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EMPLOYER CONTRIBUTION AND PREMIUM GROWTH IN HEALTH INSURANCE

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ABSTRACT

We study whether employer premium contribution schemes could impact the pricing behavior of health plans and contribute to rising premiums. Using 1991-2011 data before and after a 1999 premium subsidy policy change in the Federal Employees Health Benefits Program (FEHBP), we find that the employer premium contribution scheme has a differential impact on health plan pricing based on two market incentives: 1) consumers are less price sensitive when they only need to pay part of the premium increase, and 2) each health plan has an incentive to increase the employer's premium contribution to that plan. Both incentives are found to contribute to premium growth. Counterfactual simulation shows that average premium would have been 10% less than observed and the federal government would have saved 15% per year on its premium contribution had the subsidy policy change not occurred in the FEHBP.

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1 Introduction

The rising cost of health insurance has received enormous attention in the past decade. According to an annual survey conducted by the Kaiser Family Foundation and Health Research & Educational Trust (henceforth known as Kaiser/HRET), the nominal annual premium of employer-sponsored health insurance has more than doubled from 2001 to 2013, outpacing the rate of inflation every year. While new medical technology and aging population may explain part of the premium growth (Schwartz, 1987; Newhouse, 1992, 1993; Chandra and Skinner, 2012), we argue that employer contribution to health plan premium can be another important driver. Both theoretically and empirically, we show that a seemingly neutral change of employer contribution scheme can have unintended consequences on premium growth.

In the U.S. most employers offer employees health insurance as a fringe benefit for risk pooling and tax reasons. Employer-sponsored health insurance covers on average 60% of all Americans and 65% of working-age Americans in the last decade (U.S. Census Bureau, 2011). Under employer sponsorship, one common premium-sharing rule is a capped proportional contribution scheme where the employer contributes a fixed percentage of the total gross premium up to a dollar maximum, leaving workers responsible for the rest.¹ For example, in the largest employer-sponsored health insurance program in the U.S., the Federal Employee Health Benefits Program (FEHBP), the federal government subsidizes 75% of any plan premium up to a dollar maximum.² The large share of employer contribution is not unique in the FEHBP. According to Kaiser/HRET, employers contribute on average 82% of the premium for single coverage plans and 72% for family coverage plans in 2011.³

Researchers have analyzed the role that employer contribution plays in the demand for health insurance, but very few look at the supply side. To fill this gap, we exploit a shift of employer contribution scheme in the FEHBP and analyze how premium growth has changed after the shift. In particular, before 1999, the dollar maximum from the FEHBP employer contribution was defined as 60% of the simple average premium of the biggest six plans, which we refer to as the “Big Six” formula. After 1999, a “Fair Share” formula took effect, and the maximum employer contribution was calculated as 72% of the enrollment-weighted average premium of *all* health plans in the program. Not only does this policy change redefine the dollar maximum applicable to all plans, it changes the influence that each plan may have in defining the dollar maximum. This implies differential effects on health plans depending on their enrollment in the previous year, thus allowing us to identify heterogeneous effects of the policy change on premium growth.

¹Virtually all employer premium contribution schemes can be viewed as a capped proportional contribution scheme, given a certain fixed margin and a dollar maximum. When the dollar maximum is very large, we have a simple proportional contribution scheme given a fixed margin. When the dollar maximum is very small, we have a simple voucher system where each plan gets the same amount of employer contribution.

²This employer contribution scheme applies to all federal civilian employees, annuitants, and their dependents.

³The average percentage of employer contribution includes those who contribute 100% of the premium.

Before diving into the data, we present a simple oligopoly model to argue that the employer contribution scheme can affect health plan pricing via two incentives: first, consumers are less price sensitive when they only need to pay part of the premium increase; second, each health plan has an incentive to increase the employer’s premium contribution to that plan. Both incentives can contribute to premium growth.

Consistent with the theoretical insights, we have three main empirical findings: 1) due to differences in consumer price sensitivity below and above the subsidy cap, plans that have charged below the subsidy cap in the previous year increase their premiums more than those above, 2) the farther away the plan premium is below the subsidy cap, the faster the premium grows, whereas the opposite is true for plans above the subsidy cap, and 3) when health plans are able to influence the employer premium contribution after 1999 through their FEHBP-wide market share, larger plans above the subsidy cap raise their premiums more, which is consistent with their incentives to push up the upper limit of the employer contribution.

Counterfactual analysis shows that average premium would have been 10% less than observed had the subsidy policy change not occurred in the FEHBP. Due to higher employer premium contributions under the new “Fair Share” subsidy policy where the maximum employer contribution is endogenously determined by health plan premiums, the federal government bears most of the increase in insurance premiums after 1999, and would have saved 15% per year on its premium contribution toward the FEHBP.

We believe our results are useful for not only employer-sponsored health insurance but also any insurance that allows some enrollees to receive government subsidies in insurance premiums. Such subsidies, if done in a capped proportional scheme, will discourage insurers from charging gross premiums strictly below the cap. If the cap is endogenously determined by gross premiums set by insurers, the incentive to raise the premium is even greater because higher premiums can raise the cap and in turn allow insurers to receive more subsidies from the government. These supply-side incentives must be taken into account when policy makers design the subsidy scheme and predict the actual cost of government subsidies.

The rest of the paper is organized as follows. Section 2 discusses the background and reviews related literature. We present an analytical framework of the health insurance market in Section 3. We then describe the data set in Section 4, followed by empirical strategies to analyze the effect of employer premium contribution schemes on health plan pricing as well as the corresponding results. Counterfactual analysis is presented in Section 5. Section 6 discusses extensions and robustness checks, and Section 7 concludes.

2 Background

2.1 Employer Premium Contribution

From 1960s to 2010, health care spending in the U.S. has climbed from 6% of the GDP to 18%, and the share of the expenditure attributable to health insurance costs has soared from 30% to 76% ([Centers for Medicare & Medicaid Services, 2011](#)). As a result, health insurance now plays a pivotal role in the nation's health care spending, and this role will only be strengthened with the 2010 Patient Protection and Affordable Care Act (ACA), which mandates universal individual health insurance coverage since 2014.

There are many forms of health insurance, the most common being employer-sponsored health insurance, which covers about 150 million non-elderly people in the U.S. Since employer-sponsored health insurance has such a wide coverage in the U.S., and employers typically contribute to 70-80% of health plan premium, it is important to know whether the employer premium contribution scheme itself can affect both the demand and supply sides of health insurance. Lessons learned from employer-sponsored health insurance are also useful to many other health insurance programs that allow premium sharing between individual enrollees and public entities.

In analyzing the role of employer contribution in health insurance, much of the previous literature has focused on the demand side. In 1995, Harvard University moved from a linear premium subsidy scheme, where premiums are subsidized at a certain percentage rate, to a fixed contribution scheme, where each plan receives the same amount of employer contribution. Using this policy change, [Cutler and Reber \(1998\)](#) showed that the new fixed contribution scheme induced significant adverse selection while reducing plan total premiums by 5-8%, thus creating a net effect of welfare loss from adverse selection. By simulating the effect of lowering the subsidy cap to the lowest plan premium in the market using data from the FEHBP, [Florence and Thorpe \(2003\)](#) found a similar yet smaller effect.

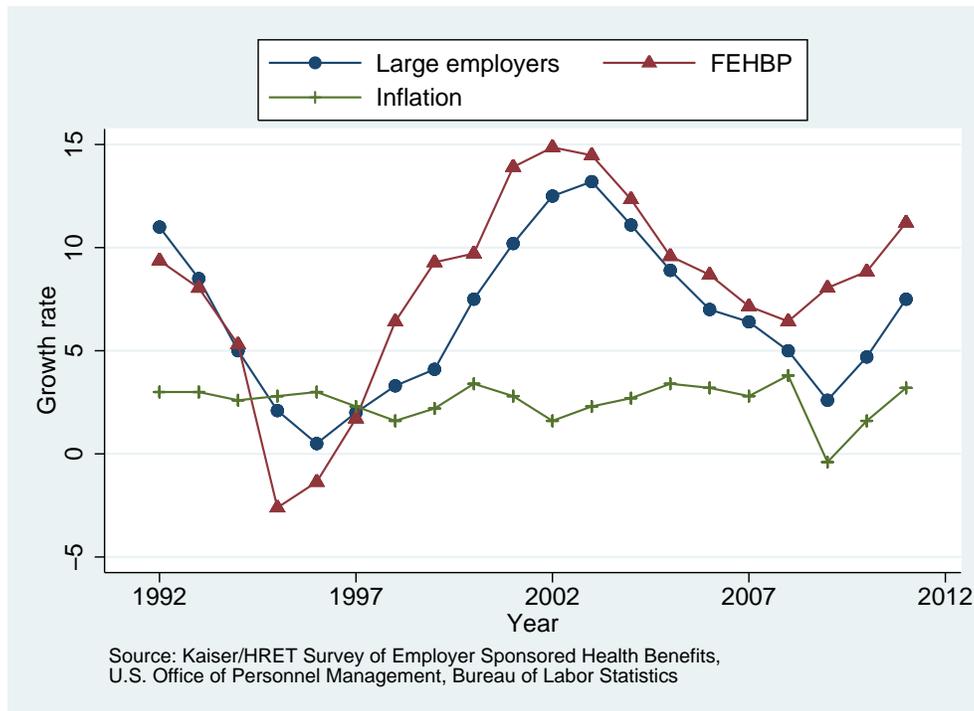
Other than plan selection, researchers have also looked at whether premium subsidy affects health insurance takeup. In the FEHBP, federal civilian employees used to deduct their out-of-pocket insurance premiums from their after-tax income. Starting from October 2000, they were allowed to pay their portion of the premium on a pre-tax basis. After this tax subsidy policy change, however, [Gruber and Washington \(2005\)](#) found little change in insurance takeup.

Other studies looking at tax subsidies have generally used data on health insurance takeup and amount purchased among the self-employed, thanks to recent changes in tax laws on the deductibility for self-employed health insurance premiums, but many have found mixed results (e.g., [Gruber and Poterba, 1994](#); [Selden, 2009](#); [Heim and Lurie, 2009](#)).

Despite the abundant evidence on the effect of premium subsidy on the demand for health insurance, there is relatively little discussion on the supply side regarding how the employer premium contribution scheme affects premium growth. According to health benefits surveys of large employ-

ers with more than 200 workers conducted by Kaiser/HRET, the annual growth rate in nominal employer-sponsored health insurance premiums has consistently outpaced the rate of inflation (see Figure 1). After deflating the premiums in the FEHBP and comparing its growth rate with GDP growth, Figure 2 shows that the real premium growth has largely outpaced GDP in the last decade, even though it grew slower than GDP in the late 1990s.⁴

Figure 1: Growth Rate of Nominal Health Insurance Premiums



There are undoubtedly many forces behind the persistent growth in health insurance premium. For example, advances in medical technology are known to contribute to health care spending growth, which in turn leads to premium growth.⁵ A number of studies attribute premium growth to market concentration (e.g., [Wholey et al., 1995](#); [Dranove et al., 2003](#); [Dafny et al., 2012](#)).

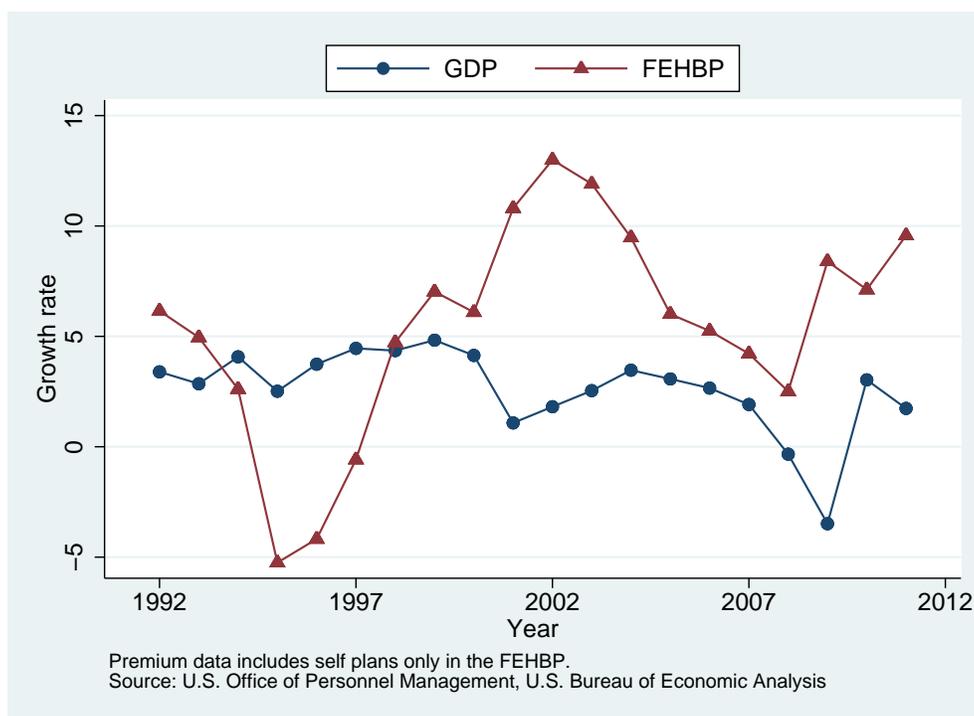
Adverse selection and moral hazard of consumers, on the other hand, can also contribute to rising premiums. Recent work on testing and documenting various forms of information asymmetry has shown great promise in understanding the complexity of the insurance market (e.g., [Finkelstein and Poterba, 2004](#); [Finkelstein and McGarry, 2006](#); [Einav and Finkelstein, 2011](#)). Relatively few studies, however, have focused on supply-side moral hazard to look at the direct impact of employer premium contribution schemes on the pricing strategies of health plans.

One assumption we make before analyzing the effect of premium contribution schemes on plan pricing is that employee wages do not adjust immediately to changes in the employer premium

⁴Real premiums for family plans show a similar trend.

⁵See [Chernew and Newhouse \(2011\)](#) for a detailed literature review.

Figure 2: Growth Rate of Real FEHB Premiums vs. GDP



subsidies. The idea of sticky prices or wages goes back to the 1980s when [Akerlof and Yellen \(1985\)](#) built a model of business cycles incorporating sticky wages. It could be argued in the case of the FEHBP that the federal government sets rigid pay schedules for all federal employees, and do not frequently revise them over time. Wage adjustments, even if they do occur, usually apply to the entire federal work force instead of a certain population.

