. The positive coefficient on the actuarial value variable, which includes the effect of moral hazard, indicates that more generous plans increase average claims. Adding insurer fixed effects has minimal effect.

I calculate the $J \times J$ claim slope matrix by combining my estimates of the demand sensitivity matrix with estimates of the claim demand slopes. The (k, j)-element of the claim slope matrix is

$$\frac{\partial c_f(\mathbf{p})}{\partial p_j} = \frac{\partial c_f(\mathbf{p})}{\partial q_k(\mathbf{p})} \frac{\partial q_k(\mathbf{p})}{\partial p_j} \tag{18}$$

where firm f sells plan k (and may or may not sell plan j). I use formula (18) to calculate how a firm's claims respond to changes in its own premiums and changes in its competitors' premiums.

5 Simulations

5.1 Simulation Design

I use the estimated model to simulate the impact of risk adjustment and the individual mandate in the ACA exchanges. To estimate the model, I assume that the observed ACA premiums define a Nash equilibrium that satisfies the firms' first order conditions defined in (12). This Nash equilibrium occurs in the ACA policy environment where risk adjustment, the individual mandate, and ACA price-linked subsidies are in place. I simulate four changes to the ACA policy environment: (1) eliminate risk adjustment; (2) replace ACA subsidies with vouchers; (3) eliminate the mandate; and (4) eliminate the mandate and replace ACA subsidies with vouchers. I simulate the elimination of risk adjustment by solving for the vector of premiums that satisfy the first-order conditions

$$MR_j(\mathbf{p}) \quad = \quad (1-\tau_f)MC_j(\mathbf{p}) + v_f \frac{\partial q_f(\mathbf{p})/\partial p_j}{\partial q_j(\mathbf{p})/\partial p_j} \tag{19}$$

for all plans j. I replace ACA subsidies with vouchers by making the benchmark premium in formula (6) a constant equal to the benchmark premium in the first scenario; I then resolve equation (12) for the Nash equilibrium. Fixing the benchmark premium replaces formula (7) with

$$\frac{\partial p_{il}(\mathbf{p})}{\partial p_j} = \begin{cases} r_{ij} & l = j \\ 0 & l \neq j \end{cases} \tag{20}$$

I simulate mandate repeal by setting the penalty to zero and resolving equation (12) for the new Nash equilibrium. In the final scenario, I resolve equation (12) after setting a zero penalty and making the benchmark premium in formula (6) a constant equal to the observed benchmark premium.

For each simulation, I compute several measures. Coverage is calculated using equation (14). I compute firm profit in the first scenario as $\pi_f(\mathbf{p}) = R_f(\mathbf{p}) - C_f(\mathbf{p}) + RI_f(\mathbf{p}) - V_f - FC_f$ and use equation (8) to compute profit in the second, third, and fourth scenarios. I also compute consumer surplus $CS_i = (\lambda/\alpha_i)\ln\left(\sum_{j\in J}\exp\left(U_{ij}/\lambda\right)\right)$. Government spending on premium subsidies equals the sum of subsidies received by each consumer in formula (6). Spending on CSRs is computed using formula (29) in Appendix D. I calculate government 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.[8] Total social welfare equals the sum of consumer surplus, firm profit, and government spending.

5.2 Results

Consider the impact of risk adjustment. Table VII compares average ACA premiums to average premiums in scenario 1 where risk adjustment is eliminated. Risk adjustment leads to reductions in (unsubsidized) platinum and gold premiums by 25% and 15%, respectively, and increases in bronze and silver premiums by 11% and 2%, respectively. Risk adjustment reduces silver premiums for insurers such as Sharp and Western that have the highest premiums without risk adjustment, but increases premiums for insurers such as L.A. Care and Molina that have the lowest premiums without risk adjustment. Table VIII shows risk adjustment decreases enrollment in bronze and silver plans and more than doubles enrollment in platinum plans, but total enrollment remains about the same. The third column of Tables VII and VIII shows the impact of risk adjustment when subsidies are fixed at the level in scenario 1. Premiums and the enrollment distribution across the metal tiers are similar under the ACA and scenario 2, but total coverage is lower in scenario 2. The reason is that the ACA's subsidy design shields consumers from the higher bronze and silver plan premiums that result from risk adjustment. Controlling for subsidy levels, risk adjustment addresses underinsurance, but exacerbates underenrollment.

Table IX reports the changes in per-capita social welfare (absolute welfare levels are not identified). I compute per-capita amounts by dividing all total dollar amounts by the number of consumers

[8] 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 timeframe of this study (Centers for Medicare and Medicaid Services, 2018).

in the market, including those choosing the outside option. Risk adjustment increases annual consumer surplus by about \$200 per consumer compared to scenario 1 because average premiums for gold and platinum plans are lower and higher subsidies limit consumer exposure to higher bronze and silver plan premiums. Increased spending on premium subsidies largely offsets the gains in consumer surplus. Risk adjustment in scenario 2 decreases consumer surplus by about $\$200$ per year compared to scenario 1. Taxpayer outlays are largely unchanged. Importantly, consumer surplus falls by more than the government saves in premium subsidy outlays. The loss of highly-profitable low-risk consumers reduces firm profit. Per-capita social welfare declines by about $\$460$ per year.

Consider the impact of the individual mandate. Table X compares average ACA premiums to average premiums in scenario 3 where the mandate is repealed. The mandate reduces (unsubsidized) bronze plan premiums by about 4%, while platinum plan premiums increase by 1.7%. Silver and gold plan premiums also decrease modestly. Although the unsubsidized premium impacts may seem small, many consumers face substantially larger percentage changes in premiums after accounting for subsidies.[9] Table XI indicates that the mandate increases total exchange enrollment by 24%, but shifts enrollment from platinum plans to bronze and silver plans. The individual mandate therefore addresses underenrollment, but exacerbates underinsurance. Table XII indicates that the mandate decreases consumer surplus by about $\$150$ per consumer per year because (1) platinum plan premiums are higher; (2) some consumers are compelled to purchase insurance against their will; and (3) subsidies are lower, limiting the extent to which consumers benefit from lower bronze, silver, and gold premiums. Although subsidy spending increases because of higher exchange enrollment, the government generates revenue from the individual mandate penalty and has reduced uncompensated care costs. The mandate has minimal net impact on social welfare.

The third columns of Tables X and XI show the impact of the mandate when consumer subsidies

[9] For example, suppose a hypothetical consumer is eligible for a \$200 subsidy. On average, the consumer would pay \$115 for a gold plan and \$153 for a platinum plan (i.e., 33% more for platinum). Eliminating the mandate roughly increases the consumer's subsidy by \$3 to \$203 because of the increase in silver premiums. Consumers would now pay \$123 for a gold plan and \$144 for a platinum plan (i.e., 17% more for platinum).

are fixed at ACA levels. The effect on premiums is not particularly sensitive to the subsidy design, but total exchange enrollment is lower in scenario 4 than in scenario 3. The mandate increases annual per-capita consumer surplus by about $150 per consumer because consumers benefit from the lower bronze, silver, and gold plan premiums (i.e., subsidies are not reduced). The gains in consumer surplus, however, are offset by higher subsidy spending due to higher exchange enrollment. The overall social welfare impact is not particularly sensitive to the subsidy design.

