Abstract

Title of dissertation:	The Impact of Employer Premium Contribution Schemes on the Supply and Demand of Health Insurance
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This dissertation consists of three essays on health insurance markets, analyzing the impact of employer premium contribution schemes on both the supply and demand sides of the market. The first two essays focus on the supply side, whereas the third essay looks at the demand side.

In the first essay, I present an analytical framework to illustrate the effect of employer premium contribution schemes on health plan pricing. I model the employer-sponsored health insurance market as a differentiated-product oligopoly and study the pricing strategies of insurance plans before and after a policy change in employer premium contribution. I 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.

In the second essay, I confirm the theoretical predictions using 1991-2011 data before and after a premium contribution policy change that occurred in 1999 in the

Federal Employees Health Benefits (FEHB) Program. Empirical results suggest that both market incentives mentioned above contribute to premium growth. Furthermore, I perform counterfactual analysis to show that average premium would have been 10% less than observed had the subsidy policy change not occurred in the FEHB program, and the federal government would have incurred 15% less in premium contribution.

The third essay looks at how capped employer premium subsidies affect the level of adverse selection among consumers. Previous research suggests that the employer premium contribution scheme can exacerbate or mitigate the level of adverse selection among consumers. Using longitudinal health plan enrollment records of federal civilian employees from years 1997-2000, I present empirical results supporting previous theoretical as well as cross-sectional empirical evidence on the dampening effect of a higher employer premium subsidy cap on adverse selection. The overall level of adverse selection, approximated by the different premium levels enrollees select based on their age, does not change significantly over time in the FEHB program.

The Impact of Employer Premium Contribution Schemes on the Supply and Demand of Health Insurance

by

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Dissertation submitted to the Faculty of the Graduate School of the
University of Maryland, College Park, in partial fulfillment
of the requirements for the degree of
Doctor of Philosophy
2013

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To my parents,
For encouraging me to always keep learning.

Acknowledgments

I would like to thank my advisor, Professor Ginger Zhe Jin, for spending countless hours with me and guiding me through my PhD studies. I would also like to thank Professor Roger Betancourt and Professor Emel Filiz-Ozbay for giving me invaluable input on my dissertation. I am very grateful to Professor Melissa Kearney and Professor Kenneth Leonard for participating in my dissertation defense. I give special thanks to my friend, Cody Dunne, who gave me a lot of moral support and technical assistance to help me work through the most difficult times of my PhD studies. Last but not least, I want to thank my PhD classmates and colleagues at the Department of Economics as well as seminar participants at the University of Maryland for helpful comments and suggestions. All remaining errors are my own.

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Chapter 1

Introduction and Background

1.1 Introduction

In the U.S. most public and private employers offer employees health insurance as a fringe benefit for risk pooling and tax reasons. Employer-sponsored health insurance covered on average 60% of all Americans in recent years, with a higher coverage rate among working Americans (U.S. Census Bureau, 2011). The growth rate of health plan premiums, however, has significantly outpaced that of gross domestic product (GDP) in the past decade. A number of studies have investigated why health insurance premiums have been growing at an alarming rate. For instance, new medical technology and aging populations are known to play an important role in raising health care expenditures (e.g., Schwartz, 1987; Newhouse, 1992, 1993; Chandra and Skinner, 2012), which in turn increases health insurance premiums.

Under employer-sponsored health insurance, employers usually contribute a substantial portion of the premium, leaving workers responsible for only a small percentage. In light of this market design, I study whether the employer premium contribution scheme could be another channel that contributes to the rise in health insurance premiums, and whether it has a differential impact on the pricing behavior of health plans depending on their characteristics.

The premium contribution schemes vary across employers, depending on the size and demographic composition of employees. 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.[1] In order to study how the pricing behavior of health plans reacts to changes in the premium contribution scheme, I use 1991-2011 health plan data from the largest employer-sponsored health insurance program in the U.S. – the Federal Employees Health Benefits (FEHB) Program – which offers over 200 health plans per year to federal employees across 50 states.