2.2 Subsidy Policy Change

Effective January 1, 1999, the FEHBP changed the employer contribution scheme for all federal civilian employees and annuitants, providing a natural laboratory to study the effect of subsidy on premium growth. Before 1999, the federal government contributed 75% of any plan premium up to a dollar maximum, determined by 60% of the simple average of the so-called “Big Six” plans.⁶ Starting in 1999, under provisions in the Balanced Budget Act of 1997 (Public Law 105-33), while the federal government still contributes at most 75% of the gross premium, the new subsidy cap is determined by a “Fair Share” formula, which is 72% of the enrollment-weighted average premium of all health plans in the program.

Each Spring, the Office of Personnel Management (OPM), who administers the program, sends

⁶According to [Thorpe et al. \(1999\)](#), the “Big Six” plans are the two largest national employee association plans, two largest health maintenance organization (HMO) plans, the Blue Cross Blue Shield high-option plan, as well as a phantom plan whose premium is calculated each year using the average increase in the other five plans.

out a “call letter” outlining the basic benefits and reporting requirements, along with any statutory changes that would apply to the next plan year. The FEHBP has been widely touted as a model for Medicare reform as well as the most recent state health insurance exchanges mandated by the ACA, partly due to its simple program design that allows market competition and low administrative cost. The OPM does not actively negotiate premiums with plans or solicit competitive bids (Feldman et al., 2002). Once a private health plan meets the basic requirements stipulated by OPM, it can participate in the FEHBP.

One paper that discusses premium growth in relation to employer premium contribution schemes is by Thorpe et al. (1999), who showed that in the FEHBP, among plans whose employer contribution was below the subsidy cap, premiums rose at least five percentage points faster annually from 1992 to 1999 than plans above it. Nevertheless, their paper did not analyze the effect of the 1999 subsidy policy change.

By incorporating this policy change and extending the study period to 2011, we contribute to the previous literature in two ways. First, under a simple duopoly model, we show that there are two market incentives at play that contribute to growth in employer-sponsored health insurance premiums. Second, we present empirical evidence that supports these two market incentives and analyze their impact on health plan premium growth.

3 Model

This section presents a simple differentiated oligopoly model with logit demand, in order to highlight the role of employer contribution in health insurance pricing. The first subsection presents a model with J plans and derives implications from the first order condition. The second subsection simulates how equilibrium solutions change when the FEHBP subsidy rule changes from “Big Six” to “Fair Share.” The simulation is done for a market with $J = 2$ plans for the purpose of illustration.

3.1 Basic Set Up

On the demand side, consider consumer i whose utility function from consuming health plan j depends on the net premium she needs to pay (\tilde{P}_j), other plan characteristics (α_j) and an i.i.d. error term that is assumed to follow a type 1 extreme value distribution (ε_{ij}):

$$U_{ij} = \alpha_j - \beta_j \tilde{P}_j + \varepsilon_{ij}, \tag{1}$$

Given a choice set of J plans, consumers choose a health plan that yields the highest utility. Since the consumer base in the data set is composed of those who choose a plan every year, we do not

consider an outside option here.⁷

Given this utility formulation, the logit demand model computes the share of plan j in a local market relative to the other alternatives as

$$S_j = \frac{\exp(\alpha_j - \beta_j \tilde{P}_j)}{\sum_{j'=1, \dots, J} \exp(\alpha_{j'} - \beta_{j'} \tilde{P}_{j'})},$$

If the employer contributes $1 - \theta$ fraction of any plan's gross premium (P_j) up to a dollar maximum (MAX), the net premium an employee pays can be expressed as

$$\tilde{P}_j = \max(\theta P_j, P_j - MAX).$$

In the case of the FEHBP, $\theta = 0.25$. In the case of Medicaid where enrollees are too poor to share any premium, $\theta = 0$. In the individual insurance market where enrollees must pay for plan premiums in full, $\theta = 1$. Most employer-sponsored health insurance plans have $0 < \theta < 1$, and so do the Medicare Part D plans or plans to be offered in the health insurance exchanges following the 2010 ACA, if individual enrollees qualify for government subsidy.

To help illustrate, we define the maximum gross premium a plan can charge, while still being subsidized at the $1 - \theta$ margin by the employer, to be the ‘‘subsidy cap’’ ($\frac{MAX}{1-\theta}$). For plans who set their gross premiums below the subsidy cap, consumers pay $\tilde{P}_j = \theta P_j$, whereas for plans with gross premiums above the subsidy cap, consumers pay $\tilde{P}_j = P_j - MAX$. Therefore, the newly defined subsidy cap acts as a cutoff point for health plan gross premiums in terms of maximum subsidy benefits.

On the supply side, plan j faces a constant marginal cost of C_j and chooses a gross premium P_j to maximize its profit

$$\pi_j = P_j D_j(\tilde{P}) - C_j D_j(\tilde{P}), \tag{2}$$

where D_j is the demand for plan j , which depends on the net premium \tilde{P} of all plans.

If we normalize the market size to one, the demand for a health plan is equal to its market share, $D_j = S_j$. Therefore, if an interior solution exists, the optimal price must satisfy the first order condition (FOC). When the employer subsidizes health plan premiums by a fraction $1 - \theta$, the FOC can be rewritten as:

$$P_j = C_j + \frac{1}{\theta \beta_j (1 - S_j)}. \tag{3}$$

⁷In the data set we later use for empirical analysis, the percentage of employees who opt out of the employer-sponsored health insurance offered by the FEHBP remains roughly the same over time.

where

$$S_j = \frac{\exp(\alpha_j - \theta\beta_j P_j)}{\sum_{j'=1,2,\dots,J} \exp(\alpha_{j'} - \theta\beta_{j'} P_{j'})}.$$

The FOC has two implications. First, taking the other plans' premiums as given, it can be shown that $\frac{\partial P_j}{\partial \theta} < 0$. In other words, plan j has an incentive to lower its gross premium if employees are required to pay a higher fraction of the premium. This result is intuitive: the bigger the employee contribution (θ), the more disutility an employee gets from a marginal increase in the gross premium, and the more elastic the demand will be for plan j .⁸

For any employer contribution scheme that pays a fraction of gross premium up to a dollar maximum, the fraction of the employee contribution is $0 < \theta < 1$ if a plan's gross premium is below the employer's subsidy cap. This fraction becomes $\theta = 1$ if a plan's gross premium is above the subsidy cap. The FOC implies that, everything else being equal, every plan faces less elastic demand below the subsidy cap and therefore has more incentive to raise the premium when it is below the cap than above the cap. This is essentially the incentive of "chasing the cap" as described in Thorpe et al. (1999).

The second implication of the FOC is that prices are strategic complements among competing plans. Mathematically, $\frac{\partial P_j}{\partial P_k} > 0, \forall k \neq j$. This implies that when one plan lowers its premium, all other plans would lower their premiums as well. In a symmetric equilibrium where every plan faces the same parameters ($C_j = C$ and $\beta_j = \beta$) and charges the same premium (P^*), we can derive that $P^* = C + \frac{J}{\theta\beta(J-1)}$ and $\frac{\partial P^*}{\partial J} < 0$. Obviously, the equilibrium premium declines with the number of plans as one would expect in a differentiated oligopoly, but this does not alter the fact that the equilibrium price declines with the fraction of employee contribution $\frac{\partial P^*}{\partial \theta} < 0$ for all $J \geq 2$.

3.2 From Big Six to Fair Share

The above basic set up confirms the argument that everything else being equal, plans face less elastic demand below the subsidy cap than above the cap, and therefore have incentives to "chase the cap" from below (Thorpe et al., 1999). This incentive always exists no matter how the employer determines the subsidy cap. However, when the FEHBP switched from "Big Six" to "Fair Share", the "Fair Share" formula allows *every* plan to influence the exact magnitude of the cap. In contrast, "Big Six" plans on average only make up 2.5% of the total available health plans in the FEHBP during 1991-2011.⁹ To capture the incentive difference between these two schemes, we now simulate equilibrium solutions for a simple market with $J = 2$ plans, where both plans take the cap as exogenously given in the "Big Six" scheme but recognize their power in influencing the cap in the "Fair Share" scheme.

⁸Demand elasticity of plan j is $\frac{\partial \ln S_j}{\partial \ln P_j} = -\frac{\theta\beta_j P_j (1-S_j)^2}{S_j}$.

⁹The market share of "Big Six" ranges from 1.4% to 4.3% depending on the year.

Following [Aravindakshan and Ratchford \(2011\)](#), Appendix A shows that each plan’s first order condition can be rewritten using the Lambert W function, which can be numerically approximated.¹⁰

3.2.1 Big Six

Under the “Big Six” formula before 1999, we assume both plans are non-Big-Six plans who treat the dollar maximum of FEHBP contribution as an exogenous constant (c). The subsidy cap is defined as dollar maximum/.75, which is equal to $c/.75$.

In each period, plan 1 submits a premium bid of P_1 . When plan 1 prices above the subsidy cap, consumers pay a net premium of $P_1 - c$; when plan 1 prices below the subsidy cap, consumers pay $.25P_1$.

Similarly, plan 2 can also price below or above the cap, which gives us four cases to consider. Below we present simulated solutions in the case where plan 1 prices above and plan 2 prices below the subsidy cap. Appendix B presents equilibrium solutions in the remaining three cases.

In this case of $P_1 \geq$ subsidy cap and $P_2 \leq$ subsidy cap, consumers pay a net premium of $\tilde{P}_1 = P_1 - c$ for plan 1 and $\tilde{P}_2 = .25P_2$ for plan 2. We have a constrained optimization problem with the inequality conditions $P_1 - c/.75 \geq 0$ and $P_2 - c/.75 \leq 0$. Since only plan 1’s price constraint has the argument P_1 in it, the Lagrangian function of plan 1’s profit maximization problem can be written as:

$$\mathcal{L}(P_1, \lambda) = (P_1 - C_1)D_1 + \lambda(P_1 - c/.75).$$

The FOC of the interior solution when the constraint does not bind ($P_1 > c/.75$) is

$$P_1 = C_1 + \frac{1}{\beta_1(1 - S_1)}, \quad (4)$$

and its market share is

$$S_1 = \frac{\exp(\alpha_1 - \beta_1(P_1 - c))}{\exp(\alpha_1 - \beta_1(P_1 - c)) + \exp(\alpha_2 - .25\beta_2P_2)}. \quad (5)$$

Following Appendix A, we derive the best response function of plan 1 and its market share in terms of P_2 as follows:

$$P_1^* = C_1 + \frac{1 + W(x)}{\beta_1}, \quad (6)$$

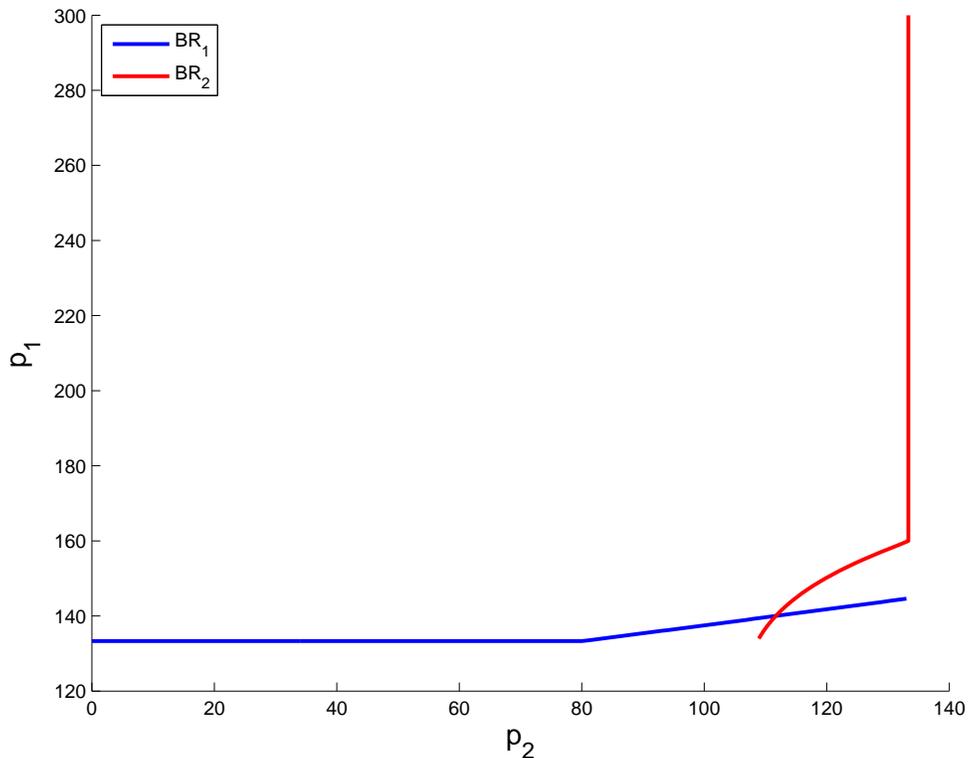
$$S_1^* = \frac{W(x)}{1 + W(x)}, \quad (7)$$

¹⁰The Lambert W function is defined as $W(x)$, which is the inverse function associated with the equation $W(x)e^{W(x)} = x$.

where $P_1 > c/.75$, $P_2 \leq c/.75$, and $x = \frac{\exp(\alpha_1 - 1 - \beta_1(C_1 - c))}{\exp(\alpha_2 - .25\beta_2 P_2)}$. When plan 1's constraint binds, we have the corner solution $P_1^* = c/.75$. Similar derivation applies to plan 2.

Since the Lambert W function can be numerically approximated, we plot the best response functions of plan 1 and plan 2 in Figure 3 when the dollar maximum $c = 100$, after initiating some parameter values.¹¹ There is a kink in each plan's best response function because of the constraint that plan 1 prices above the subsidy cap, which is equal to $c/.75 = 100/.75 = 133.3$, and plan 2 prices below the subsidy cap. When we set the dollar maximum c to be smaller, such as the actual 1998 biweekly dollar maximum level ($c = 66$) observed in the FEHBP for self-only plans, plan 2 would price at the subsidy cap ($c/.75 = 88$) at all times (see Figure 4).