6 Conclusion

In this paper, I study whether it is possible to address both underinsurance and underenrollment simultaneously. I show there is a tradeoff in addressing the intensive and extensive margin effects of adverse selection which could have important implications for social welfare. I illustrate the tradeoff by studying the impact of risk adjustment and the individual mandate both theoretically and empirically in the ACA exchanges. I find that risk adjustment addresses underinsurance, but reduces enrollment. Conversely, the mandate increases enrollment, but also increases underinsurance.

There are several opportunities to extend the analysis in this paper. It would be valuable to study how market structure affects underinsurance-underenrollment tradeoff. Adding a network formation stage to the model where providers and insurers bargain over inclusion in the network would partially address the assumption that product characteristics are exogenous. A framework that models how insurers learn over time could improve the accuracy of the welfare estimates.

The challenge in mitigating both underinsurance and underenrollment due to adverse selection has important implications for the design of efficient insurance markets. Policies targeting either underinsurance or underenrollment (but not both) can have unintended consequences. The risk adjustment design used in Medicare Advantage, where risk adjustment payments from the government to participating plans are benchmarked to the risk of those choosing the outside option, may address both underinsurance and underenrollment. Financing such a risk adjustment program could be costly and involve significant opportunity costs. Relaxing community rating regulations would target the chief cause of adverse selection in insurance markets, but expose consumers in poor health to high premiums (Handel et al., 2015). High-risk pools or guaranteed renewable insurance with longer time horizons (Pauly et al., 1995; Herring and Pauly, 2006) are alternatives to community rating that may avoid the underinsurance-underenrollment tradeoff examined in this paper.

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Appendix A: Proofs for the Basic Model

Finding $\frac{\partial p_L}{\partial \psi}$ and $\frac{\partial p_H}{\partial \psi}$

Differentiating price equations (1) with respect to ψ yields

$$\begin{aligned}\frac{\partial p_L}{\partial \psi} &= \frac{\partial c'_L}{\partial \psi} = t_L + (1-\psi)\frac{\partial c_L}{\partial \psi} + \psi\frac{\partial c}{\partial \psi} \\ &= t_L + (1-\psi)\left(\frac{\partial c_L}{\partial p_L}\frac{\partial p_L}{\partial \psi} + \frac{\partial c_L}{\partial p_H}\frac{\partial p_H}{\partial \psi}\right) + \psi\left(\frac{\partial c}{\partial p_L}\frac{\partial p_L}{\partial \psi} + \frac{\partial c}{\partial p_H}\frac{\partial p_H}{\partial \psi}\right) \end{aligned} \tag{21}$$

$$\begin{aligned}\frac{\partial p_H}{\partial \psi} &= \frac{\partial c'_H}{\partial \psi} = -t_H + (1-\psi)\frac{\partial c_H}{\partial \psi} + \psi\frac{\partial c}{\partial \psi} \\ &= -t_H + (1-\psi)\left(\frac{\partial c_H}{\partial p_L}\frac{\partial p_L}{\partial \psi} + \frac{\partial c_H}{\partial p_H}\frac{\partial p_H}{\partial \psi}\right) + \psi\left(\frac{\partial c}{\partial p_L}\frac{\partial p_L}{\partial \psi} + \frac{\partial c}{\partial p_H}\frac{\partial p_H}{\partial \psi}\right) \end{aligned} \tag{22}$$

Solving equation (22) for $\frac{\partial p_H}{\partial \psi}$ yields

$$\frac{\partial p_H}{\partial \psi} = \frac{-t_H + (1-\psi)\frac{\partial c_H}{\partial p_L}\frac{\partial p_L}{\partial \psi} + \psi\frac{\partial c}{\partial p_L}\frac{\partial p_L}{\partial \psi}}{1-(1-\psi)\frac{\partial c_H}{\partial p_H} - \psi\frac{\partial c}{\partial p_H}} \tag{23}$$

Substituting the right-hand side of equation (23) into equation (21) and solving for $\frac{\partial p_L}{\partial \psi}$ yields

$$\frac{\partial p_L}{\partial \psi} \quad = \quad \frac{t_L\left(1-\frac{\partial c'_H}{\partial p_H}\right)-t_H\frac{\partial c'_L}{\partial p_H}}{\left(1-\frac{\partial c'_L}{\partial p_L}\right)\left(1-\frac{\partial c'_H}{\partial p_H}\right)-\frac{\partial c'_H}{\partial p_L}\frac{\partial c'_L}{\partial p_H}}$$

Substituting for $\frac{\partial p_L}{\partial \psi}$ in equation (22) and solving for $\frac{\partial p_H}{\partial \psi}$ yields

$$\frac{\partial p_H}{\partial \psi} \quad = \quad \frac{-t_H\left(1-\frac{\partial c'_L}{\partial p_L}\right)+t_L\frac{\partial c'_H}{\partial p_L}}{\left(1-\frac{\partial c'_L}{\partial p_L}\right)\left(1-\frac{\partial c'_H}{\partial p_H}\right)-\frac{\partial c'_H}{\partial p_L}\frac{\partial c'_L}{\partial p_H}}$$

Proof of Proposition 1.1

The first step is show that the partial derivative $\frac{\partial p_L}{\partial \psi}$ is positive and the partial derivative $\frac{\partial p_H}{\partial \psi}$ is negative. Observe that the numerator of the partial derivative $\frac{\partial p_L}{\partial \psi}$ is positive and the numerator of the partial derivative $\frac{\partial p_H}{\partial \psi}$ is negative because the average transfers t_L and t_H are positive, the own-price partial derivatives satisfy $0 < \frac{\partial c'_L}{\partial p_L}, \frac{\partial c'_H}{\partial p_H} < 1$, and the cross-price partial derivatives satisfy $-1 < \frac{\partial c'_L}{\partial p_H}, \frac{\partial c'_H}{\partial p_L} < 0$. The common denominator $\left(1-\frac{\partial c'_L}{\partial p_L}\right)\left(1-\frac{\partial c'_H}{\partial p_H}\right)-\frac{\partial c'_H}{\partial p_L}\frac{\partial c'_L}{\partial p_H}$ must be strictly positive for the partial derivatives in (2) to be economically meaningful. If the common denominator were negative, higher average transfers would imply larger premium reductions for firm L's plan (i.e., $\frac{\partial p_L}{\partial \psi}$ becomes more negative) and larger premium increases for the firm H's plan (i.e., $\frac{\partial p_H}{\partial \psi}$ becomes more positive). It follows that the partial derivative $\frac{\partial p_L}{\partial \psi}$ is positive and the partial derivative $\frac{\partial p_H}{\partial \psi}$ is negative. Risk adjustment therefore compresses equilibrium premiums such that firm L's premium is increased and the firm H's premium is reduced.