In the FEHB program, the federal government contributes 75% of any plan premium up to a dollar maximum. Before 1999, the dollar maximum was 60% of the simple average premium of the biggest six plans, which was referred 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

[1] Virtually 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.

average premium of *all* health plans in the program.

Using this policy change as a natural experiment, I 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 contribute to premium growth.

I present an analytical framework to motivate the empirical findings and provide intuition on the two market incentives discussed above. The health insurance market is modeled as a differentiated-product oligopoly, where consumers choose one health plan that maximizes their expected utility. Facing logit demand, plans choose a gross premium to maximize their profits. By solving the best response functions of health plans simultaneously, I obtain the equilibrium prices and market shares under a capped employer contribution scheme. I then test the theoretical predictions with empirical data from the FEHB program.

There are three main empirical findings: 1) due to difference in consumer price sensitivity below and above the subsidy cap, plans below the subsidy cap 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 program-wide market share, larger plans above the subsidy cap have incentives to raise their premiums more in order 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 FEHB program. Due to higher employer premium contribution 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 premium costs after 1999, and would have saved 15% per year on its premium contribution toward the FEHB program.

Other than its supply-side effect, a premium contribution scheme could potentially affect how consumers choose health plans as well. I supplement the health plan information with micro-level consumer choice data in the FEHB program as well as demographic characteristics of enrollees from years 1997-2000, and look at whether the adverse selection pattern changed among plan enrollees after the change in subsidy policy.

I confirm previous findings that a higher subsidy cap can reduce adverse selection among enrollees. However, since the new subsidy policy effective in 1999 only changes the way the maximum employer contribution is determined, it is not surprising that this policy change itself does not have much impact on adverse selection patterns among enrollee. This demand-side analysis further strengthens the supply-side findings by exploring whether higher prices set by health plans after the policy change are due to increased adverse selection.

The rest of the paper is organized as follows. The remainder of Chapter 1 discusses the industry background and policy change this study focuses on. I present an analytical framework of the health insurance market and derive the theoretical implications of the policy change in Chapter 2, followed by empirical evidence on the effect of employer premium contribution schemes on the pricing behavior of health plans in Chapter 3. Chapter 4 looks at the effect of premium subsidies on adverse selection as well as changes in the degree of adverse selection. Chapter 5 concludes.

1.2 Background

1.2.1 Employer Premium Contribution

Health care spending in the U.S. has climbed from 6% of the GDP in the 1960s to the latest 18% in both 2009 and 2010, and at the same time, health insurance costs have soared from 30% of the health care expenditures in 1960 to 76% in 2010 (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 signing of the Patient Protection and Affordable Care

Act (ACA) in March 2010, which mandates universal individual health insurance coverage.

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. According to an annual national survey of non-federal private and public employers conducted by Kaiser Family Foundation and Health Research & Educational Trust (2011), henceforth known as Kaiser/HRET, employers contribute on average 82% of the premium for single coverage plans and 72% for family coverage plans in 2011, similar to the percentages they contributed in 2010.[2] In the largest employer-sponsored health insurance program in the U.S., the FEHB program, the federal government subsidizes 75% of any plan premium up to a dollar maximum, leaving the rest of the premium to its employees.[3]

Since employer-sponsored health insurance has such a wide coverage in the U.S., and premium sharing between the employer and the employee is common, it is important to know whether the employer premium contribution scheme itself can affect both the demand and supply side of health insurance.

In analyzing the role that contribution schemes play in health insurance markets, much of the previous literature has focused on the demand side. In 1995,

[2]The average percentage of employer contribution includes those who contribute 100% of the premium.