Figure 3: Equilibrium Prices of the Two Plans Before 1999
(subsidy cap = $100/.75$, $P_1 \geq$ subsidy cap, $P_2 \leq$ subsidy cap)

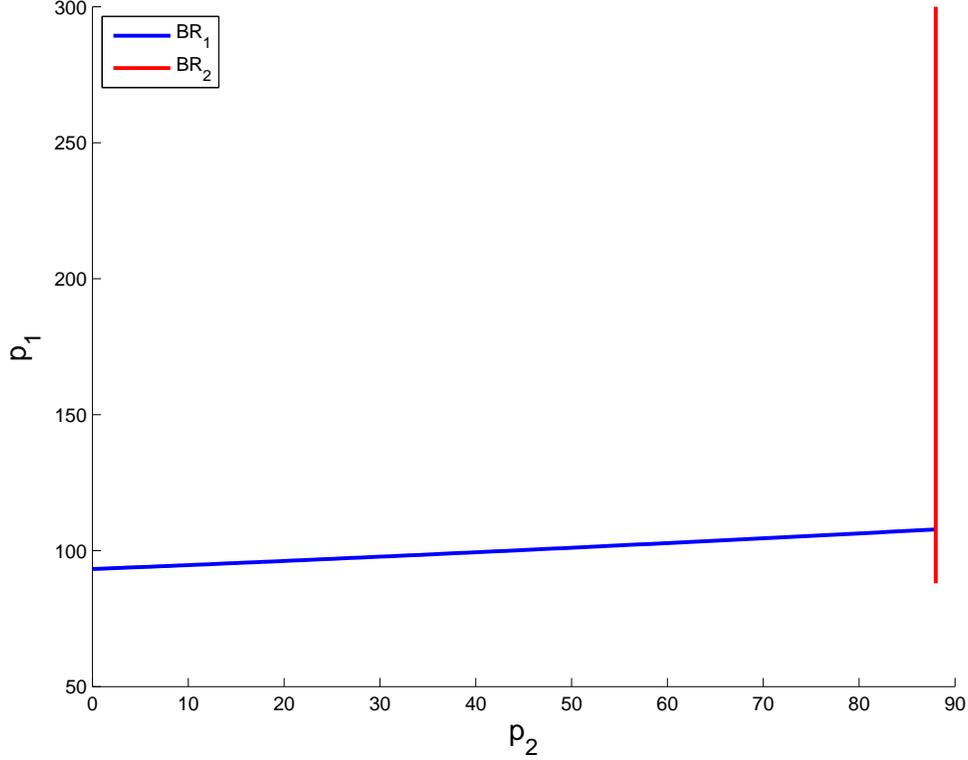


3.2.2 Fair Share

After 1999, the dollar maximum of employer contribution is set at 72% of the enrollment-weighted average of *all* plan premiums. If we denote the lagged program-wide market share (or enrollment weight) of the two plans as w_1 and w_2 , respectively, the maximum employer contribution can now

¹¹ $\alpha_1 = 3$, $\alpha_2 = 0$, $\beta_1 = \beta_2 = .1$, $C_1 = 70$, and $C_2 = 65$.

Figure 4: Equilibrium Prices of the Two Plans Before 1999
(subsidy cap = $66/.75$, $P_1 \geq$ subsidy cap, $P_2 \leq$ subsidy cap)



be expressed as $.72(w_1P_1 + w_2P_2)$. As a result, the maximum gross premium a plan can charge that is still subsidized at the 75% margin, namely the subsidy cap, is $.72(w_1P_1 + w_2P_2)/.75 = .96(w_1P_1 + w_2P_2)$.

Again, depending on whether plan 2 chooses to price above or below the subsidy cap, plan 1's profit function can change. Given the new subsidy cap policy, however, it is not possible for both plans to price below the subsidy cap. We briefly present the solutions to the profit maximization problem of plan 1 in the case of $P_1 \geq$ subsidy cap and $P_2 \leq$ subsidy cap below, leaving the remaining cases to Appendix B. Similar derivation applies to plan 2.

After the policy change, since the subsidy cap is now $.96(w_1P_1 + w_2P_2)$, when plan 1 prices above the subsidy cap and plan 2 prices below, we have two inequality constraints:

$$P_1 \geq .96(w_1P_1 + w_2P_2),$$

$$P_2 \leq .96(w_1P_1 + w_2P_2).$$

It turns out that only the second constraint is needed since it automatically implies the first one. The net premiums consumers pay for plan 1 and plan 2 are $\tilde{P}_1 = P_1 - .72(w_1P_1 + w_2P_2)$ and

$\tilde{P}_2 = .25P_2$, respectively. The Lagrangian function of plan 1's profit maximization problem can be written as:

$$\mathcal{L}(P_1, \lambda) = (P_1 - C_1)D_1 + \lambda(.96(w_1P_1 + w_2P_2) - P_2).$$

Consider the interior solution first. When the constraint does not bind, the FOC of plan 1 is

$$P_1 = C_1 + \frac{1}{\beta_1(1 - .72w_1)(1 - S_1)}, \quad (8)$$

where

$$S_1 = \frac{\exp(\alpha_1 - \beta_1(P_1 - .72(w_1P_1 + w_2P_2)))}{\exp(\alpha_1 - \beta_1(P_1 - .72(w_1P_1 + w_2P_2))) + \exp(\alpha_2 - .25\beta_2P_2)}. \quad (9)$$

Solving the above simultaneous equations, we get the following closed form solution to be plan 1's best response function and market share, in terms of P_2 :

$$P_1^* = C_1 + \frac{1 + W(x)}{\beta_1(1 - .72w_1)}, \quad (10)$$

$$S_1^* = \frac{W(x)}{1 + W(x)}, \quad (11)$$

where $P_2 < .96(w_1P_1^* + w_2P_2)$ and $x = \frac{\exp(\alpha_1 - 1 - \beta_1(1 - .72w_1)C_1)}{\exp(\alpha_2 - (.25\beta_2 + .72w_2\beta_1)P_2)}$.

When the constraint binds, the corner solution in this case is $P_2 = .96(w_1P_1 + w_2P_2)$, or $\frac{P_2}{P_1} = \frac{.96w_1}{1 - .96w_2}$. Plugging the above expression into plan 1's market share expression in (9), we derive the following corner solution:

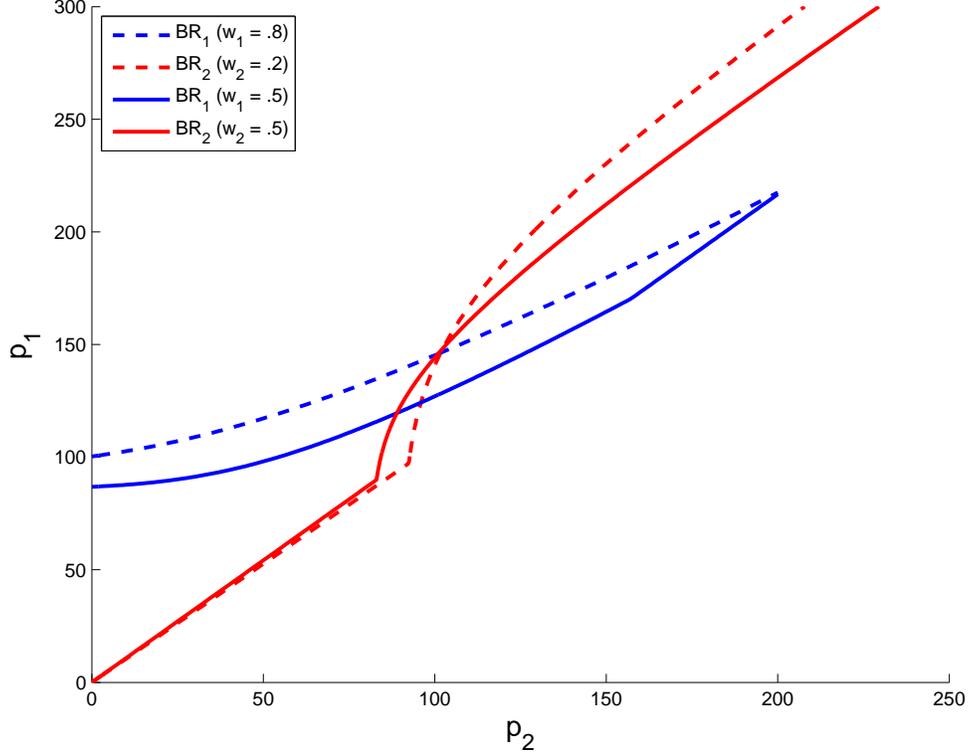
$$P_1^* = \frac{1 - .96w_2}{.96w_1} P_2, \quad (12)$$

$$S_1^* = \frac{\exp(\alpha_1 - \beta_1((1 - .72w_1)\frac{1 - .96w_2}{.96w_1} P_2 - .72w_2P_2))}{\exp(\alpha_1 - \beta_1((1 - .72w_1)\frac{1 - .96w_2}{.96w_1} P_2 - .72w_2P_2)) + \exp(\alpha_2 - .25\beta_2P_2)}. \quad (13)$$

Similar derivation applies to plan 2.

When drawing the best response functions, in addition to using the same parameter values as in Section 3.2.1 before the subsidy policy change, we present simulations in two settings: one has $w_1 = .8$ and $w_2 = .2$, and the other has $w_1 = w_2 = .5$. The contrast of these two market settings sheds light on the importance of the lagged global market shares that now enter the equilibrium conditions. As shown in Figure 5, both best response functions move as the lagged market shares change. Again, the kinks in both plans' best response functions are due to the constraint that plan 1 prices above the subsidy cap and plan 2 prices below. The new equilibrium price levels of both plans are lower in the case of $w_1 = w_2 = .5$ than in the case of $w_1 = .8$ and $w_2 = .2$.

Figure 5: Equilibrium Prices of the Two Plans After 1999
(subsidy cap = $.96(w_1P_1 + w_2P_2)$, $P_1 \geq$ subsidy cap, $P_2 \leq$ subsidy cap)



What role does the lagged market share play in a plan’s pricing behavior under the “Fair Share” scheme? Taking P_2 as given, plan 1 would set an optimal price (P_1^*) depending on the subsidy policy. Before 1999, plan 1 (a non-Big-Six plan) takes the dollar maximum (c) as given in addition to P_2 . After 1999, however, the dollar maximum becomes endogenous in that each plan has some weight in determining its level: the larger the plan’s market share, the more influence it has on setting the dollar maximum.

When plan 1 prices above the subsidy cap and plan 2 prices below, we have

$$\frac{\partial P_1^*}{\partial w_1} = \frac{.72C_1}{1 - .72w_1} \frac{W(x)}{1 + W(x)} + \frac{.72\beta_1(1 + W(x))}{\beta_1^2(1 - .72w_1)^2} > 0,$$

where $x = \frac{\exp(\alpha_1 - 1 - \beta_1(1 - .72w_1)C_1)}{\exp(\alpha_2 - (.25\beta_2 + .72w_2\beta_1)P_2)}$. The intuition behind this result is that if plan 1 prices above the subsidy cap and has a large market share, it will have an incentive to increase its premium bid for the upcoming year, which could in turn help raise the upcoming subsidy cap given plan 1’s large weight in determining the dollar maximum. We refer to this incentive as “raising the cap.”

In comparison, plan 2, which prices below the subsidy cap, faces a different situation. Taking

the first partial derivative of plan 2's equilibrium price equation

$$P_2^* = C_2 + \frac{1 + W(x)}{.25\beta_2 + .72w_2\beta_1},$$

We present the comparative statistics as follows:

$$\frac{\partial P_2^*}{\partial w_2} = -\frac{.72\beta_1 C_2}{.25\beta_2 + .72w_2\beta_1} \frac{W(x)}{1 + W(x)} - \frac{.72\beta_1(1 + W(x))}{(.25\beta_2 + .72w_2\beta_1)^2} < 0,$$

where $x = \frac{\exp(\alpha_2 - 1 - (.25\beta_2 + .72w_2\beta_1)C_2)}{\exp(\alpha_1 - \beta_1(1 - .72w_1)P_1)}$.

The intuitive reason for the negative sign here, as opposed to the positive sign derived earlier in the case of plan 1, is that a low enrollment weight of plan 2 indicates a large enrollment weight enjoyed by plan 1. The smaller the plan's market share is, the more it anticipates plan 1 to raise the premium. Because prices are strategic complements and there is an incentive to chase the cap from below, the smaller the plan is, the more it raises its own price to keep up with the subsidy cap. Taken together, this explains why in Figure 5, we observe lower equilibrium prices when the two plans share the market equally than when plan 1 enjoys a larger market share than plan 2.

3.3 Policy Experiment

Keeping the same parameter values described in Section 3.2.1, we conduct a policy experiment to see how the change from "Big Six" to "Fair Share" could affect the equilibrium prices of the two plans in the market.

We simulate three scenarios in Table 1. In Scenario 1, both plans choose their own equilibrium gross premium while taking the exogenous dollar maximum c as given ($c = 66$ is the actual 1998 biweekly dollar maximum level in the FEHBP). To facilitate comparison with other scenarios, we assume the cost and demand parameters are such that plan 2 sets its gross premium at the subsidy cap ($P_2^* = c/.75 = 88$). With the values of c and P_2^* , we can derive P_1^* based on plan 1's best response function. It turns out that $P_1^* = 107.8$.

In Scenario 2, we change the way the dollar maximum is determined from the "Big Six" formula to the "Fair Share" formula, assuming there is no behavioral change in health plans. When $w_1 = .8$ and $w_2 = .2$, we derive the new dollar maximum $c = .72(.8P_1^* + .2P_2^*)$, and combine this equation with the FOCs under the "Big Six" formula to calculate the "naive" equilibrium price levels P_1^* and P_2^* . The reason we phrase these new equilibrium price levels as "naive" is that we are assuming the two plans would consider the dollar maximum exogenous as before and therefore react in the same way as the pre-1999 case facing a new c' . Simulation suggests that this will lead to a new equilibrium with higher premiums in both plans ($P_1^* = 116.7$ and $P_2^* = 99.7$).