Now consider the effect of risk adjustment on enrollment in firm H's plan. Observe that

$$\frac{\partial q_H}{\partial \psi} = \frac{\partial q_H}{\partial p_L}\frac{\partial p_L}{\partial \psi} + \frac{\partial q_H}{\partial p_H}\frac{\partial p_H}{\partial \psi} > 0$$

because $\frac{\partial q_H}{\partial p_L} > 0$, $\frac{\partial p_L}{\partial \psi} > 0$, $\frac{\partial q_H}{\partial p_H} < 0$, and $\frac{\partial p_H}{\partial \psi} < 0$. Hence, risk adjustment reduces underinsurance.

Now consider the effect of risk adjustment on total enrollment. The effect of risk adjustment on average market claims is given by

$$
\begin{aligned}
\frac{\partial c}{\partial \psi} &= \frac{\partial c}{\partial p_L}\frac{\partial p_L}{\partial \psi} + \frac{\partial c}{\partial p_H}\frac{\partial p_H}{\partial \psi} \\
&= \frac{\frac{\partial c}{\partial p_L}\left[t_L\left(1-\frac{\partial c'_H}{\partial p_H}\right) - t_H\frac{\partial c'_L}{\partial p_H}\right] - \frac{\partial c}{\partial p_H}\left[t_H\left(1-\frac{\partial c'_L}{\partial p_L}\right) - t_L\frac{\partial c'_H}{\partial p_L}\right]}{\left(1-\frac{\partial c'_L}{\partial p_L}\right)\left(1-\frac{\partial c'_H}{\partial p_H}\right) - \frac{\partial c'_H}{\partial p_L}\frac{\partial c'_L}{\partial p_H}}
\end{aligned} \tag{24}
$$

Observe that the numerator of equation (24) is positive because

$$
\begin{aligned}
& \frac{\partial c}{\partial p_L}\left[t_L\left(1-\frac{\partial c'_H}{\partial p_H}\right) - t_H\frac{\partial c'_L}{\partial p_H}\right] - \frac{\partial c}{\partial p_H}\left[t_H\left(1-\frac{\partial c'_L}{\partial p_L}\right) - t_L\frac{\partial c'_H}{\partial p_L}\right] \\
= \; & t_L\frac{\partial c}{\partial p_L}\left[1-\frac{\partial c'_H}{\partial p_H}+\frac{\partial c'_H}{\partial p_L}\right] - t_H\frac{\partial c}{\partial p_H}\left[1-\frac{\partial c'_L}{\partial p_L}+\frac{\partial c'_L}{\partial p_H}\right] \\
& -\left(\frac{\partial c}{\partial p_L}-\frac{\partial c}{\partial p_H}\right)\left(t_H\frac{\partial c'_L}{\partial p_H}+t_L\frac{\partial c'_H}{\partial p_L}\right) \\
> \; & t_L\frac{\partial c}{\partial p_L}\left[1-\frac{\partial c'_H}{\partial p_H}+\frac{\partial c'_H}{\partial p_L}\right] - t_H\frac{\partial c}{\partial p_H}\left[1-\frac{\partial c'_L}{\partial p_L}+\frac{\partial c'_L}{\partial p_H}\right] \\
> \; & t_L\frac{\partial c}{\partial p_L} - t_H\frac{\partial c}{\partial p_H} \; > \; 0
\end{aligned}
$$

where the first inequality follows because $|\frac{\partial c}{\partial p_L}| > |\frac{\partial c}{\partial p_H}|$, the second inequality follows because $|\frac{\partial c'_L}{\partial p_L}| > |\frac{\partial c'_L}{\partial p_H}|$ and $|\frac{\partial c'_H}{\partial p_L}| \geq |\frac{\partial c'_H}{\partial p_H}|$, and the third inequality follows because $t_L\frac{\partial c}{\partial p_L} > t_H\frac{\partial c}{\partial p_H}$. Because the denominator of equation (24) is also positive, risk adjustment must increase average market claims (i.e., $\frac{\partial c}{\partial \psi} > 0$). Because $q(p'_L, p'_H) < q(p''_L, p''_H)$ if and only if $c(p'_L, p'_H) > c(p''_L, p''_H)$ for any premium vectors $p' = (p'_L, p'_H)$ and $p'' = (p''_L, p''_H)$, it follows that risk adjustment must decrease total enrollment (i.e., $\partial q/\partial \psi < 0$).

Finding $\frac{\partial p_L}{\partial \rho}$ and $\frac{\partial p_H}{\partial \rho}$

Differentiating equilibrium equations (3) with respect to ρ yields

$$
\frac{\partial p_L}{\partial \rho} = \frac{\partial c_L}{\partial p_L}\frac{\partial p_L}{\partial \rho} + \frac{\partial c_L}{\partial p_H}\frac{\partial p_H}{\partial \rho} + \frac{\partial c_L}{\partial \rho} \tag{25}
$$

$$
\frac{\partial p_H}{\partial \rho} = \frac{\partial c_H}{\partial p_L}\frac{\partial p_L}{\partial \rho} + \frac{\partial c_H}{\partial p_H}\frac{\partial p_H}{\partial \rho} + \frac{\partial c_H}{\partial \rho} \tag{26}
$$

Solving equation (26) for $\frac{\partial p_H}{\partial \rho}$ yields

$$\frac{\partial p_H}{\partial \rho} = \frac{\frac{\partial c_H}{\partial p_L}\frac{\partial p_L}{\partial \rho} + \frac{\partial c_H}{\partial \rho}}{1 - \frac{\partial c_H}{\partial p_H}} \tag{27}$$

Substituting the right-hand side of equation (27) into equation (25) and solving for $\frac{\partial p_L}{\partial \rho}$ yields

$$\frac{\partial p_L}{\partial \rho} = \frac{\frac{\partial c_L}{\partial \rho}\left(1 - \frac{\partial c_H}{\partial p_H}\right) + \frac{\partial c_H}{\partial \rho}\frac{\partial c_L}{\partial p_H}}{\left(1 - \frac{\partial c_L}{\partial p_L}\right)\left(1 - \frac{\partial c_H}{\partial p_H}\right) - \frac{\partial c_H}{\partial p_L}\frac{\partial c_L}{\partial p_H}}$$

Substituting for $\frac{\partial p_L}{\partial \rho}$ in equation (26) and solving for $\frac{\partial p_H}{\partial \rho}$ yields

$$\frac{\partial p_H}{\partial \rho} = \frac{\frac{\partial c_H}{\partial \rho}\left(1 - \frac{\partial c_L}{\partial p_L}\right) + \frac{\partial c_L}{\partial \rho}\frac{\partial c_H}{\partial p_L}}{\left(1 - \frac{\partial c_L}{\partial p_L}\right)\left(1 - \frac{\partial c_H}{\partial p_H}\right) - \frac{\partial c_H}{\partial p_L}\frac{\partial c_L}{\partial p_H}}$$