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

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 FEHB program, 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 FEHB program, 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 employers 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 1.1). After deflating the premiums in the FEHB program and comparing its growth rate with GDP growth, Figure 1.2 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]

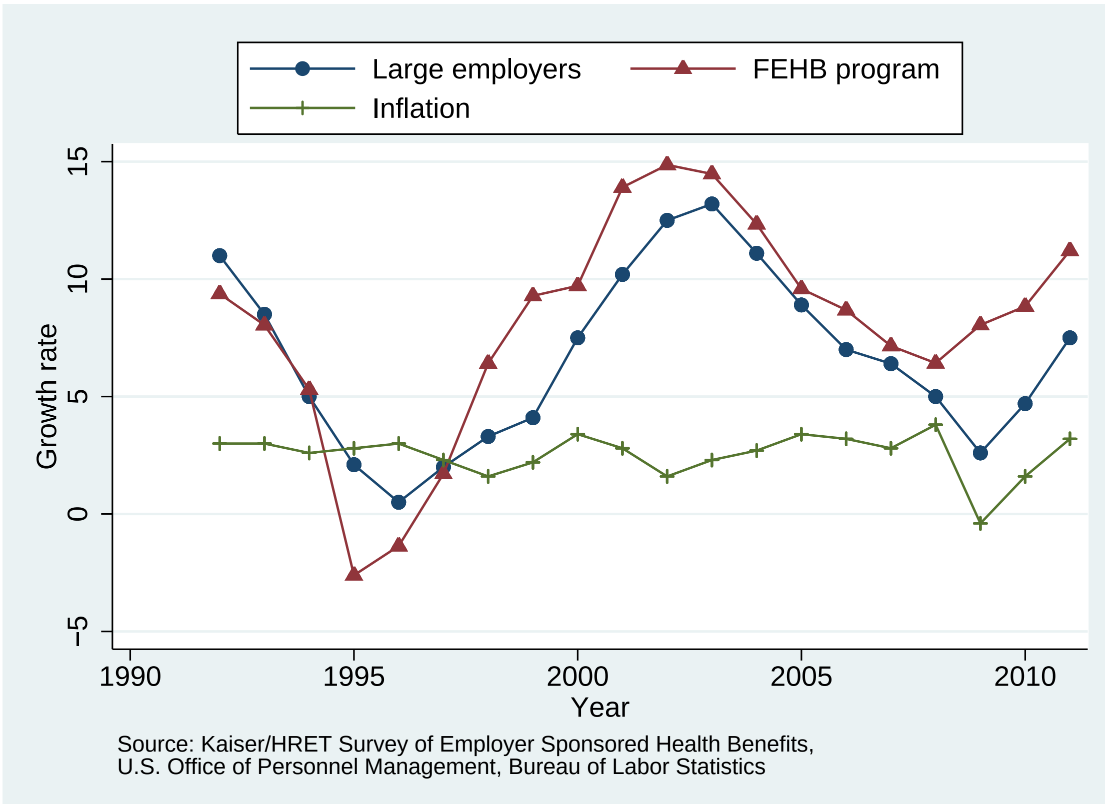
There are undoubtedly many forces behind this persistent growth in health insurance premiums. For example, advances in medical technology are known to contribute to health care spending growth, which in turn leads to premium growth.[5] A number of studies attribute premium growth to market concentration (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

[4]Real premiums for family plans show a similar trend.