Scenario 3 describes the real situation of "Fair Share." After the policy change in 1999, the two plans now choose their price levels taking into account the fact that the dollar maximum is

Table 1: Simulated Gross Premiums under Big Six and Fair Share

Scenario	Employer Contribution Scheme	Assumption on Plans	Dollar Max (c)	Subsidy Cap ($c/.75$)	Simulated P_1^*	Simulated P_2^*
1	Big Six	Take the subsidy cap as given	66	88	107.8	88
2	Fair Share	Naively take the subsidy cap as given	81.6	108.8	116.7	99.7
3	Fair Share	Recognize its self influence on the subsidy cap	98.9	131.9	146.3	101.7

now a function of their own prices. As a result, their best response functions are dependent on their lagged market shares w_1 and w_2 . As shown in Table 1, the equilibrium premiums of both plans are higher than the “naive” prices after we let the plans internalize the maximum employer contribution ($P_1^* = 146.3$ and $P_2^* = 101.7$). Dollar maximum and subsidy cap increase accordingly.

Overall, the simple oligopoly model presented above highlights two pricing incentives of employer-sponsored health plans: first, plans below the subsidy cap face less elastic demand and therefore have extra incentives to charge gross premiums up to the cap. In the FEHBP, one dollar increase in gross premium will require one more dollar of out-of-pocket enrollee payment if a plan charges above the subsidy cap, but the enrollee payment only increases by 25 cents if a plan charges below the cap. This difference in consumer price sensitivity creates an incentive of “chasing the cap” from below. The second incentive is raising the cap if a plan’s own premium has a large positive influence on the subsidy cap. This implies that, in the FEHBP’s “Fair Share” scheme, plans with a larger FEHBP-wide market share last year will have a stronger incentive to increase its own premium in order to raise the cap. Because prices are strategic complements, one plan’s incentive to increase its premium will motivate competing plans to increase premiums even further. The raised subsidy cap also reinforces the incentive to chase the cap from below. As a result, strategic interactions among competing health plans, the incentive to “chase the cap” from below and the incentive to “raise the cap”, reinforce each other to promote premium growth under the “Fair Share” scheme.

4 Empirical Analysis

4.1 Data

Our data come from the Office of Personnel Management (OPM), who oversees the FEHBP. The plan-level dataset contains information on various characteristics of all health plans offered in the FEHBP during 1991-2011. Although the subsidy policy change applies to both federal civilian employees and annuitants in self-only as well as family plans, we focus on federal civilian employees under age 65 who enroll in self plans only, due to other possible health insurance coverage (such as Medicare) faced by annuitants and the lack of information on dependents among those who enroll in family plans.¹²

Each year, the OPM contracts with over 200 plans. A health plan in a certain year is defined as a unique combination of a federal plan code and an option code (high or standard). If a plan is fee-for-service (FFS), it is offered nationwide and open to anyone covered by the FEHBP. A managed care (non-FFS) plan, however, is associated primarily with one state, and only residents within that state, or sometimes within certain counties, can enroll.

4.2 Testable Predictions and Empirical Strategy

Recall that our model predicts an incentive to chase the cap from below for all years and an incentive to raise the cap after the FEHBP adopted the “Fair Share” formula in 1999. This facilitates two comparisons: the difference between plans above and below the subsidy cap captures the first incentive, and the difference before and after 1999 captures the second incentive. Moreover, we can calculate how much a plan is below the cap and how large a plan’s market share is in the entire FEHBP program. These continuous measures allow us to assess the strength of the two incentives.

Before we carry these intuition to the real data, it is worth noting that the data departs from the model in several ways. First, our model takes the subsidy cap as exogenously given under the “Big Six” scheme, and endogenizes the subsidy cap under the “Fair Share” scheme. In either scheme, all health plans (including the Big Six) choose their own premiums simultaneously and do not know the concurrent subsidy cap for sure when they report their premiums to the OPM. This implies that regressing plan premiums on whether or not a premium ends up being above or below the current subsidy cap is subject to a serious endogeneity problem. However, every plan does observe last year’s subsidy cap. A plan that was below last year’s subsidy cap has reasons to believe that it faces a lower demand elasticity than an above-cap plan, because every dollar of premium increase implies 75 cents more in subsidies from the federal government and 25 cents more in out-of-pocket payments from enrollees. According to our model, a below-cap plan should have a greater incentive to raise its premium this year than an above-cap plan. This motivates us to use

¹²FEHBP plans charge both civilian (non-postal) and postal federal employees the same gross premium, but the government subsidizes at a much higher margin (around 85% in 2012) for postal workers.

premium growth as the dependent variable, and create the dummy variable of below cap based on whether a plan was below or above last year’s subsidy cap.

Additionally, our model emphasizes market equilibrium in a single year but many plans exist in the FEHBP for many years. In both theoretical and empirical analyses, we assume away plans’ dynamic incentives such as setting a low premium in one year in order to attract new employees and then raising the premium next year when existing enrollees are reluctant to switch. While switching costs are important in health insurance, we argue that this dynamic incentive is similar across all plans and therefore can be controlled by year fixed effects.

With these limitations in mind, we propose three specifications, each focusing on a separate channel through which the employer subsidy policy can affect the pricing strategies of health plans. The impact from local competition is taken into account in all specifications by introducing the lagged number of plans in a local market as well as a plan’s lagged local market share.

To check whether the capped subsidy system affects plans below or above the subsidy cap differently, we estimate the first baseline regression model as follows:

$$\begin{aligned} \Delta P_{jst} = & \beta_0 + \beta_1 Post_t + \beta_2 Below_{js,t-1} + \beta_3 Below_{js,t-1} \times Post_t \\ & + \beta_4 Plans_{s,t-1} + \beta_5 LocalShare_{js,t-1} + X'_{jst}\Gamma + \theta_s + \epsilon_{jst}. \end{aligned} \quad (14)$$

The unit of observation in the equation above is plan j in state s and year t . As argued above, demand elasticity is related to marginal change of premium, so our dependent variable, $\Delta P_{jst} = P_{jst} - P_{js,t-1}$, is the first difference in real biweekly gross premium of each plan.

The $Post_t$ dummy variable takes on a value of one for years greater than or equal to 1999. The $Below_{js,t-1}$ dummy variable indicates whether plan j in state s prices below the subsidy cap in year $t - 1$. We also include an interaction term between $Post_t$ and $Below_{js,t-1}$ in order to capture any differential impact before and after the subsidy policy change. The variables $Plans_{s,t-1}$ and $LocalShare_{js,t-1}$ indicate the total number of self-only plans and plan j ’s local market share in state s and year $t - 1$.¹³

Local market structure ($Plans_{s,t-1}$) and a plan’s local market power ($LocalShare_{js,t-1}$) are both lagged because when plans submit their premium bids for year t in April of year $t - 1$, they do not yet have the market-specific characteristics in year t available to them. As a result, we assume they decide how much to increase premium next year based on the existing information in the previous year.

The plan control variables X_{jst} include dummy variables such as whether the plan is “Big Six”, FFS, high option, and whether it has a companion high or standard option. Additionally, we collect plan benefits and quality measures from the annual Guide to Federal Employees Health Benefits Plans distributed by OPM. Because our dependent variable is premium change from the previous

¹³In order to capture health plan competition within the local market only, we do not include the nation-wide FFS plans in the calculation of the number of local plans.

year, these benefits enter the equation as changes in outpatient copay, hospital deductible, generic and brand drug copay, as well as each plan’s national accreditation status in the regressions. Last but not least, we include state fixed effects, θ_s , to control for time-invariant state-specific characteristics.

The coefficient β_2 in equation (14) tells us whether plans below the subsidy cap raise premiums faster than plans above, and β_3 indicates whether after the subsidy policy change, the sign and magnitude of that difference stay the same. Coefficients β_4 and β_5 capture local competition effect.

In the second specification, we introduce into the equation the distance of how far away the plan’s lagged gross premium is from last year’s subsidy cap ($Distance_{j,s,t-1}$), and interact it with whether the lagged premium is below or above the subsidy cap, as well as whether it is before or after the policy change. The second estimation equation can be written as follows:

$$\begin{aligned}
\Delta P_{jst} = & \beta_0 + \beta_1 Post_t + \beta_2 Below_{j,s,t-1} + \beta_3 Below_{j,s,t-1} \times Post_t \\
& + Distance_{j,s,t-1} \times \{\beta_4 Below_{j,s,t-1} \times Pre_t \\
& + \beta_5 Above_{j,s,t-1} \times Pre_t + \beta_6 Below_{j,s,t-1} \times Post_t \\
& + \beta_7 Above_{j,s,t-1} \times Post_t\} + \beta_8 Plans_{s,t-1} \\
& + \beta_9 LocalShare_{j,s,t-1} + X'_{jst}\Gamma + \theta_s + \epsilon_{jst}
\end{aligned} \tag{15}$$

The dummy variables $Below_{j,s,t-1}$ and $Above_{j,s,t-1}$ indicate whether plan j in state s prices below or above the subsidy cap, the dummy Pre_t is an indicator for whether the year is before 1999. Compared to the baseline specification, equation (15) has the added independent variables estimated by β_4 through β_7 , indicating how premium growth are affected by how far a plan was below or above the subsidy cap in the previous year before and after the policy change.

Next we look at whether the plan’s program-wide global market share, as opposed to its local market share, could impact its pricing behavior after the policy change. Since the subsidy cap before 1999 is the simple average premium of the “Big Six” plans regardless of the enrollment pattern of the remaining plans, we do not expect a plan’s lagged global market share to play a role in influencing premium growth before 1999 unless the plan itself is one of the “Big Six.” After all, we have already included the plan’s local market share in the regression model. After the policy change, however, the subsidy cap is determined by an enrollment-weighted average of all plan premiums in the program, which would potentially have a differential impact on plans of different enrollment sizes, or global market shares. Therefore, we specify the third estimation equation as

follows:

$$\begin{aligned}
\Delta P_{jst} = & \beta_0 + \beta_1 Post_t + \beta_2 Below_{js,t-1} + \beta_3 Below_{js,t-1} \times Post_t \\
& + GlobalShare_{js,t-1} \times \{ \beta_4 Below_{js,t-1} \times Pre_t \\
& + \beta_5 Above_{js,t-1} \times Pre_t + \beta_6 Below_{js,t-1} \times Post_t \\
& + \beta_7 Above_{js,t-1} \times Post_t \} + \beta_8 Plans_{s,t-1} \\
& + \beta_9 LocalShare_{js,t-1} + X'_{jst} \Gamma + \theta_s + \epsilon_{jst}
\end{aligned} \tag{16}$$

The global market share of plan j in state s and year $t - 1$, $GlobalShare_{js,t-1}$, is calculated as the percentage of enrollees choosing plan j among all federal civilian employees in the FEHBP who enroll in self-only plans.¹⁴ Comparing equation (16) with (14), we are now allowing a plan's lagged global market share to play a role in determining next year's premium, with potentially heterogeneous effects depending on whether the plan prices above or below the subsidy cap, and whether it occurs before or after the policy change.

In all three regression specifications discussed above, due to the inclusion of the $Post$ dummy variable, which is equal to one for all years greater than or equal to 1999, we do not include year fixed effects. In order to account for macroeconomic shocks such as advances in medical technology and an aging population, we need to introduce some time trends. As a result, for all three specifications, we add separate linear time trends before and after the policy change, and later year fixed effects (after getting rid of the $Post$ dummy) as model variants. In an attempt to control for time-invariant characteristics at the plan code level, we also try including plan code fixed effects in lieu of state fixed effects.

4.3 Evidence From the Raw Data

Table 2 provides the descriptive statistics for average plan characteristics of all years. The average annual premium in nominal terms increases in most years, as does the subsidy cap. The average annual growth rates of real premiums and the subsidy cap are close in magnitude. This is reasonable because the subsidy cap for the new plan year is determined by the premium bids submitted by insurance plans, whether through a simple average before 1999 or an enrollment-weighted average after 1999.

At the same time, the total number of plans increased in the late 1990s, before falling back in the early 2000s due to mergers and consolidation among health maintenance organization (HMO) plans. Figure 6 plots the growth rate of real premiums along with the average number of health plans per

¹⁴We choose the denominator to be the total number of federal civilian enrollees in the FEHBP who choose self-only plans because the new subsidy policy effective in 1999 uses the same methodology to calculate enrollment weights for the subsidy cap. However, since the new subsidy cap also takes into account enrollment among postal workers when calculating the enrollment-weighted average, our measure is an approximation of the program-wide market share since our plan data does not include those for postal workers.

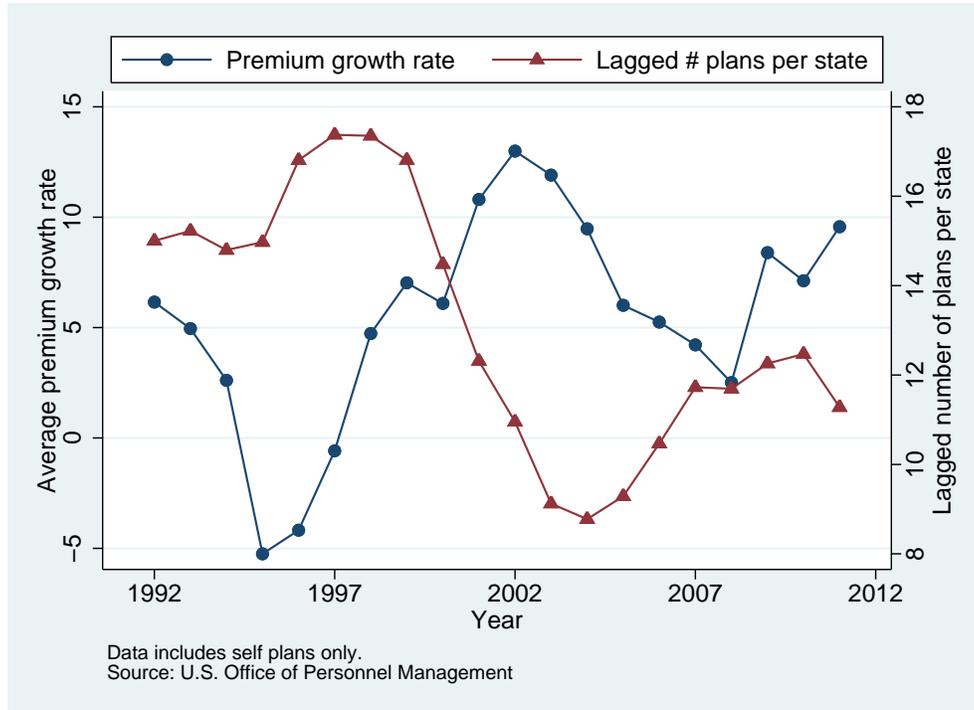
Table 2: Mean Statistics for Self Plan Characteristics

Year	Annual Premium (Nominal \$)	Dollar Max (Nominal \$)	FFS (%)	High Option (%)	Plan Enrollment (No.)	Total # Plans (No.)	# Plans Per State (No.)
1991	1,752	1,521	4.4	94.5	1,423	384	15
1992	1,894	1,573	4.2	95.3	1,445	384	15
1993	2,017	1,675	4.0	95.3	1,428	379	15
1994	2,107	1,721	3.8	95.2	1,325	398	15
1995	2,034	1,596	3.3	96.5	1,132	455	17
1996	1,987	1,599	3.0	96.5	1,010	492	18
1997	1,992	1,634	3.3	96.5	983	490	17
1998	2,095	1,715	3.3	96.2	1,059	453	16
1999	2,265	1,874	3.9	96.1	1,309	363	14
2000	2,477	2,050	5.0	95.3	1,583	300	12
2001	2,807	2,251	6.7	93.7	2,244	255	11
2002	3,220	2,544	8.7	93.4	2,980	196	9
2003	3,601	2,842	9.6	90.9	3,291	187	9
2004	3,891	3,156	8.8	88.8	3,054	205	10
2005	4,164	3,408	8.5	81.4	2,528	247	11
2006	4,436	3,619	7.5	79.0	2,207	281	12
2007	4,694	3,690	6.7	75.1	2,191	285	12
2008	4,919	3,771	6.7	71.7	2,243	283	12
2009	5,183	4,047	7.1	69.4	2,479	268	12
2010	5,507	4,358	8.1	67.9	2,976	234	11
2011	6,055	4,697	9.2	66.2	3,340	207	10
Mean	2,987	2,401	5.3	89.3	1,786	350	14

Notes: The 1991-2011 plan-level data comes from the U.S. Office of Personnel Management. The FFS column shows the percentage of plans that are fee-for-service. The High Option column shows the percentage of plans that are considered high-option in the FEHBP.

state in the previous year. The strong correlation between these two variables are consistent with [Dafny et al. \(2012\)](#).