Proof of Proposition 1.2

The first step is to establish that the partial derivative $\frac{\partial p_L}{\partial \rho}$ is negative and the partial derivative $\frac{\partial p_H}{\partial \rho}$ is positive. The numerator of the partial derivative $\frac{\partial p_L}{\partial \rho}$ is negative because (1) its first term is negative and (2) the magnitude of its first term exceeds the magnitude of its second term under the assumptions $|\frac{\partial c_L}{\partial \rho}| > |\frac{\partial c_H}{\partial \rho}|$ and $|\frac{\partial c_L}{\partial p_H}| + \frac{\partial c_H}{\partial p_H} < 1$. The numerator of the partial derivative $\frac{\partial p_H}{\partial \rho}$ is positive because (1) its second term is positive and (2) the magnitude of its second term exceeds the magnitude of its first term under the assumptions $|\frac{\partial c_L}{\partial \rho}| > |\frac{\partial c_H}{\partial \rho}|$ and $|\frac{\partial c_H}{\partial p_L}| + \frac{\partial c_L}{\partial p_L} > 1$. The common denominator $\left(1 - \frac{\partial c_L}{\partial p'_L}\right)\left(1 - \frac{\partial c_H}{\partial p'_H}\right) - \frac{\partial c_H}{\partial p'_L}\frac{\partial c_L}{\partial p'_H}$ must be strictly positive for the partial derivatives in (4) to be economically meaningful. If the common denominator were negative, a reduction in the responsiveness of the low plan's average claims to the high plan's premium ($\frac{\partial c_L}{\partial p_H}$) would imply larger premium increases for firm L's plan (i.e. $\frac{\partial p_L}{\partial \rho}$ becomes more positive). Hence, the common denominator is positive, which implies the mandate penalty decreases the premium of firm L's plan ($\frac{\partial p_L}{\partial \rho} < 0$) and increases the premium of firm H's plan ($\frac{\partial p_H}{\partial \rho} > 0$).

Consider the impact of the mandate on underinsurance. Because the right-hand side of equation (26) equals the full derivative $\frac{dc_H}{d\rho}$, it follows that $\frac{dc_H}{d\rho}$ is positive. The derivative $\frac{dq_H}{d\rho}$ is negative because $\frac{dc_H}{d\rho} = \frac{dc_H}{dq_H}\frac{dq_H}{d\rho}$ and $\frac{dc_H}{dq_H} < 0$. Hence, the mandate penalty increases underinsurance.

Consider the impact of the mandate on total enrollment. By assumption, $\frac{\partial c}{\partial p_L} > \frac{\partial c}{\partial p_H}$ and

$$\left|\frac{\partial p_L}{\partial \rho}\right| - \frac{\partial p_H}{\partial \rho} = \frac{\left[-\frac{\partial c_L}{\partial \rho}\left(1-\frac{\partial c_H}{\partial p_H}\right)+\frac{\partial c_H}{\partial \rho}\left(1-\frac{\partial c_L}{\partial p_L}\right)\right]+\left[-\frac{\partial c_H}{\partial \rho}\frac{\partial c_L}{\partial p_H}+\frac{\partial c_L}{\partial \rho}\frac{\partial c_H}{\partial p_L}\right]}{\left(1-\frac{\partial c_L}{\partial p_L}\right)\left(1-\frac{\partial c_H}{\partial p_H}\right)-\frac{\partial c_H}{\partial p_L}\frac{\partial c_L}{\partial p_H}} > 0$$

because $|\frac{\partial c_L}{\partial \rho}| > |\frac{\partial c_H}{\partial \rho}|$, $\frac{\partial c_L}{\partial p_L} > \frac{\partial c_H}{\partial p_H}$, and $|\frac{\partial c_H}{\partial p_L}| \geq |\frac{\partial c_L}{\partial p_H}|$. The penalty therefore reduces firm L's premium more than it increases firm H's premium. It follows that

$$\frac{dc}{d\rho} = \frac{\partial c}{\partial p_L}\frac{\partial p_L}{\partial \rho} + \frac{\partial c}{\partial p_H}\frac{\partial p_H}{\partial \rho} + \frac{\partial c}{\partial \rho} < 0$$

Because $q(p'_L, p'_H) < q(p''_L, p''_H)$ if and only if $c(p'_L, p'_H) > c(p''_L, p''_H)$ for any premium vectors $p' = (p'_L, p'_H)$ and $p'' = (p''_L, p''_H)$, the mandate must increase total enrollment (i.e., $\frac{dq}{d\rho}$ is positive).

Appendix B: Mathematical Formulas in ACA Exchange Model

In this appendix, I write the variables in equation (12) in terms of four variables: (1) the household choice probabilities $q_{ij}(\mathbf{p})$; (2) the household demand sensitivity matrix $D_i(\mathbf{q})$; (3) the firm's average claims function $c_f(\mathbf{p})$; and (4) the claim slope matrix $D(\mathbf{c})$. Marginal revenue $MR_j(\mathbf{p})$, marginal claims $MC_j(\mathbf{p})$, average marginal claims $\overline{MC}_j(\mathbf{p})$, average marginal revenue $\overline{MR}_j(\mathbf{p})$, and $\widetilde{MC}_j(\mathbf{p})$ can be expressed as

$$MR_j(\mathbf{p}) = \frac{\partial R_f(\mathbf{p})}{\partial q_j(\mathbf{p})} = \left(\frac{\partial q_j(\mathbf{p})}{\partial p_j}\right)^{-1} \sum_{i\in I}\left(r_{ij}q_{ij}(\mathbf{p}) + \sum_{k\in J_f} r_{ik}p_k\frac{\partial q_{ik}(\mathbf{p})}{\partial p_j}\right)$$

$$MC_j(\mathbf{p}) = \frac{\partial C_f(\mathbf{p})}{\partial q_j(\mathbf{p})} = c_f(\mathbf{p})\left(\frac{\partial q_j(\mathbf{p})}{\partial p_j}\right)^{-1}\frac{\partial q_f(\mathbf{p})}{\partial p_j} + q_f(\mathbf{p})\frac{\partial c_f(\mathbf{p})}{\partial q_j(\mathbf{p})} \tag{28}$$

$$\overline{MC}_j(\mathbf{p}) = \frac{\partial(rs_f(\mathbf{p})C(\mathbf{p}))}{\partial q_j(\mathbf{p})} = \left(\frac{\partial q_j(\mathbf{p})}{\partial p_j}\right)^{-1}\left[C(\mathbf{p})\frac{\partial rs_f(\mathbf{p})}{\partial p_j} + rs_f(\mathbf{p})\frac{\partial C(\mathbf{p})}{\partial p_j}\right]$$

$$\overline{MR}_j(\mathbf{p}) = \frac{\partial(rs_f(\mathbf{p})R(\mathbf{p}))}{\partial q_j(\mathbf{p})} = \left(\frac{\partial q_j(\mathbf{p})}{\partial p_j}\right)^{-1}\left[R(\mathbf{p})\frac{\partial rs_f(\mathbf{p})}{\partial p_j} + rs_f(\mathbf{p})\frac{\partial R(\mathbf{p})}{\partial p_j}\right]$$