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

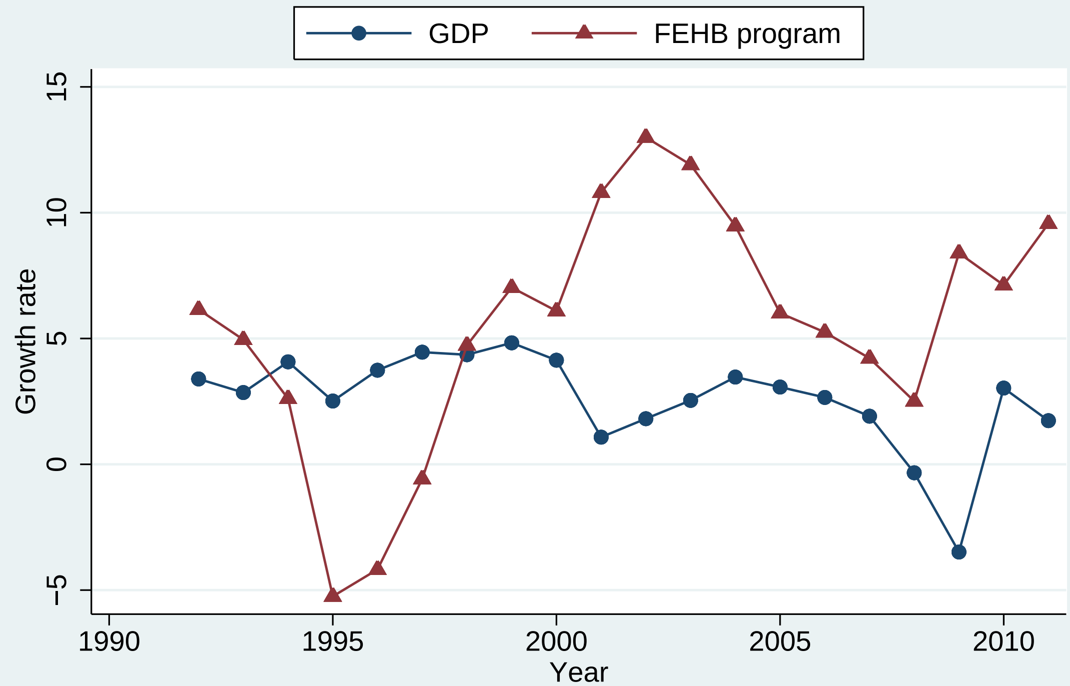
Figure 1.1: Growth Rate of Nominal Health Insurance Premiums



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 I 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 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 FEHB program

Figure 1.2: Growth Rate of Real FEHB Premiums vs. GDP



Premium data includes self plans only in the FEHB program.
Source: U.S. Office of Personnel Management, U.S. Bureau of Economic Analysis

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.

1.2.2 Subsidy Policy Change

Effective January 1, 1999, the FEHB program 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 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 FEHB program has been widely touted as a model for Medicare reform as well as the most recent state health insurance exchanges mandated by 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 FEHB program.

One paper that discusses premium growth in relation to employer premium contribution schemes is by Thorpe et al. (1999), who showed that in the FEHB

[6] According 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.

program, among plans whose employer contribution was below the subsidy cap, premiums rose at least 5 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, I contribute to the previous literature in three ways. First, under an analytical framework, I show that there are two market incentives at play that contribute to growth in employer-sponsored health insurance premiums. Second, I present empirical evidence that supports these two market incentives and analyze their impact on health plan pricing and premium growth. Third, I take a closer look at the demand for employer-sponsored health insurance, and focus on the adverse selection pattern under different employer premium contribution schemes.

Chapter 2

Market Incentives and Pricing Behavior in Health Insurance: Analytical Framework

I model the employer-sponsored health insurance market as a differentiated-product oligopoly. In reality, health plans also compete on their benefits, coverage, physician network, customer service, etc., but I will focus on the pricing strategy of health insurance plans in this theoretical model.

On the demand side, consumers choose one health plan each year after comparing all plans in their choice set. In order to motivate and provide intuition on some of the empirical results discussed later, I adopt a simplified choice model where the consumer's utility function generates a logit demand system. Facing this demand, a health insurance plan chooses a price, or a gross premium, to maximize its profit.

In employer-sponsored health insurance, an added complexity is that the price consumers face is the plan's net premium after deducting the employer contribution. When insurance plans decide on their gross premiums, their pricing strategies can vary under different employer contribution schemes.

2.1 Demand

In this simplified model, we have a consumer whose utility function is defined over consumption of a health plan, which has multiple plan characteristics, of which the most important one is price.