Figure 6: Premium Growth vs. Number of Plans



Over time, the percentage of plans who price below the subsidy cap decreased (see Figure 7), meaning more plans have caught up with the subsidy cap and are taking full advantage of maximum premium contribution from the employer. Table 3 tabulates the real premium growth rate of plans who priced below versus above the subsidy cap. We see a clear pattern that plans who priced below the subsidy cap in the previous year choose to grow faster than plans pricing above, especially before 1999, confirming the findings by [Thorpe et al. \(1999\)](#). After 2000, however, the difference between the two diminished.

One concern is that plans below the subsidy cap could grow faster than plans above merely due to their lower base premium. Therefore, we also graph the average premium change for plans above and below the subsidy cap over time in Figure 8, which shows that plans below did increase their premiums more on average than those above, although that difference diminished after 1999.

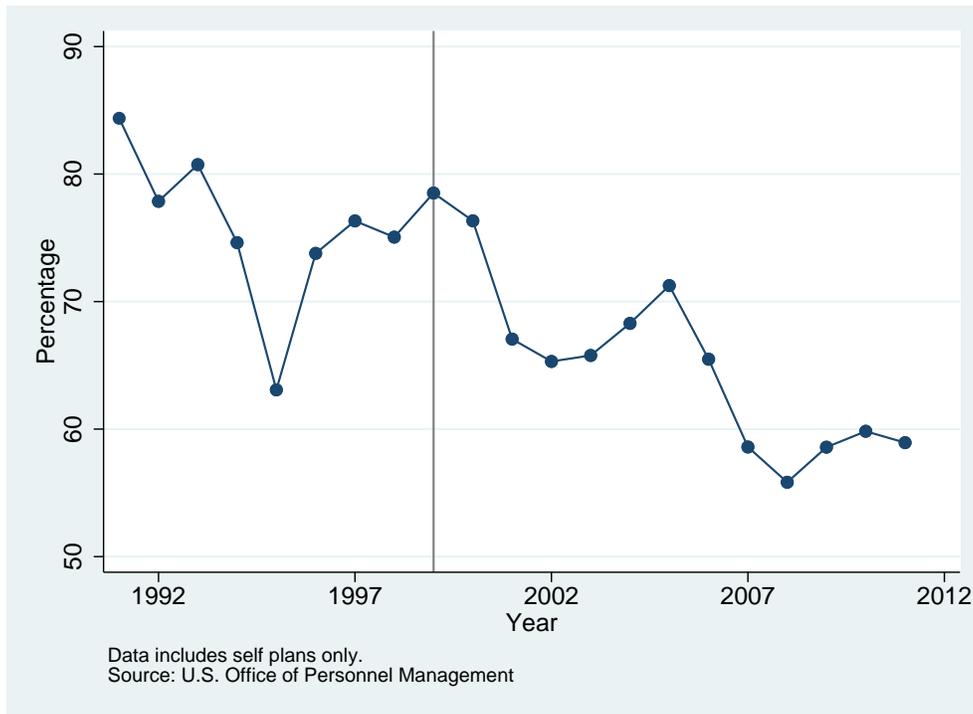
Ideally, we would like to explicitly control for aggregated demographic characteristics of enrollees under each health plan such as their age, gender, education, and salary. Unfortunately, we only have enrollees' demographic information in the FEHBP from years 1991-2000. By examining enrollee characteristics during 1991-2000, however, we find very little change in the aggregate demographic composition of federal employees. It is understandable since the population of federal employees remains fairly stable over time.

Table 3: Premium Growth Below and Above the Subsidy Cap

Premium Growth (%)				
Year	Below	Above	Difference	
1992	7.0	1.3	5.7	***
1993	5.7	1.7	4.0	***
1994	3.3	-0.6	3.9	***
1995	-4.1	-8.7	4.6	***
1996	-2.5	-7.0	4.5	***
1997	0.6	-4.2	4.8	***
1998	5.6	1.7	3.9	***
1999	8.7	1.9	6.8	***
2000	7.0	2.8	4.2	***
2001	11.3	9.2	2.1	*
2002	14.0	10.8	3.2	*
2003	13.8	7.8	6.0	***
2004	9.5	9.3	0.2	
2005	6.4	5.1	1.3	
2006	6.0	3.5	2.5	**
2007	5.1	2.5	2.6	**
2008	3.0	1.7	1.3	
2009	9.4	6.9	2.5	**
2010	7.9	5.8	2.1	*
2011	9.7	9.3	0.4	
Mean	5.3	2.0	3.3	***

Notes: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Figure 7: Percentage of Plans Below the Subsidy Cap



4.4 Evidence from Regressions

Recall that when a plan prices below the subsidy cap the employer subsidizes 75% of the gross premium, and consumers only pay 25 cents of every one-dollar increase in the gross premium. On the other hand, when a plan prices above the subsidy cap, the employer subsidizes a fixed dollar maximum, and a one-dollar increase in the gross premium in this case will be fully borne by the consumer. As a result, considering the different price sensitivities faced by consumers, health plans will price accordingly depending on whether they are above or below the subsidy cap.

Echoing the results presented in Table 3, the consumer sensitivity OLS estimates in Table 4 from regression equation (14) show that before 1999, plans below the subsidy cap would increase their real biweekly premiums by \$5 to \$8 more on average compared to plans above the cap, which is around \$130 to \$208 per person per year.¹⁵ After 1999, however, the average biweekly increase seen in plans below the cap is only around \$2 more than plans above, which translates into a \$52 increase per year. Therefore, even though premiums among plans below the subsidy cap still grow faster than plans above after the policy change, the magnitude is largely dampened.

The coefficient on the lagged number of plans turns out to be negative as expected, indicating that local competition can keep premium growth in check. One caveat is that although statistically significant, the magnitude of the impact from local competition is relatively small – one more plan

¹⁵Premiums are deflated using the Consumer Price Index (CPI) and expressed in year 2000 dollars.

Table 4: Premium Level Change: Consumer Sensitivity

	Basic	Linear Trend	FE (1)	FE (2)
Post	10.56*** (0.731)	10.80*** (0.786)		
Below	5.923*** (0.501)	5.686*** (0.515)	5.028*** (0.490)	7.920*** (0.713)
Below \times Post	-4.612*** (0.793)	-4.064*** (0.789)	-3.223*** (0.750)	-2.525*** (0.913)
Plans	-0.276*** (0.0365)	-0.198*** (0.0411)	-0.118*** (0.0449)	-0.0507 (0.0563)
LocalShare	3.002*** (0.857)	2.887*** (0.889)	2.216** (0.892)	8.955*** (2.068)
Plan Controls	<i>Yes</i>	<i>Yes</i>	<i>Yes</i>	<i>Yes</i>
Plan Code FE				<i>Yes</i>
State FE	<i>Yes</i>	<i>Yes</i>	<i>Yes</i>	
Year FE			<i>Yes</i>	<i>Yes</i>
<i>N</i>	5746	5746	5746	5746
adj. <i>R</i> ²	0.159	0.165	0.242	0.250

Notes: The dependent variable is the first difference in real biweekly plan premium.

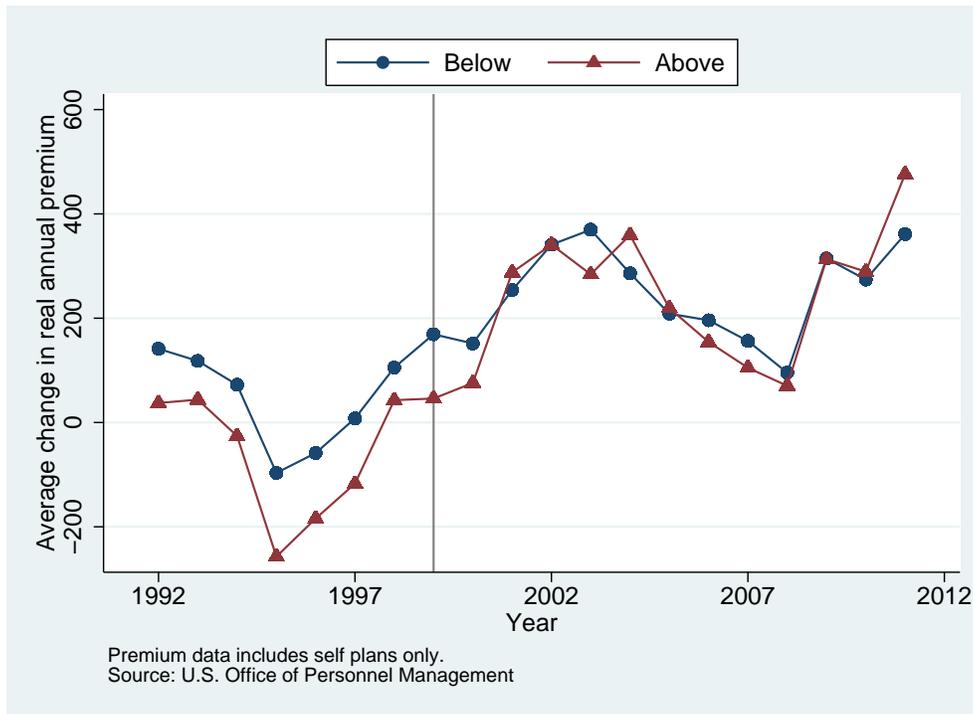
Separate linear time trends before and after 1999 included in column 2.

Additional plan control variables include plan characteristics as well as benefits and quality changes.

Standard errors clustered at the plan code level in parentheses.

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Figure 8: Premium Change Below and Above the Subsidy Cap



in the local market only decreases the average biweekly plan premium by less than a dollar. One explanation is that plans within a local market are differentiated enough that they are able to limit the effect of competition, which is also why larger plans seem to be able to charge higher premiums, as the local market share of a plan is positively correlated with the level of premium increase. Another explanation is that due to little switching among enrollees, large plans are able to capture more consumers even if they raise prices.

The Post dummy is positive and significant at the 1% level, showing that real biweekly plan premiums increase around \$11 more on average after the “Fair Share” formula took effect, which is an annual increase of \$286, even after taking into account separate linear time trends for the two time periods before and after 1999. The Post dummy has to be omitted in the third and fourth columns when we include year fixed effects in the model, but all the other regression coefficients remain relatively stable.

The results from the second specification, as shown in Table 5, indicate that conditional on pricing below the subsidy cap, the farther away a plan is from the cap, the faster it grows. After controlling for plan code fixed effects, for plans below the subsidy cap before 1999, being one more dollar away from the cap translates roughly into an additional 36-cent increase in biweekly premium next year, or around \$10 annually, *ceteris paribus*. On the other hand, the opposite is true for plans above the subsidy cap, as all of the coefficients are negative. After 1999, however, the effect of distance from the subsidy cap on premium growth is largely dampened for all plans,

similar to the results discussed earlier in Table 4.

Table 5: Premium Level Change: Distance from the Subsidy Cap

	Basic	Linear Trend	FE (1)	FE (2)
Post	10.49*** (1.119)	10.31*** (1.173)		
Below	2.007** (0.975)	2.033** (0.976)	1.601* (0.920)	2.175** (1.087)
Below \times Post	-2.160* (1.187)	-1.540 (1.188)	-1.320 (1.116)	-0.554 (1.310)
Distance \times Below \times Pre	0.196*** (0.0239)	0.187*** (0.0240)	0.170*** (0.0222)	0.363*** (0.0397)
Distance \times Above \times Pre	-0.133 (0.0868)	-0.126 (0.0874)	-0.130 (0.0860)	-0.286** (0.112)
Distance \times Below \times Post	0.0245* (0.0128)	0.00113 (0.0144)	0.0237* (0.0140)	0.160*** (0.0367)
Distance \times Above \times Post	-0.0670* (0.0369)	-0.0763* (0.0389)	-0.0713** (0.0347)	-0.182*** (0.0439)
Plans	-0.262*** (0.0381)	-0.196*** (0.0424)	-0.116** (0.0471)	-0.0360 (0.0649)
LocalShare	2.582*** (0.847)	2.281** (0.889)	1.779** (0.897)	7.167*** (2.034)
Plan Controls	<i>Yes</i>	<i>Yes</i>	<i>Yes</i>	<i>Yes</i>
Plan Code FE				<i>Yes</i>
State FE	<i>Yes</i>	<i>Yes</i>	<i>Yes</i>	
Year FE			<i>Yes</i>	<i>Yes</i>
<i>N</i>	5746	5746	5746	5746
adj. <i>R</i> ²	0.171	0.176	0.252	0.290

Notes: The dependent variable is the first difference in real biweekly plan premium.