$$\begin{aligned}
\widetilde{MC}_j(\mathbf{p}) &= \frac{\partial}{\partial q_j(\mathbf{p})}\left(\frac{C_f(\mathbf{p})R(\mathbf{p})}{C(\mathbf{p})}\right) \\
&= \frac{C(\mathbf{p})\left[\frac{\partial C_f(\mathbf{p})}{\partial p_j}R(\mathbf{p}) + C_f(\mathbf{p})\frac{\partial R(\mathbf{p})}{\partial p_j}\right] - C_f(\mathbf{p})R(\mathbf{p})\frac{\partial C(\mathbf{p})}{\partial p_j}}{\frac{\partial q_j(\mathbf{p})}{\partial p_j}[C(\mathbf{p})]^2} \\
&= MC_j(\mathbf{p})\frac{R(\mathbf{p})}{C(\mathbf{p})} + \\
&\quad \frac{C_f(\mathbf{p})\sum_{f'\in F}\sum_{k'\in J_{f'}}\left(C(\mathbf{p})MR_{k'}(\mathbf{p}) - R(\mathbf{p})MC_{k'}(\mathbf{p})\right)\frac{\partial q_{k'}(\mathbf{p})}{\partial p_j}}{[C(\mathbf{p})]^2}
\end{aligned}$$

where

$$\frac{\partial rs_f(\mathbf{p})}{\partial p_j} = \frac{\sum_{i\in I,l\in J} h_l q_{il}(\mathbf{p})\sum_{i\in I,k\in J_f} h_k \frac{\partial q_{ik}(\mathbf{p})}{\partial p_j} - \sum_{i\in I,k\in J_f} h_k q_{ik}(\mathbf{p})\sum_{i\in I,l\in J} h_l \frac{\partial q_{il}(\mathbf{p})}{\partial p_j}}{\left(\sum_{i\in I,l\in J} h_l q_{il}(\mathbf{p})\right)^2}$$

$$\frac{\partial C(\mathbf{p})}{\partial p_j} = \sum_{f'\in F}\sum_{k'\in J_{f'}}\frac{\partial C_{f'}(\mathbf{p})}{\partial q_{k'}(\mathbf{p})}\frac{\partial q_{k'}(\mathbf{p})}{\partial p_j} = \sum_{f'\in F}\sum_{k'\in J_{f'}} MC_{k'}(\mathbf{p})\frac{\partial q_{k'}(\mathbf{p})}{\partial p_j}$$

$$\frac{\partial R(\mathbf{p})}{\partial p_j} = \sum_{f'\in F}\sum_{k'\in J_{f'}}\frac{\partial P_{f'}(\mathbf{p})}{\partial q_{k'}(\mathbf{p})}\frac{\partial q_{k'}(\mathbf{p})}{\partial p_j} = \sum_{f'\in F}\sum_{k'\in J_{f'}} MR_{k'}(\mathbf{p})\frac{\partial q_{k'}(\mathbf{p})}{\partial p_j}$$

Appendix C: Risk Adjustment Under the ACA

In this appendix, I derive the ACA risk adjustment formula. I start with Pope et al. (2014)'s transfer formula as derived in their first appendix, which allows plans to vary only by their actuarial values (and not by differences in firm efficiency, geographic costs, allowable rating factors, or moral hazard).[10] Pope et al. (2014) show that the per-member per-month risk adjustment transfer can be

[10] I start with this formula because I want to capture all differences in expected risk, except for cost sharing and any associated moral hazard, in the plan's risk score (i.e., cost sharing and moral hazard are addressed through the

calculated according to formula $(A14)$:

$$T_j = \left(PLRS_j - \frac{AV_j}{\sum_l AV_l s_l} \right) \overline{p}$$

where $PLRS_j$ is plan j's plan liability risk score, $\overline{p}$ is the share-weighted average statewide premium, AV_l is the actuarial value of plan l, and s_l is plan l's market share. The per-member per-month plan transfer $ra'_j(\mathbf{p})$ in my notation, is

$$ra'_j(\mathbf{p}) = \left(\omega_j(\mathbf{p}) - \frac{h_j \sum_{i \in I, j \in J} q_{ij}}{\sum_{i \in I, l \in J} h_l q_{il}(\mathbf{p})} \right) \overline{p}$$

The total risk adjustment transfer $RA'_j(\mathbf{p})$ for plan j is given by

$$RA'_j(\mathbf{p}) = ra'_j(\mathbf{p}) \sum_{i \in I, j \in J_f} q_{ij}(\mathbf{p}) = \left(\omega_j(\mathbf{p}) \sum_{i \in I, j \in J_f} q_{ij}(\mathbf{p}) - rs_j(\mathbf{p}) \sum_{i \in I, j \in J} q_{ij}(\mathbf{p}) \right) \overline{p}$$

Summing across all plans offered by firm f yields formula (9):

$$RA'_f(\mathbf{p}) = \left(\omega_f(\mathbf{p}) \sum_{i \in I, j \in J_f} q_{ij}(\mathbf{p}) - rs_f(\mathbf{p}) \sum_{i \in I, j \in J} q_{ij}(\mathbf{p}) \right) \overline{p}$$

Appendix D: Cost Sharing Reductions

In this appendix, I discuss how the ACA provides CSRs to consumers and construct a formula for computing government spending on CSRs. To receive CSRs, eligible consumers with income below 250% of FPL must purchase a silver plan. CSRs increase the actuarial value of the silver plan from 70% to 94% for consumers with income below 150% of FPL (group 1), to 87% for consumers with income between 150% and 200% of poverty (group 2), and to 73% of poverty for consumers with income between 200% and 250% of poverty (group 3). Ignoring moral hazard, the government's expected outlay is 24% of claims for group 1, 17% for group 2, and 3% for group 3. To account for moral hazard, I follow Pope et al. (2014) and assume there is no moral hazard for consumers in the

risk-adjusted share $rs_f(\mathbf{p})$). In contrast, the plan liability risk score $PLRS_j$ as defined in Pope et al. (2014)'s second appendix does not account for certain differences such as variation in geographic cost. Instead, Pope et al. (2014) account for these differences by applying factors in the transfer formula.

73% plan, while consumers in the 87% and 94% plans increase consumption by 12%. Including moral hazard, the government's expected outlay is 26.88% of claims for group 1, 19.04% for group 2, and 3% for group 3. Government spending on cost sharing reductions equals

$$CSR = \sum_{i \in I, j \in J} s_i^g q_{ij}(\mathbf{p})(r_{ij}^c c_j'(\mathbf{p})) \tag{29}$$

where s_i^g is the government's expected share for consumer i as defined above, $q_{ij}(\mathbf{p})$ is the household choice probability, r_{ij}^c is a cost factor accounting for the plan and the household members' ages and geographic residence, and $c_j'(\mathbf{p})$ is plan base claims. The cost factors come from insurer rate filings (Department of Managed Health Care, 2016). Plan base claims are computed from the estimated household choice probabilities and data on firm average claims and cost factors.