Consumer i's utility when choosing plan j can be expressed as

$$U_{ij} = \alpha_j - \beta_j \tilde{P}_j + \varepsilon_{ij}, \tag{2.1}$$

where α_j captures all characteristics of plan j other than its price, β_j is the price response parameter for plan j, $\tilde{P}_j$ is the net premium the consumer pays, and ε_{ij} is an i.i.d. error term that is assumed to follow a type 1 extreme value distribution.

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.[1]

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

$$S_j = \frac{\exp(\alpha_j - \beta_j \tilde{P}_j)}{\sum_J \exp(\alpha_J - \beta_J \tilde{P}_J)},$$

[1] In 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 FEHB program remains roughly the same over time.

where J indexes each plan in the consumer's choice set.

Since in the FEHB program, the employer contributes 75% of any plan premium up to a dollar maximum, employees pay at least 25% of the gross premium. As a result, the net premium a consumer pays can be expressed as

$$\tilde{P}_j = \max(.25P_j, P_j - \text{dollar maximum}).$$

To help illustrate, I define the maximum gross premium a plan can charge, while still being subsidized at the 75% margin by the employer, to be the "subsidy cap" (dollar maximum/.75) used in the rest of the paper. For plans who set their gross premiums below the subsidy cap, consumers pay $\tilde{P}_j = .25P_j$, whereas for plans with gross premium above the subsidy cap, consumers pay $\tilde{P}_j = P_j - \text{dollar maximum}$. Therefore, the newly defined subsidy cap acts as a cutoff point for health plan gross premiums in terms of maximum subsidy benefits.

2.2 Supply

To keep the model simple, I consider a differentiated-product duopoly with two health plans, plan 1 and plan 2, although one can easily extend the model to accommodate more plans. Each plan has a constant marginal cost. Plan j chooses a gross premium P_j to maximize its profit

$$\pi_j = P_j D_j(\tilde{P}) - C_j D_j(\tilde{P}), \tag{2.2}$$

where D_j is the demand for plan j, which depends on the net premium $\tilde{P}$ of all plans, and C_j is its marginal cost.

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 following first order condition (FOC) of the profit maximization problem

$$P_j = C_j - \frac{S_j}{\frac{\partial S_j}{\partial P_j}}, \tag{2.3}$$

where $S_j = \dfrac{\exp(\alpha_j - \beta_j \tilde{P}_j)}{\sum_J \exp(\alpha_J - \beta_J \tilde{P}_J)}$ is the market share of plan j.

Before I present the analytical solutions to optimal health plan prices in the existence of an employer premium subsidy, I consider the case where there is no employer subsidy, i.e., $\tilde{P}_j = P_j$ for all j. Plan j's market share can be written as

$$S_j = \frac{\exp(\alpha_j - \beta_j P_j)}{\sum_J \exp(\alpha_J - \beta_J P_J)},$$

and I can derive the following expression after some algebra

$$\frac{S_j}{\frac{\partial S_j}{\partial P_j}} = -\frac{1}{\beta_j(1 - S_j)}.$$

Plugging the above expression in equation (2.3), we have

$$P_j = C_j + \frac{1}{\beta_j(1 - S_j)}. \tag{2.4}$$

When the employer subsidizes health plan premiums, the FOC of a plan's optimal price can be derived in a similar fashion (see Appendix A).

2.3 Equilibrium Solutions

To facilitate understanding, I present the equilibrium solutions without an employer subsidy first, followed by solutions under a capped employer contribution scheme before and after the policy change.