Separate linear time trends before and after 1999 included in column 2.

Additional plan control variables include plan characteristics as well as benefits and quality changes.

Standard errors clustered at the plan code level in parentheses.

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

In terms of global market share, the results in Table 6 are as expected in that the program-wide enrollment share of a plan did not influence its premium growth before 1999, whereas the coefficients are significant at the 1% level after the policy change when we include state and year fixed effects. In column 4, the sign and the magnitude of the coefficient for the above-cap plans after 1999 indicate that a 1% increase in the global market share of an above-cap plan would lead to an almost 20-cent increase in the plan's biweekly gross premium next year, which is approximately

a \$5 increase in annual premium. Moreover, the signs of the coefficients for the effect of global market share among below-cap plans after 1999 are consistent with theory predictions.

Table 6: Premium Level Change: Global Market Share

	Basic	Linear Trend	FE (1)	FE (2)
Post	10.55*** (0.741)	10.78*** (0.802)		
Below	6.007*** (0.506)	5.775*** (0.520)	5.106*** (0.496)	8.070*** (0.712)
Below × Post	-4.571*** (0.810)	-4.009*** (0.806)	-3.121*** (0.763)	-2.425*** (0.936)
GlobalShare × Below × Pre	-6.633 (5.258)	-2.664 (5.857)	2.241 (5.164)	-3.862 (18.43)
GlobalShare × Above × Pre	19.96 (18.74)	25.49 (17.99)	24.65 (15.26)	42.93* (24.29)
GlobalShare × Below × Post	-18.15 (11.12)	-22.44** (10.69)	-28.02*** (10.50)	-40.12 (40.88)
GlobalShare × Above × Post	7.433** (3.691)	8.333** (4.004)	10.83*** (3.824)	19.58** (8.652)
Plans	-0.277*** (0.0365)	-0.198*** (0.0411)	-0.116*** (0.0449)	-0.0560 (0.0563)
LocalShare	2.925*** (0.923)	2.759*** (0.951)	2.001** (0.935)	8.675*** (2.139)
Plan Controls	<i>Yes</i>	<i>Yes</i>	<i>Yes</i>	<i>Yes</i>
Plan Code FE				<i>Yes</i>
State FE	<i>Yes</i>	<i>Yes</i>	<i>Yes</i>	
Year FE			<i>Yes</i>	<i>Yes</i>
<i>N</i>	5746	5746	5746	5746
adj. <i>R</i> ²	0.159	0.165	0.242	0.250

Notes: The dependent variable is the first difference in real biweekly plan premium.

Separate linear time trends before and after 1999 included in column 2.

Additional plan control variables include plan characteristics as well as benefits and quality changes.

Standard errors clustered at the plan code level in parentheses.

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

In all three specifications, the regression coefficients do not change much across different models as indicated by each separate column. In column two we include separate linear time trends for before and after the policy change, in column three we present estimates including year fixed effects, and in column four we drop state fixed effects and include plan code fixed effects instead. It is possible that plans of the same plan code but different option code (high or standard) tend to

follow the same pricing strategy over time, therefore we estimate clustered standard errors of the coefficients by allowing correlation within the same plan code.

In addition, we test for serial correlation using the method derived by [Wooldridge \(2001\)](#) for linear panel-data models. For all model variants in the first and third regression specifications presented in [Tables 4 and 6](#), the null hypothesis that there is no first-order autocorrelation cannot be rejected. For the second specification, however, the null hypothesis is rejected, which means that the standard errors reported in [Table 5](#) could be understated.

As a result, we re-estimate the second regression specification involving the distance of the premium from the subsidy cap by allowing an AR(1) process in the error term. It turns out that all the variables in interest still bear the same sign as in [Table 5](#) and are statistically significant, with the only difference being coefficients having larger magnitudes.

5 Counterfactual Simulation

In the following counterfactual analysis, we simulate the trajectory of the average annual gross premium in the FEHBP had the pre-1999 subsidy policy remained in effect, or had the health plans not changed their pricing strategies facing the new subsidy policy.¹⁶ First, we estimate the following regression model using the pre-1999 data set, with the same set of plan control variables (X_{jst}) mentioned in [Section 4](#) as well as both state (θ_s) and year (η_t) fixed effects:

$$\begin{aligned} \Delta P_{jst} = & \beta_0 + \beta_1 \textit{Below}_{js,t-1} + \textit{Distance}_{js,t-1} \times \{ \beta_2 \textit{Below}_{js,t-1} \\ & + \beta_3 \textit{Above}_{js,t-1} \} + \beta_4 \textit{Plans}_{s,t-1} + \beta_5 \textit{LocalShare}_{js,t-1} \\ & + X'_{jst} \Gamma + \theta_s + \eta_t + \epsilon_{jst} \end{aligned} \quad (17)$$

One way to take into account the time trend for post-1999 counterfactual premium prediction is to introduce a linear trend. However, we know from reality that the time trend is far from linear. In order to better model how the average premium changes over time after 1999, we calculate the post-1999 year fixed effects using the average percentage increase in health insurance premiums observed in large firms that sponsor health insurance programs during years 1999-2011. These average growth rates of large firms are reported in annual Kaiser/HRET surveys of employer-sponsored health benefits.¹⁷

In the post-1999 prediction equation, we use the simulated real gross premiums to produce the counterfactual subsidy cap, in order to determine independent variables such as $\textit{Below}_{js,t-1}$ and the two interaction terms that involve $\textit{Distance}_{js,t-1}$. Based on either the pre-1999 “Big Six” formula or the post-1999 “Fair Share” formula, we first calculate the counterfactual subsidy cap,

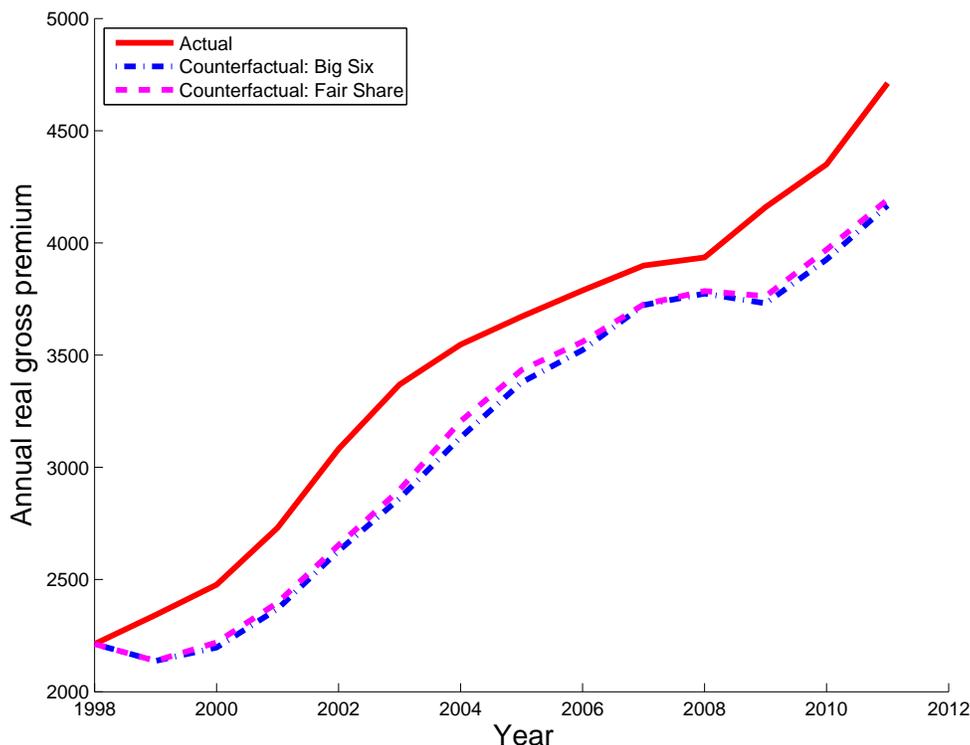
¹⁶Same as before, premiums here are deflated using CPI and expressed in year 2000 dollars.

¹⁷Before 2008, we took the average growth rates for large firms with 5,000 or more workers. After 2008, however, only growth rates for large firms with 200 or more workers are reported.

then determine whether the health plans price below or above the subsidy cap, and finally find out the distance of these simulated premiums to the counterfactual “Big Six” or “Fair Share” subsidy cap. For other plan and state characteristics, however, we use the actual data from years 1999-2011. The regression coefficients are taken directly from equation (17) above in order to maintain the pre-1999 data generating process.

Figure 9 shows the counterfactual trajectories of the average annual real gross premium after 1999 along with the actual real premium observed in the data set. It is clear that the counterfactual average premiums using both formulas stay below the actual premium throughout the post-1999 period, albeit being pretty close during 2007-2008. The mean dollar difference between the actual real premium and the simulated counterfactual real premium is around \$320 under the “Big Six” formula and \$290 under the “Fair Share” formula per person per year, which means that average premium in the FEHBP would have been around 10% less than observed after 1999.

Figure 9: Actual Vs. Counterfactual Average Annual Real Gross Premium

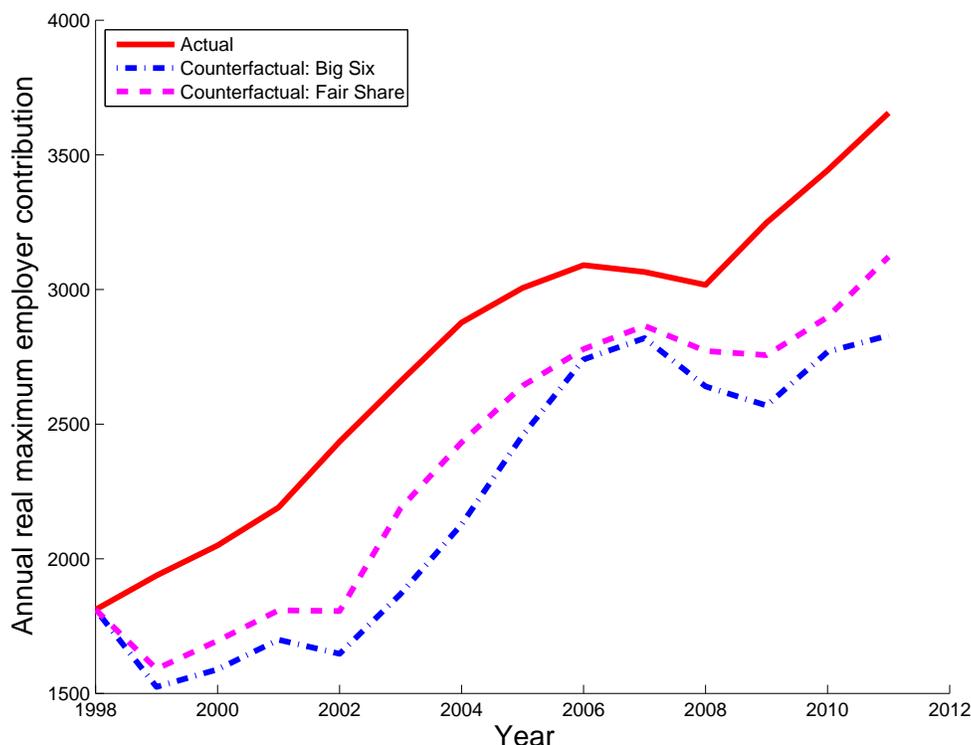


Notes: We consider two counterfactual scenarios based on either the “Big Six” or the “Fair Share” formula in order to determine the counterfactual subsidy cap after 1999.

We also plot the maximum annual employer contribution in real dollars after 1999 under different scenarios in Figure 10. The actual dollar maximum consistently surpasses the counterfactual maximum employer contribution, meaning that health plans would have faced a lower subsidy cap had they maintained the same pricing strategies or behaviors as before 1999, while facing either

the “Big Six” or the “Fair Share” formula after 1999.

Figure 10: Actual Vs. Counterfactual Maximum Employer Contribution



Notes: We consider two counterfactual scenarios based on either the “Big Six” or the “Fair Share” formula in order to determine the counterfactual subsidy cap after 1999.

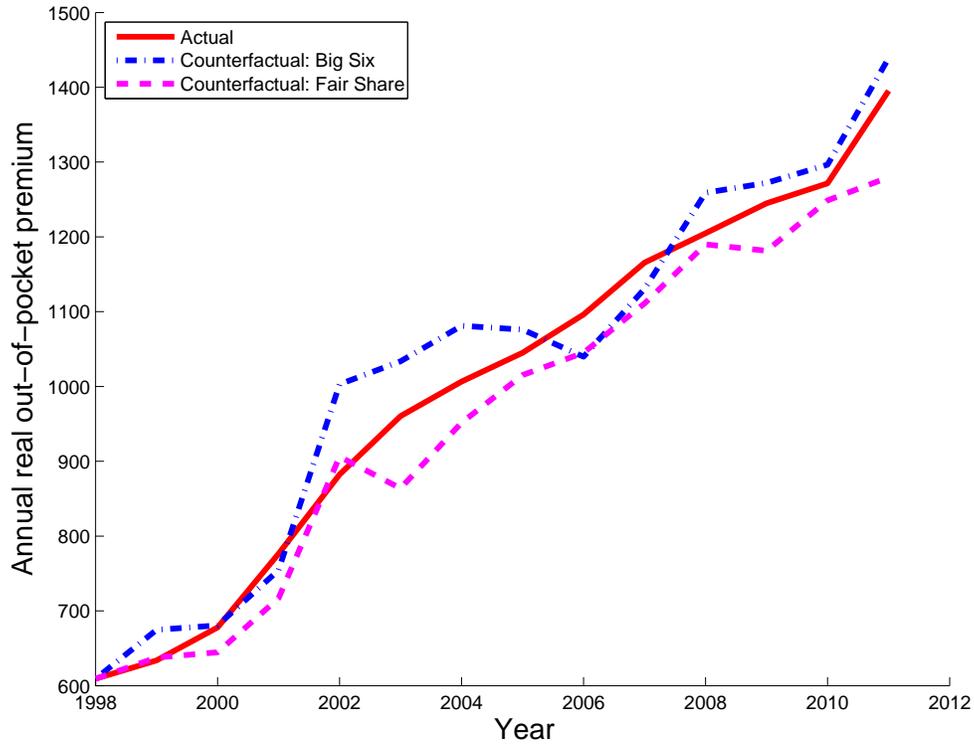
Finally, Figures 11 and 12 plot the actual versus predicted average annual employee and employer contribution for all years after the subsidy policy change. It appears that employees would have contributed the most amount of premium had the pre-1999 “Big Six” subsidy policy stayed in effect, whereas the employer would have incurred the least premium contribution costs among the three scenarios. In comparison, if the “Fair Share” formula took effect in 1999, but the health plans did not adjust their pricing behavior – meaning if they kept their pre-1999 pricing strategies – then we would have seen a similar level of average employee premium contribution to the actual figures, while at the same time the employer would still have contributed less.