Appendix E: Demand Estimates

Table I: Full Regression Results

	Base	Control Function
Monthly Premium ($100)	-0.429^{***}	-0.506^{***}
	(0.027)	(0.024)
Actuarial Value (AV)	4.125^{***}	5.180^{***}
	(0.240)	(0.200)
HMO	-0.275^{***}	-0.212^{***}
	(0.016)	(0.011)
Premium ($100) ×		
138-250	-0.035^{**}	-0.031^{**}
	(0.017)	(0.015)
250-400	0.070^{***}	0.059^{***}
	(0.016)	(0.015)
400+	0.126^{***}	0.128^{***}
	(0.016)	(0.016)
Male	-0.059^{***}	-0.072^{***}
	(0.005)	(0.004)
0-17	-0.569^{***}	-0.889^{***}
	(0.027)	(0.028)
18-34	-0.616^{***}	-0.634^{***}
	(0.033)	(0.025)
35-54	-0.306^{***}	-0.289^{***}
	(0.016)	(0.012)
Family	-0.015^{***}	-0.153^{***}
	(0.003)	(0.006)
Year 2015	-0.019^{***}	-0.020^{***}
	(0.002)	(0.002)
Intercept		
Base	-3.866^{***}	-4.755^{***}
	(0.216)	(0.195)
400+	-0.676^{***}	-0.478^{***}
	(0.074)	(0.065)
Male	0.154^{***}	0.197^{***}
	(0.026)	(0.026)

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Table I – *Continued from previous page*

	Base	Control Function
0-17	−2.350***	−2.006***
	(0.101)	(0.112)
18-34	−1.031***	−1.194***
	(0.048)	(0.046)
35-54	−1.099***	−1.385***
	(0.040)	(0.045)
Family	2.046***	2.510***
	(0.031)	(0.042)
Year 2015	0.327***	0.317***
	(0.029)	(0.030)
Mandate	0.479***	0.197***
	(0.062)	(0.067)
Insurers		
Anthem	0.199***	0.554***
	(0.030)	(0.033)
Blue Shield CA	−0.276***	0.128***
	(0.031)	(0.028)
Health Net	−0.438***	−0.183***
	(0.038)	(0.031)
Chinese Community	−0.077***	−0.068***
	(0.026)	(0.025)
Kaiser	−1.210***	−0.823***
	(0.089)	(0.068)
LA Care	0.515***	0.723***
	(0.054)	(0.051)
Molina	−0.798***	−0.541***
	(0.061)	(0.047)
Sharp	−0.061**	0.170***
	(0.028)	(0.027)
Valley	−0.277***	−0.235***
	(0.035)	(0.031)
Western Health	0.186***	0.154***
	(0.032)	(0.031)
Rating Areas		
CA2	2.311***	3.036***
	(0.156)	(0.171)
CA3	0.627***	1.325***
	(0.087)	(0.097)
CA4/8	2.590***	3.246***
	(0.117)	(0.129)
CA5	1.861***	2.458***
	(0.168)	(0.171)
CA6	4.177***	4.507***
	(0.160)	(0.149)
CA7	2.434***	3.115***
	(0.124)	(0.141)
CA9	1.743***	2.452***
	(0.099)	(0.114)
CA10	−0.300***	0.249**
	(0.101)	(0.108)
CA11	0.399***	0.646***
	(0.137)	(0.130)
CA12	3.029***	3.303***
	(0.118)	(0.115)
CA14	−1.481***	−0.903***
	(0.080)	(0.093)
CA15	−0.755***	−0.366***
	(0.096)	(0.092)
CA16	0.765***	1.046***
	(0.062)	(0.072)
CA17	−0.189**	0.178**
	(0.080)	(0.087)

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Table I – *Continued from previous page*

	Base	Control Function
CA18	1.102***	1.429***
	(0.067)	(0.078)
CA19	0.764***	1.164***
	(0.067)	(0.076)
Anthem ×		
CA2	0.086***	−0.210***
	(0.019)	(0.019)
CA3	0.082***	−0.081***
	(0.022)	(0.021)
CA4/8	−0.452***	−0.686***
	(0.034)	(0.032)
CA5	−0.175***	−0.396***
	(0.024)	(0.025)
CA6	−1.945***	−1.821***
	(0.134)	(0.104)
CA7	−0.114***	−0.358***
	(0.014)	(0.017)
CA9	−0.161***	−0.420***
	(0.017)	(0.020)
CA10	−0.202***	−0.597***
	(0.018)	(0.023)
CA11	−1.727***	−1.584***
	(0.120)	(0.092)
CA12	−1.461***	−1.382***
	(0.101)	(0.079)
CA14	0.170***	−0.055**
	(0.027)	(0.024)
CA15	0.396***	0.355***
	(0.041)	(0.036)
CA16	−0.289***	−0.247***
	(0.026)	(0.022)
CA17	−0.915***	−0.846***
	(0.068)	(0.054)
CA18	−0.897***	−0.840***
	(0.065)	(0.051)
CA19	−0.458***	−0.436***
	(0.035)	(0.028)
Blue Shield ×		
CA2	0.366***	−0.009
	(0.034)	(0.027)
CA3	0.611***	0.153***
	(0.053)	(0.041)
CA4/8	0.276***	−0.018
	(0.022)	(0.017)
CA5	0.629***	0.239***
	(0.051)	(0.039)
CA6	−1.638***	−1.653***
	(0.109)	(0.086)
CA7	0.356***	0.126***
	(0.027)	(0.020)
CA9	0.060***	−0.329***
	(0.015)	(0.017)
CA10	0.062***	−0.265***
	(0.016)	(0.017)
CA11	−1.315***	−1.296***
	(0.090)	(0.071)
CA12	−1.130***	−1.117***
	(0.078)	(0.062)
CA14	0.704***	0.438***
	(0.057)	(0.044)
CA15	1.207***	1.084***
	(0.093)	(0.075)

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Table I – *Continued from previous page*