2.3.1 No Subsidy

Without an employer subsidy, the two plans in the market – plan 1 and plan 2 – have symmetric FOCs and market shares. For plan 1's profit maximization problem, the FOC is

$$P_1 = C_1 + \frac{1}{\beta_1(1 - S_1)}, \tag{2.5}$$

and market share is

$$S_1 = \frac{\exp(\alpha_1 - \beta_1 P_1)}{\exp(\alpha_1 - \beta_1 P_1) + \exp(\alpha_2 - \beta_2 P_2)}. \tag{2.6}$$

In order to solve the above two simultaneous equations, I follow the method used by Aravindakshan and Ratchford (2011) and employ the concept of Lambert W function, which can be numerically approximated.[2]

With the help of Lambert W function, we can now solve for the best response function of plan 1 and its market share in terms of P_2 and other exogenous variables:

$$P_1^* = C_1 + \frac{1 + W(x)}{\beta_1}, \tag{2.7}$$

$$S_1^* = \frac{W(x)}{1 + W(x)}, \tag{2.8}$$

where $x = \dfrac{\exp(\alpha_1 - 1 - \beta_1 C_1)}{\exp(\alpha_2 - \beta_2 P_2)}$. Appendix B provides the proof.

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

By symmetry, the best response function of plan 2 and its market share are:

$$P_2^* = C_2 + \frac{1 + W(x)}{\beta_2}, \tag{2.9}$$

$$S_2^* = \frac{W(x)}{1 + W(x)}, \tag{2.10}$$

where $x = \dfrac{\exp(\alpha_2 - 1 - \beta_2 C_2)}{\exp(\alpha_1 - \beta_1 P_1)}$.

The intersection of the two best response functions above, equations (2.7) and (2.9), yields the equilibrium prices of the two plans.

2.3.2 With Subsidy: Big Six

Before 1999, when the subsidy policy changed, the maximum employer contribution was 60% of the simple average premium of the "Big Six" plans. Since these "Big Six" plans on average only make up 2.5% of the total available health plans in the FEHB program during years 1991-2011 (ranging from 1.4% to 4.3% depending on the year), I will treat these plans' gross premium (hence the subsidy cap) as exogenous in the model before 1999. For ease of exposition, I model the remaining health plans in the FEHB program as a differentiated-product duopoly.[3]

Since before 1999, the dollar maximum the employer contributes to any health plan is determined exogenously (to the rest of the plans) by the premium of the

[3] In a separate model, I group all the "Big Six" plans as one plan in the market and treat all other plans in the market as the second plan, the theoretical implications do not change very much.

"Big Six" plans, I denote it with a constant c. The subsidy cap is defined as dollar maximum/.75, which then equals $c/.75$. In each period, plan 1 submits a premium bid of P_1. When plan 1 prices above the subsidy cap before the policy change, consumers pay a net premium of $P_1 - c$; when plan 1 prices below the subsidy cap, however, consumers pay $.25P_1$.

Similarly, plan 2 can also price below or above the subsidy cap, which gives us four cases to consider. I present the solutions to plan 1's profit maximization problem in the first case below, which is when plan 1 prices above and plan 2 prices below the subsidy cap. Appendix C.1 presents plan 1's equilibrium solutions in the remaining three cases. Since the pricing game the two plans play here is symmetric, I only present plan 1's solutions.

- **Case 1: $\boldsymbol{P_1 \geq}$ subsidy cap, $\boldsymbol{P_2 \leq}$ subsidy cap**

In this case, consumers pay a net premium of $\tilde{P}_1 = P_1 - c$ for plan 1 and $\tilde{P}_2 = .25P_2$ for plan 2. Instead of the unconstrained optimization seen in Section 2.3.1 when there is no subsidy, we now 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

$$P_1 = C_1 + \frac{1}{\beta_1(1 - S_1)}, \tag{2.11}$$

which looks almost the same as the no-subsidy case, except that its market share is now

$$S_1 = \frac{\exp(\alpha_1 - \beta_1(P_1 - c))}{\exp(\alpha_1 - \beta_1(P_1 - c)) + \exp(\alpha_2 - .25\beta_2 P_2)}. \tag{2.12}$$