The average difference between the actual and counterfactual annual employer contribution in year 2000 dollars is around \$350 under the “Big Six” formula and \$250 under the “Fair Share” formula per person per year. In percentage terms, the \$350 savings in annual subsidies represent a 15% drop in average employer contribution. If we assume that the same counterfactual results apply to family plans, and we consider the fact that the FEHBP covers 9 million enrollees, then the new subsidy policy is costing the federal government \$3.15 billion a year.

Under the “Fair Share” formula, market incentives exist such that large above-cap plans want

to increase their premiums, while at the same time below-cap plans want to catch up with the subsidy cap. Taken together, the new “Fair Share” subsidy policy in the FEHBP seems to have pushed up the average gross premium level as well as employer subsidies, which contradicts the original intent of the Balanced Budget Act of 1997 to curb government spending and balance the nation’s budget.

Figure 11: Actual Vs. Counterfactual Average Annual Employee Contribution

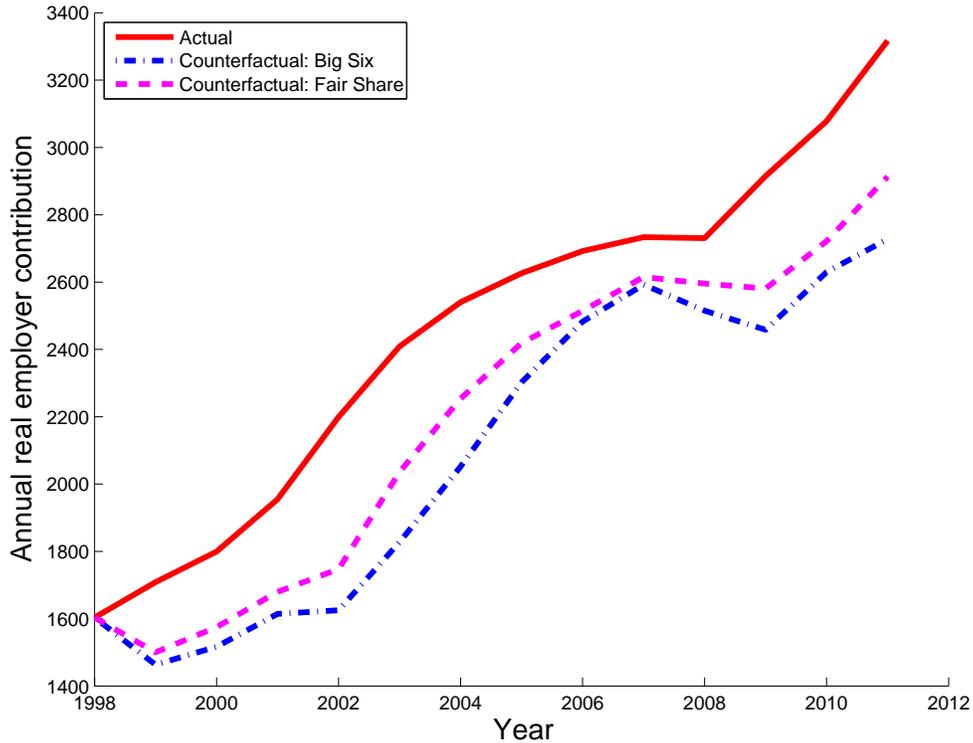


Notes: We consider two counterfactual scenarios based on either the “Big Six” or the “Fair Share” formula in order to determine the counterfactual subsidy cap after 1999.

6 Extensions and Robustness Checks

The results thus far have shown that plans below the subsidy cap increase premiums more than plans above, although the magnitude is much smaller after the “Fair Share” subsidy policy took effect in 1999. The reason for this dampened magnitude was due to the fact that plans in the program have internalized the subsidy cap under the “Fair Share” formula – in that they can now influence the dollar maximum directly – especially if they are large above-cap plans as measured by their program-wide global market share. As a result, large plans above the subsidy cap are increasing their premiums more than before, which counteracts the premium increase among plans below the subsidy cap. In this section, we present several extensions and robustness checks to

Figure 12: Actual Vs. Counterfactual Average Annual Employer Contribution



Notes: We consider two counterfactual scenarios based on either the “Big Six” or the “Fair Share” formula in order to determine the counterfactual subsidy cap after 1999.

complement the main results.

6.1 Premium Growth Rate

In order to get an idea of the premium growth rate under different employer contribution schemes, which would help us better gauge the magnitude of the increase, we use the percentage change in premium level as the dependent variable and rerun all the regression specifications discussed previously. The results are shown in Tables 7 through 9, and are very similar to those described in Section 4.

The average increase in premium growth rate after 1999 is estimated to be 8-11 percentage points higher than before. Among health plans below the subsidy cap, their premiums increase on average 6-8% faster than plans above, although after 1999, the magnitude falls back to 4-6% when compared to plans above.

In terms of the effect of the distance between plan premium and the subsidy cap, the sign and magnitude of the coefficients among the four interaction terms remain the same when we look at premium growth rates instead of level changes.

Finally, the program-wide global market share did not matter before 1999, but afterward, among

Table 7: Premium Growth Rate: Consumer Sensitivity

	Basic	Linear Trend	FE (1)	FE (2)
Post	8.261*** (0.580)	11.07*** (0.728)		
Below	6.374*** (0.499)	6.021*** (0.510)	5.222*** (0.479)	8.056*** (0.716)
Below × Post	-2.703*** (0.645)	-2.507*** (0.645)	-1.551** (0.603)	-1.453* (0.778)
Plans	-0.172*** (0.0322)	-0.147*** (0.0349)	-0.0920** (0.0369)	-0.0471 (0.0478)
LocalShare	1.592** (0.722)	1.584** (0.708)	1.120 (0.713)	6.858*** (1.563)
Plan Controls	<i>Yes</i>	<i>Yes</i>	<i>Yes</i>	<i>Yes</i>
Plan Code FE				<i>Yes</i>
State FE	<i>Yes</i>	<i>Yes</i>	<i>Yes</i>	
Year FE			<i>Yes</i>	<i>Yes</i>
<i>N</i>	5746	5746	5746	5746
adj. <i>R</i> ²	0.134	0.139	0.228	0.230

Notes: The dependent variable is the percentage change in real biweekly plan premium. Separate linear time trends before and after 1999 included in column 2.

Additional plan control variables include plan characteristics as well as benefits and quality changes.

Standard errors clustered at the plan code level in parentheses.

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 8: Premium Growth Rate: Distance from the Subsidy Cap

	Basic	Linear Trend	FE (1)	FE (2)
Post	9.113*** (0.818)	11.24*** (0.946)		
Below	1.738** (0.824)	1.734** (0.817)	1.234 (0.756)	2.065** (0.927)
Below \times Post	-0.331 (0.951)	-0.699 (0.960)	-0.377 (0.892)	0.199 (1.098)
Distance \times Below \times Pre	0.299*** (0.0316)	0.281*** (0.0321)	0.260*** (0.0296)	0.471*** (0.0484)
Distance \times Above \times Pre	-0.0661 (0.0573)	-0.0680 (0.0563)	-0.0721 (0.0545)	-0.199*** (0.0742)
Distance \times Below \times Post	0.0605*** (0.0127)	0.0730*** (0.0134)	0.0922*** (0.0129)	0.239*** (0.0358)
Distance \times Above \times Post	-0.0711*** (0.0207)	-0.0662*** (0.0201)	-0.0626*** (0.0178)	-0.147*** (0.0255)
Plans	-0.138*** (0.0342)	-0.134*** (0.0371)	-0.0805** (0.0397)	-0.0233 (0.0575)
LocalShare	1.474* (0.759)	1.600** (0.743)	1.268* (0.754)	6.614*** (1.705)
Plan Controls	<i>Yes</i>	<i>Yes</i>	<i>Yes</i>	<i>Yes</i>
Plan Code FE				<i>Yes</i>
State FE	<i>Yes</i>	<i>Yes</i>	<i>Yes</i>	
Year FE			<i>Yes</i>	<i>Yes</i>
<i>N</i>	5746	5746	5746	5746
adj. R^2	0.162	0.165	0.252	0.297

Notes: The dependent variable is the percentage change in real biweekly plan premium.

Separate linear time trends before and after 1999 included in column 2.

Additional plan control variables include plan characteristics as well as benefits and quality changes.

Standard errors clustered at the plan code level in parentheses.

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

plans above the subsidy cap, the larger they are, the more they grow, whereas the opposite is true for plans below the cap.

After including plan code and year fixed effects, a one-percentage increase in an above-cap plan's global market share would contribute to a 14 basis point increase in the plan premium, which in turn pushes up the maximum employer contribution.

Table 9: Premium Growth Rate: Global Market Share

	Basic	Linear Trend	FE (1)	FE (2)
Post	8.284*** (0.592)	11.08*** (0.739)		
Below	6.460*** (0.505)	6.111*** (0.517)	5.294*** (0.486)	8.202*** (0.722)
Below × Post	-2.648*** (0.659)	-2.466*** (0.659)	-1.466** (0.613)	-1.400* (0.803)
GlobalShare × Below × Pre	0.268 (3.884)	-0.869 (3.813)	3.446 (3.796)	-5.280 (11.38)
GlobalShare × Above × Pre	27.66 (19.18)	28.78 (18.56)	24.77* (13.77)	39.09* (23.73)
GlobalShare × Below × Post	-27.10*** (9.411)	-23.35** (9.088)	-26.41*** (9.356)	-34.47 (39.58)
GlobalShare × Above × Post	7.278** (3.052)	6.959** (2.930)	9.019*** (2.812)	14.12** (6.964)
Plans	-0.171*** (0.0322)	-0.146*** (0.0350)	-0.0898** (0.0370)	-0.0505 (0.0479)
LocalShare	1.480* (0.766)	1.470* (0.755)	0.930 (0.744)	6.684*** (1.638)
Plan Controls	<i>Yes</i>	<i>Yes</i>	<i>Yes</i>	<i>Yes</i>
Plan Code FE				<i>Yes</i>
State FE	<i>Yes</i>	<i>Yes</i>	<i>Yes</i>	
Year FE			<i>Yes</i>	<i>Yes</i>
<i>N</i>	5746	5746	5746	5746
adj. <i>R</i> ²	0.134	0.139	0.228	0.230

Notes: The dependent variable is the percentage change in real biweekly plan premium.

Separate linear time trends before and after 1999 included in column 2.

Additional plan control variables include plan characteristics as well as benefits and quality changes.

Standard errors clustered at the plan code level in parentheses.

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

6.2 Low- Versus High-Cost Markets

The main empirical results show that the downward pressure on premiums increases as more plans enter the market. As an empirical extension, we show that this competition pressure can vary across local markets depending on whether the market is composed of plans mostly above or below the subsidy cap. The hypothesis is that competition matters less in low-cost markets where most of the plans are below the subsidy cap.

We test this hypothesis using the same FEHB data set described before, and estimate the following regression specification:

$$\begin{aligned}
 \% \Delta P_{jst} = & \beta_0 + \beta_1 Post_t + \beta_2 Below_{js,t-1} + \beta_3 Below_{js,t-1} \times Post_t \\
 & + \beta_4 Plans_{s,t-1} + \beta_5 PercBelow_{s,t-1} \\
 & + \beta_6 Plans_{s,t-1} \times PercBelow_{s,t-1} \\
 & + \beta_7 LocalShare_{js,t-1} + X'_{jst} \Gamma + \epsilon_{jst}
 \end{aligned} \tag{18}$$

Compared to the baseline model in equation (14), the newly added explanatory variables here are those preceded by β_5 and β_6 . The variable $PercBelow_{s,t-1}$ stands for the percentage of plans within a local market (in state s and year $t - 1$) that price below the national subsidy cap determined by either the pre-1999 “Big Six” formula or the post-1999 “Fair Share” formula. In the specification above, we do not include the state fixed effects since the variable $PercBelow_{s,t-1}$ is a state-specific variable that varies little over time in some smaller states.

According to our hypothesis, plans in low-cost markets should face lower consumer price sensitivity, thus dampening the effect of competition on premium growth. As shown in the first column of Table 10, the sign of the coefficient for the interaction term between $Plans_{s,t-1}$ and $PercBelow_{s,t-1}$ is positive, counteracting the negative coefficient in front of the variable $Plans_{s,t-1}$. This result suggests that in low-cost markets where the percentage of plans below the subsidy cap is high, competition matters less in that the composite effect of competition is measured by both β_4 and β_6 .

After we include state fixed effects in column 2, however, the coefficient β_6 is no longer significant. On the other hand, the coefficient β_5 on $PercBelow_{s,t-1}$ is now positive and significant, meaning that plans in low-cost states tend to increase their premiums faster, possibly in an attempt to catch up with the subsidy cap. When we include both state and year fixed effects, these market-based variables can no longer explain the variation in premium growth.

7 Conclusion

Many studies have tried to figure out why health insurance premiums and expenditures have been growing much faster than GDP in the last decade. Few studies, however, have looked at the effect of

Table 10: Premium Growth Rate: Low- Versus High-Cost Markets

	Basic	FE (1)	FE (2)
Post	8.789*** (0.535)	8.644*** (0.584)	
Below	5.601*** (0.519)	5.714*** (0.523)	5.067*** (0.494)
Below \times Post	-2.658*** (0.633)	-2.893*** (0.643)	-1.643*** (0.601)
Plans	-0.123** (0.0559)	-0.266*** (0.0746)	-0.0635 (0.0719)
PercBelow	-0.704 (0.938)	3.211*** (1.096)	1.608 (1.032)
Plans \times PercBelow	0.126* (0.0687)	0.108 (0.0790)	-0.0377 (0.0741)
LocalShare	0.540 (0.713)	1.626** (0.733)	1.128 (0.723)
Plan Controls	<i>Yes</i>	<i>Yes</i>	<i>Yes</i>
State FE		<i>Yes</i>	<i>Yes</i>
Year FE			<i>Yes</i>
<i>N</i>	5746	5746	5746
adj. R^2	0.122	0.135	0.227

Notes: The dependent variable is the percentage change in real biweekly plan premium. Additional plan control variables include whether the plan is “Big Six”, FFS, high option, and whether it offers a companion high or standard option.