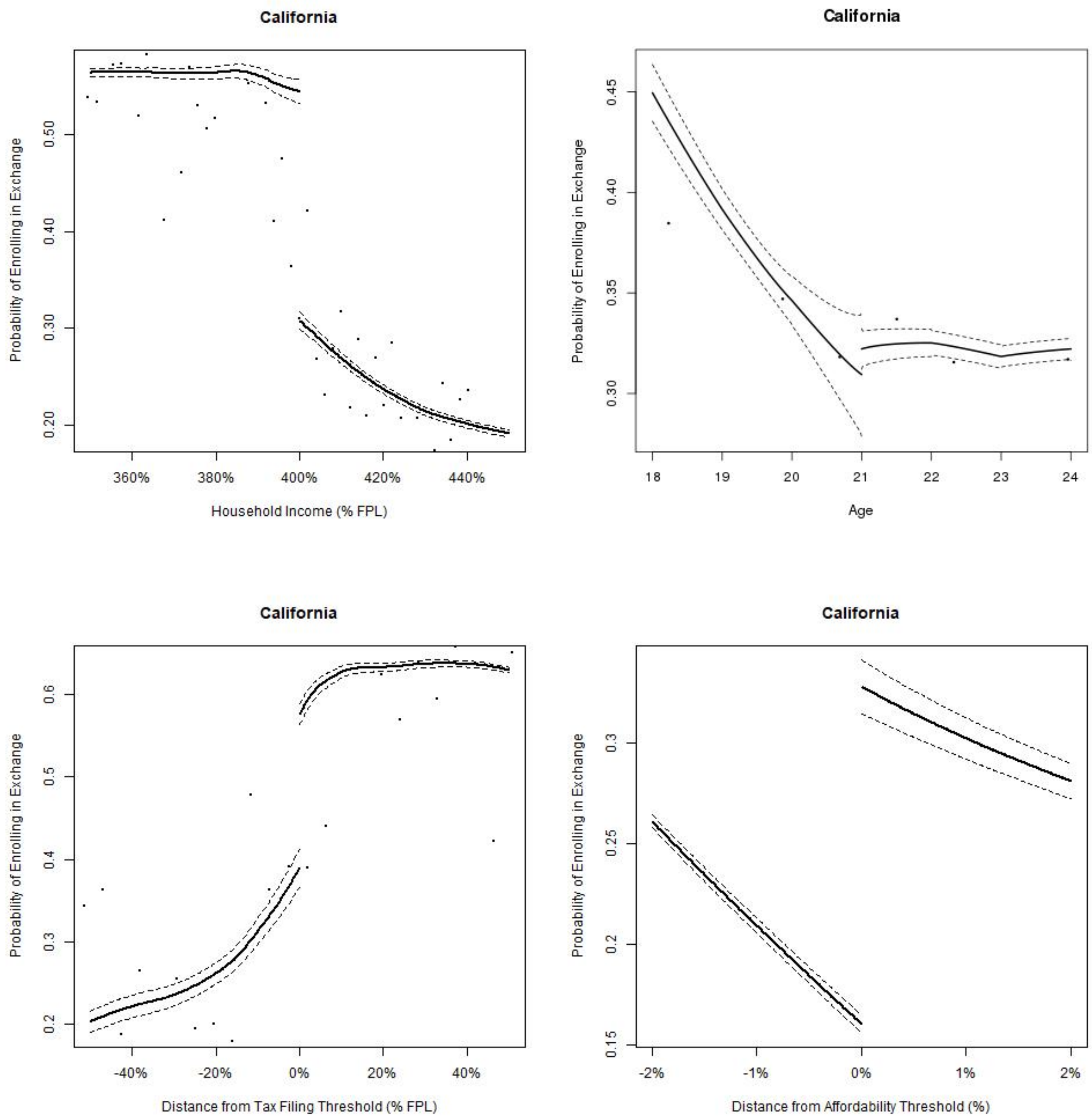
	Base	Control Function
CA16	0.318***	0.318***
	(0.022)	(0.018)
CA17	−0.214***	−0.249***
	(0.014)	(0.012)
CA19	0.298***	0.246***
	(0.025)	(0.021)
Health Net ×		
CA15	1.278***	1.161***
	(0.098)	(0.078)
CA16	0.363***	0.343***
	(0.028)	(0.022)
CA19	0.381***	0.284***
	(0.031)	(0.025)
Kaiser ×		
CA2	2.091***	1.693***
	(0.145)	(0.110))
CA3	1.982***	1.473***
	(0.142)	(0.107)
CA4/8	1.558***	1.188***
	(0.108)	(0.081)
CA5	2.047***	1.623***
	(0.143)	(0.108)
CA7	1.722***	1.419***
	(0.118)	(0.089)
CA10	1.471***	1.055***
	(0.103)	(0.079)
CA14	1.870***	1.622***
	(0.129)	(0.098)
CA15	2.335***	2.225***
	(0.162)	(0.127)
CA16	1.456***	1.418***
	(0.098)	(0.077)
CA17	1.074***	1.044***
	(0.073)	(0.058)
CA18	0.981***	1.002***
	(0.066)	(0.054)
CA19	1.365***	1.205***
	(0.098)	(0.076)
LA Care × CA16	−0.791***	−0.729***
	(0.066)	(0.054)
Residual		0.001***
		(0.000)
eta		0.004
		(0.003)
Nesting Parameter	0.308***	0.297***
	(0.022)	(0.017)

***Significant at the 1% level. ** Significant the 5% level. Significant at the 10% level. Robust standard errors that correct for potential misspecification are shown in parentheses (see p.503 of Wooldridge (2010)).

Figure 1: Premium Rating Regions in California

Notes: Figure shows the premium rating regions in the California exchange (Department of Managed Health Care, 2016). California's 58 counties are divided into 19 rating areas.

Figure 2: Regression Discontinuity Plots: Probability of Enrolling in an Exchange Plan



Notes: Figure shows the results of four different regression discontinuity design regressions in which the choice of enrolling in an exchange plan is regressed on dummy variables for whether (1) the household has income above the upper limit for receiving subsidies of 400% of FPL (top left panel); (2) the consumer is above the age of 21 (top right panel); (3) the household has income above the tax filing threshold (bottom left panel); and (4) the household has an affordable offer (bottom right panel). Local linear regressions are performed on either side of the thresholds using a triangular kernel and the Imbens-Kalyanamaran optimal bandwidth calculation. Standard errors are clustered at the rating area level.

Table II: Insurer Market Share in the California Exchange

	2014	2015
Anthem	29.0%	27.8%
Blue Shield	28.3%	26.4%
Chinese Community	1.1%	0.8%
Contra Costa	0.1%	
Health Net	19.7%	16.4%
Kaiser	17.4%	24.2%
LA Care	2.3%	1.1%
Molina	0.7%	1.5%
Sharp	1.0%	1.2%
Valley	0.1%	0.1%
Western Health	0.3%	0.4%

Table III: Choice and Demographic Distribution

	Exchange	Uninsured
Metals		
Catastrophic	0.7%	
Bronze	24.0%	
Silver	64.9%	
Gold	5.5%	
Platinum	4.8%	
Network Type		
HMO	45.7%	
PPO	45.1%	
EPO	9.2%	
Income		
0% to 138% of FPL	2.9%	2.8%
138% to 150% of FPL	15.0%	5.4%
150% to 200% of FPL	33.8%	20.5%
200% to 250% of FPL	17.4%	16.2%
250% to 400% of FPL	22.7%	29.6%
400%+ of FPL	8.2%	25.4%
Subsidy Eligibility		
Premium tax credits	90.7%	74.6%
Cost sharing reductions	68.5%	44.9%
Penalty Status		
Exempt	3.8%	6.3%
Subject	96.2%	93.7%
Age		
0-17	4.8%	3.2%
18-25	10.4%	20.9%
26-34	15.7%	25.5%
35-44	15.6%	17.0%
45-54	24.4%	17.8%
55-64	29.0%	15.4%
Gender		
Female	52.3%	43.1%
Male	47.7%	56.9%
Year		
2014	48.9%	58.9%
2015	51.1%	41.1%
Average Annual Population	1,239,268	1,407,430

NOTES: Table provides summary statistics on consumers in the California exchange market for the 2014 and 2015 plan years. Data on exchange consumers come from the California exchange. Data on the uninsured come from the ACS.