Following the same procedure to solve the simultaneous equations as the no-subsidy case, I derive the best response function of plan 1 and its market share in terms of P_2 as follows:

$$P_1^* = C_1 + \frac{1 + W(x)}{\beta_1}, \tag{2.13}$$

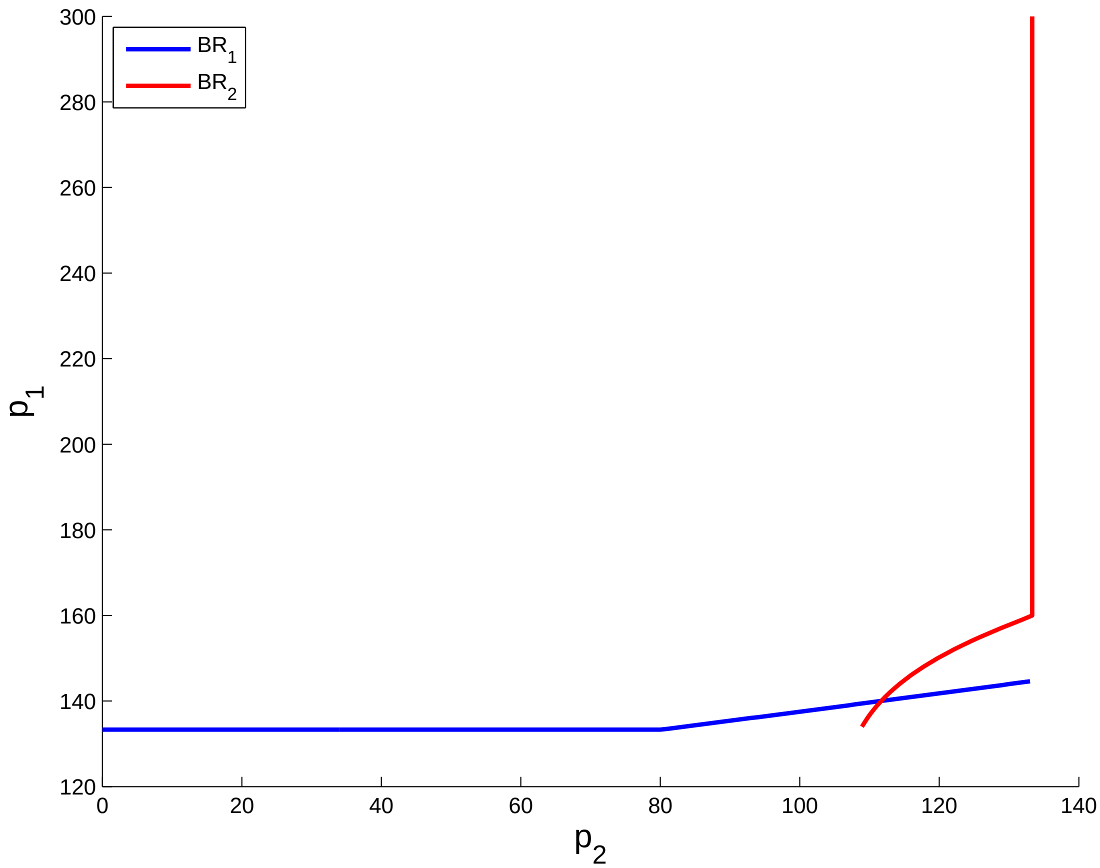
$$S_1^* = \frac{W(x)}{1 + W(x)}, \tag{2.14}$$

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

Since the Lambert W function can be numerically approximated, I plot the best response functions of plan 1 and plan 2 in Figure 2.1 when the dollar maximum