Standard errors clustered at the plan code level in parentheses.

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

employer premium contribution schemes on the pricing strategies of health plans. Using a subsidy policy change that occurred in the FEHBP, largest employer-sponsored health insurance program in the U.S., we study whether and how the employer premium contribution scheme affects health plan pricing.

With the help of a simplified analytical framework featuring differentiated products, we show that two market incentives may contribute to higher health insurance premiums: 1) consumers are less price sensitive when they only need to pay part of the premium increase, and 2) each health plan has an incentive to increase the employer’s premium contribution to that plan.

Empirically, we find that the “Fair Share” formula that took place in 1999 under the Balanced Budget Act introduced incentives for large health plans above the subsidy cap to raise their premiums more, after learning that the maximum employer contribution is now determined by an enrollment-weighted average of all plan premiums. At the same time, health plans below the subsidy cap still increase their premiums more than above-cap plans due to lower consumer price sensitivity and strategic complementarity among competitors. Taken together, both market incentives contribute to higher insurance premiums in the FEHBP.

Under the new “Fair Share” formula, health plans internalized the subsidy cap and pushed the upper limit of the employer premium contribution higher than it would have been under the “Big Six” formula. As a result, the federal government ended up bearing most of the increase in premium costs. In the absence of the new subsidy policy, average premium level would have been 10% lower than observed, and the federal government would have incurred 15% less in premium contribution toward the FEHBP.

These findings suggest that employer premium contribution schemes can influence health plan pricing strategies and significantly impact total premium costs. Admittedly, instead of choosing the optimal premium level in each period statically as modeled in this paper, a health plan might base next year’s premium on its previous premium levels as well as its expectation of future market conditions. A richer dynamic model would allow us to analyze the entry and exit decisions of plans over time, in response to changes in employer premium contribution schemes, although such a model is beyond the scope of this paper. Future research topics can thus explore other potential impacts of the employer premium contribution scheme on the supply of health insurance.

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Appendix A Solving Simultaneous Equations

This appendix presents the steps to express the equilibrium prices and market shares in the Lambert W function, following [Aravindakshan and Ratchford \(2011\)](#). One can use the same method to express equilibrium conditions under different subsidy schemes.

Assuming the fraction of employee contribution is θ , Section 2.1 has illustrated the simultaneity equations that plan j 's price and market share need to satisfy in the logit demand model. Substituting the market share equation into the price equation, we get

$$P_1 = C_1 + \frac{1}{\beta_1 \left(1 - \frac{\exp(\alpha_1 - \theta\beta_1 P_1)}{\exp(\alpha_1 - \theta\beta_1 P_1) + \exp(\alpha_2 - \theta\beta_2 P_2)} \right)}. \quad (19)$$

This equation can be rearranged as:

$$\frac{\exp(\alpha_1 - \theta\beta_1 P_1)}{\exp(\alpha_2 - \theta\beta_2 P_2)} \exp\left(\frac{\exp(\alpha_1 - \theta\beta_1 P_1)}{\exp(\alpha_2 - \theta\beta_2 P_2)}\right) = \frac{\exp(\alpha_1 - 1 - \theta\beta_1 C_1)}{\exp(\alpha_2 - \theta\beta_2 P_2)}. \quad (20)$$

Recall that the Lambert W function is defined as the inverse function associated with $W(x)e^{W(x)} = x$. Assume $W_1 = \frac{\exp(\alpha_1 - \theta\beta_1 P_1)}{\exp(\alpha_2 - \theta\beta_2 P_2)}$, and we can rewrite the above equation as

$$W_1(x_1)e^{W_1(x_1)} = x_1,$$

where $x_1 = \frac{\exp(\alpha_1 - 1 - \theta\beta_1 C_1)}{\exp(\alpha_2 - \theta\beta_2 P_2)}$.

Taking log on both sides and substitute in the newly defined $W(x)$, we get the best response function of plan 1 as:

$$P_1 = C_1 + \frac{1 + W_1(x_1)}{\theta\beta_1},$$

In equilibrium, the market share of plan 1 can also be written as a function of $W_1(x)$:

$$S_1 = \frac{W_1(x_1)}{1 + W_1(x_1)}.$$

Similarly, for plan 2 we have:

$$P_2 = C_2 + \frac{1 + W_2(x_2)}{\theta\beta_2},$$

$$S_2 = \frac{W_2(x_2)}{1 + W_2(x_2)},$$

where $W_2 = \frac{\exp(\alpha_2 - \theta\beta_2 P_2)}{\exp(\alpha_1 - \theta\beta_1 P_1)}$, and $x_2 = \frac{\exp(\alpha_2 - 1 - \theta\beta_2 C_2)}{\exp(\alpha_1 - \theta\beta_1 P_1)}$.

Appendix B Solving Remaining Profit Maximization Problems

B.1 Before 1999: Big Six

- **Case 2: $P_1 \geq$ subsidy cap, $P_2 \geq$ subsidy cap**

When plan 2 prices above the subsidy cap, consumers pay a net premium of $\tilde{P}_2 = P_2 - c$, whereas the net premium of plan 1 remains $\tilde{P}_1 = P_1 - c$. Similar to case 1, we can write out the Lagrangian function of plan 1's profit maximization problem with the inequality constraints $P_1 - c/.75 \geq 0$ and $P_2 - c/.75 \geq 0$. Holding $P_2 - c/.75 \geq 0$,

$$\mathcal{L}(P_1, \lambda) = (P_1 - C_1)D_1 + \lambda(P_1 - c/.75).$$

The FOC when there is an interior solution is

$$P_1 = C_1 + \frac{1}{\beta_1(1 - S_1)}, \tag{21}$$

and plan 1's market share is

$$S_1 = \frac{\exp(\alpha_1 - \beta_1(P_1 - c))}{\exp(\alpha_1 - \beta_1(P_1 - c)) + \exp(\alpha_2 - \beta_2(P_2 - c))}.$$

Solving the above two simultaneous equations, we derive the best response function of plan 1 and

its market share as follows in terms of P_2 :

$$P_1^* = C_1 + \frac{1 + W(x)}{\beta_1}, \quad (22)$$

$$S_1^* = \frac{W(x)}{1 + W(x)}, \quad (23)$$

where $P_1^* > c/.75$, $P_2 \geq c/.75$, and $x = \frac{\exp(\alpha_1 - 1 - \beta_1(C_1 - c))}{\exp(\alpha_2 - \beta_2(P_2 - c))}$.

When plan 1's constraint binds, $P_1^* = c/.75$, and depending on the optimal level of P_2 (holding $P_2 \geq c/.75$), we can derive plan 1's equilibrium market share.

• **Case 3: $P_1 \leq$ subsidy cap, $P_2 \geq$ subsidy cap**

When plan 1 prices below the subsidy cap, and plan 2 prices above, we have $\tilde{P}_1 = .25P_1$ and $\tilde{P}_2 = P_2 - c$. Given the constraints $P_1 \leq c/.75$ and $P_2 \geq c/.75$, the Lagrangian function of plan 1's profit maximization problem, given $P_2 \geq c/.75$, can be written as:

$$\mathcal{L}(P_1, \lambda) = (P_1 - C_1)D_1 + \lambda(c/.75 - P_1),$$

and plan 1's best response function and market share in the interior solution are

$$P_1^* = C_1 + \frac{1 + W(x)}{.25\beta_1}, \quad (24)$$

$$S_2^* = \frac{W(x)}{1 + W(x)}, \quad (25)$$

where $P_1^* < c/.75$, $P_2 \geq c/.75$, and $x = \frac{\exp(\alpha_1 - 1 - .25\beta_1 C_1)}{\exp(\alpha_2 - \beta_2(P_2 - c))}$. The corner solution is $P_1^* = c/.75$.

• **Case 4: $P_1 \leq$ subsidy cap, $P_2 \leq$ subsidy cap**

When both plans price below the subsidy cap, we have $\tilde{P}_1 = .25P_1$ and $\tilde{P}_2 = .25P_2$. The Lagrangian function of plan 1 given the constraints $P_1 \leq c/.75$ and $P_2 \leq c/.75$ is

$$\mathcal{L}(P_1, \lambda) = (P_1 - C_1)D_1 + \lambda(c/.75 - P_1),$$

and the interior solution is

$$P_1^* = C_1 + \frac{1 + W(x)}{.25\beta_1}, \quad (26)$$

$$S_2^* = \frac{W(x)}{1 + W(x)}, \quad (27)$$

where $P_1^* < c/.75$, $P_2 \leq c/.75$, and $x = \frac{\exp(\alpha_1 - 1 - .25\beta_1 C_1)}{\exp(\alpha_2 - .25\beta_2 P_2)}$. The corner solution is $P_1^* = c/.75$.

Since the simultaneous pricing game plan 1 and 2 play is symmetric, we omit the derivation process to solve for plan 2's equilibrium prices and market shares, as plan 2's equilibrium solutions are the same as plan 1's as presented above, after substituting the subscript 1 with 2 in each case.

B.2 After 1999: Fair Share

- **Case 2: $P_1 \geq$ subsidy cap, $P_2 \geq$ subsidy cap**

Given both plans price above the subsidy cap, we have two inequality constraints:

$$\begin{aligned} P_1 &\geq .96(w_1P_1 + w_2P_2), \\ P_2 &\geq .96(w_1P_1 + w_2P_2). \end{aligned}$$

The two constraints are not redundant in this case, and they can be rewritten into

$$\frac{.96w_1}{1 - .96w_2} \leq \frac{P_2}{P_1} \leq \frac{1 - .96w_1}{.96w_2}.$$

The Lagrangian function of plan 1 is:

$$\begin{aligned} \mathcal{L}(P_1, \lambda_1, \lambda_2) \\ = (P_1 - C_1)D_1 + \lambda_1(P_1 - .96(w_1P_1 + w_2P_2)) + \lambda_2(P_2 - .96(w_1P_1 + w_2P_2)). \end{aligned}$$

The two corner solutions are $P_1 = .96(w_1P_1 + w_2P_2)$ and $P_2 = .96(w_1P_1 + w_2P_2)$, or in other words, $\frac{P_2}{P_1} = \frac{.96w_1}{1 - .96w_2}$ and $\frac{P_2}{P_1} = \frac{1 - .96w_1}{.96w_2}$. When neither constraint binds, The interior solution can be derived as:

$$\begin{aligned} P_1^* &= C_1 + \frac{1 + W(x)}{(1 - .72w_1)\beta_1 + .72w_1\beta_2}, \\ S_1^* &= \frac{W(x)}{1 + W(x)}, \end{aligned}$$

where $P_1^* > .96(w_1P_1^* + w_2P_2)$, $P_2 > .96(w_1P_1^* + w_2P_2)$, and

$$x = \frac{\exp(\alpha_1 - 1 - [(1 - .72w_1)\beta_1 + .72w_1\beta_2]C_1)}{\exp(\alpha_2 - [(1 - .72w_2)\beta_2 + .72w_2\beta_1]P_2)}.$$

It is easily observed that when both plans price above the subsidy cap, assuming $\beta_1 = \beta_2$, the solution to the profit maximization problem after the policy change is the same as before.

- **Case 3: $P_1 \leq$ subsidy cap, $P_2 \geq$ subsidy cap**

Case 3 is symmetric to case 1 discussed in Section 3.2.2 in the sense that plan 1 and plan 2 switch roles here as compared to case 1. The two inequality constraints are now:

$$\begin{aligned} P_1 &\leq .96(w_1P_1 + w_2P_2), \\ P_2 &\geq .96(w_1P_1 + w_2P_2). \end{aligned}$$

Similar to case 1, the first constraint implies the second constraint. The net premiums consumers pay for both plans are $\tilde{P}_1 = .25P_1$ and $\tilde{P}_2 = P_2 - .72(w_1P_1 + w_2P_2)$, respectively. The Lagrangian function of plan 1's profit maximization problem is

$$\mathcal{L}(P_1, \lambda) = (P_1 - C_1)D_1 + \lambda(.96(w_1P_1 + w_2P_2) - P_1).$$

The corner solution is $P_1 = .96(w_1P_1 + w_2P_2)$, or $\frac{P_2}{P_1} = \frac{1 - .96w_1}{.96w_2}$. As for interior solutions, when $P_1 < .96(w_1P_1 + w_2P_2)$, the FOC of plan 1 is

$$P_1 = C_1 + \frac{1}{(.25\beta_1 + .72w_1\beta_2)(1 - S_1)},$$

where

$$S_1 = \frac{\exp(\alpha_1 - .25\beta_1P_1)}{\exp(\alpha_1 - .25\beta_1P_1) + \exp(\alpha_2 - \beta_2(P_2 - .72(w_1P_1 + w_2P_2)))}.$$

Solving the above simultaneous equations, we get the closed form expressions of plan 1's best response function and market share, in terms of P_2 :

$$P_1^* = C_1 + \frac{1 + W(x)}{.25\beta_1 + .72w_1\beta_2},$$

$$S_1^* = \frac{W(x)}{1 + W(x)},$$

where $P_1^* < .96(w_1P_1^* + w_2P_2)$, and $x = \frac{\exp(\alpha_1 - 1 - (.25\beta_1 + .72w_1\beta_2)C_1)}{\exp(\alpha_2 - \beta_2(1 - .72w_2)P_2)}$.

- **Case 4: $P_1 \leq$ subsidy cap, $P_2 \leq$ subsidy cap**

It is not possible for both plans to price below the subsidy cap since the following two inequality conditions cannot both hold at the same time:

$$P_1 \leq .96(w_1P_1 + w_2P_2),$$

$$P_2 \leq .96(w_1P_1 + w_2P_2).$$

Similar to the pricing game before 1999, the two plans play a symmetric game here, which means that plan 2's equilibrium solutions are the same as plan 1's after substituting the subscript 1 with 2 in each case.