Table IV: Summary Financial Data by Year

	Average Claims		Risk Adj. Received		Reinsurance Received	
	2014	2015	2014	2015	2014	2015
Anthem	$294	$349	($26)	($4)	$58	$44
Blue Shield	$338	$378	$24	$26	$63	$40
Chinese Community	$212	$160	($119)	($185)	$13	$17
Contra Costa	$912		$179		$234	
Health Net	$306	$365	($17)	($23)	$54	$43
Kaiser	$344	$336	$17	($11)	$40	$26
LA Care	$196	$177	($132)	($126)	$1	$1
Molina	$114	$141	($126)	($130)	$13	$6
Sharp	$515	$458	$85	$42	$90	$42
Valley	$430	$391	($21)	($5)	$29	$22
Western Health	$569	$425	$63	($21)	$143	$74

NOTES: Table provides insurer financial data for the 2014 and 2015 plan years on per-member per-month claims, risk adjustment received, and reinsurance received. Claims data are from the MLR reports. Risk adjustment and reinsurance data are from CMS reports (Centers for Medicare and Medicaid Services, 2015, 2016).

Table V: Estimated Mean Elasticities and Semi-Elasticities

	Own-Premium		Exchange Coverage	
	Elasticity	Semi-Elasticity	Elasticity	Semi-Elasticity
Overall	-9.1	-21.8	-1.2	-3.3
Income (% of FPL)				
0-138	-8.8	-21.3	-1.2	-3.3
138-250	-9.7	-23.1	-1.3	-3.5
250-400	-8.2	-20.0	-1.1	-3.1
400+	-7.8	-19.1	-1.0	-2.9
Gender				
Female	-8.8	-21.0	-1.1	-3.2
Male	-9.5	-22.6	-1.2	-3.4
Age				
18-34	-13.1	-27.9	-1.6	-4.1
35-54	-9.3	-19.9	-1.1	-2.9
55+	-5.6	-12.0	-0.7	-1.7

Notes: Table shows mean (unsubsidized) premium elasticities and semi-elasticities of demand by demographic group for the base case estimates. The first column reports the mean own-premium elasticity of demand. The second column reports the mean own-premium semi-elasticity of demand, which is the the percentage change in a plan's enrollment associated with a $100 increase in its annual premium. The third column reports the mean own-premium elasticity for exchange coverage (i.e., the percentage change in exchange enrollment associated with a one percent increase in the base premium of all exchange plans). The fourth column reports the mean own-premium semi-elasticity for exchange coverage, which is the percentage change in exchange enrollment associated with a $100 annual increase in all exchange premiums. I use the plan market shares as weights to compute the mean elasticities and semi-elasticities.

Table VI: Predicting the Claim Demand Slope $\frac{\partial c_f(\mathbf{p})}{\partial q_j(\mathbf{p})}$

	Base	Adding Insurer Fixed Effects
Inverse Demand	-4.993^{***}	-5.108^{***}
	(1.177)	(1.101)
Actuarial Value	20.728^{***}	21.911^{***}
	(7.200)	(7.030)
HMO	1.212	-3.521^{***}
	(1.205)	(1.277)
HSA	-0.381	0.282
	(1.312)	(1.328)
Observations	149	149
R^2	0.588	0.609
Adjusted R^2	0.576	0.575

Notes: Robust standard errors are in parentheses (*** indicates statistical significance at the 1% level). Table shows parameter estimates for the linear regression of the claim demand slope on inverse demand and plan characteristics. In the second column, I add insurer fixed effects to equation (17). Each observation is a plan-year combination.

Table VII: Effect of Risk Adjustment on (Pre-Subsidy) Premiums

	ACA	Scenario 1: Eliminate Risk Adjustment	Scenario 2: Replace ACA Subsidies w/ Vouchers
Metal			
Bronze	$221	$198	$218
Silver	$273	$267	$269
Gold	$315	$367	$310
Platinum	$353	$474	$346
Insurer (Silver Premium)			
Anthem BC	$291	$271	$284
Blue Shield	$262	$279	$261
Chinese Community	$342	$268	$354
Contra Costa	$355	$334	$367
Centene/Health Net	$233	$222	$229
Kaiser	$292	$286	$288
L.A. Care	$259	$238	$247
Molina	$261	$247	$262
Sharp	$324	$380	$332
Valley	$353	$286	$350
Western	$396	$412	$391

Notes: Table shows the impact of risk adjustment on weighted-average premiums by metal tier and by insurer for a 40-year-old. Average premiums for any other age are proportional to the premiums reported in Table VII according to the ACA's age rating curve (Centers for Medicare and Medicaid Services, 2013). Plan premiums are weighted by the realized ACA plan market share for all scenarios.

Table VIII: Effect of Risk Adjustment on Insurance Coverage

	ACA	Scenario 1: Eliminate Risk Adjustment	Scenario 2: Replace ACA Subsidies w/ Vouchers
Catastrophic	9,174	26,319	9,075
Bronze	314,528	322,483	304,852
Silver	850,537	870,704	818,946
Gold	72,079	70,420	75,964
Platinum	64,216	26,331	71,757
Total Coverage	1,310,535	1,316,258	1,280,594

Table IX: Change in Annual Per-Capita Social Welfare Relative to ACA

	Scenario 1: Eliminate Risk Adjustment	Scenario 2: Replace ACA Subsidies w/ Vouchers
Consumer Surplus	($196)	($405)
Profit	$92	($140)
Government Spending		
Premium Subsidies	$223	$234
CSRs	$9	$1
Mandate Revenue	($4)	$3
Uncompensated Care	$4	($25)
Social Welfare	$129	($332)

Table X: Effect of the Individual Mandate on (Pre-Subsidy) Premiums

	ACA	Scenario 3: Eliminate Individual Mandate	Scenario 4: Vouchers and Eliminate Mandate
Catastrophic	$195	$192	$194
Bronze	$221	$229	$226
Silver	$273	$276	$278
Gold	$315	$326	$322
Platinum	$353	$347	$354

Notes: Table shows the impact of the individual mandate on weighted-average premiums by metal tier for a 40-year-old. Plan premiums are weighted by the realized ACA plan market share for all scenarios.

Table XI: Effect of the Individual Mandate on Insurance Coverage

	ACA	Scenario 3: Eliminate Individual Mandate	Scenario 4: Vouchers and Eliminate Mandate
Catastrophic	9,174	5,381	5,725
Bronze	314,528	119,282	154,294
Silver	850,537	767,822	715,213
Gold	72,079	66,661	62,844
Platinum	64,216	97,583	86,695
Total	1,310,535	1,056,729	1,024,772

Table XII: Change in Annual Per-Capita Social Welfare Relative to ACA

	Scenario 3: Eliminate Individual Mandate	Scenario 4: Vouchers and Eliminate Mandate
Consumer Surplus	$142	($322)
Profit	($37)	$134
Government Spending		
Premium Subsidies	$260	$423
CSRs	$10	$28
Mandate Revenue	($192)	($192)
Uncompensated Care	($196)	($224)
Social Welfare	($13)	($153)