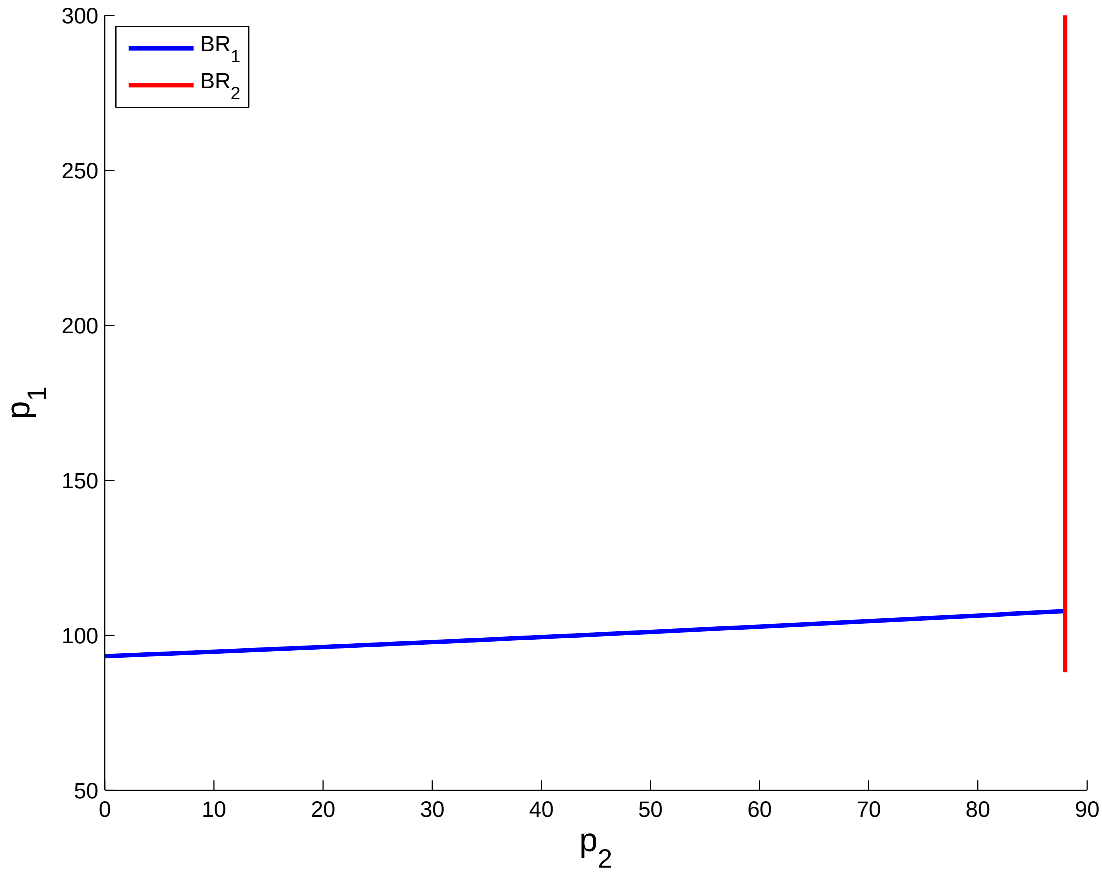
$c = 100$, after initiating some parameter values.[4] There is a kink in each plan's best response function because of the constraint that plan 1 prices above the subsidy cap, which is equal to $c/.75 = 100/.75 = 133.3$, and plan 2 prices below the subsidy cap. When I set the dollar maximum c to be smaller, such as the actual 1998 dollar maximum level ($c = 66$) observed in the FEHB program, plan 2 would price at the subsidy cap ($c/.75 = 88$) at all times (see Figure 2.2).

Figure 2.1: Equilibrium Prices of the Two Plans Before 1999
(subsidy cap $= 100/.75$, $P_1 \geq$ subsidy cap, $P_2 \leq$ subsidy cap)



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

Figure 2.2: Equilibrium Prices of the Two Plans Before 1999
(subsidy cap = 66/.75, $P_1 \geq$ subsidy cap, $P_2 \leq$ subsidy cap)



2.3.3 With Subsidy: 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 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. I briefly present the interior as well as corner solutions to the profit maximization problem of plan 1 in the first case below, leaving the remaining cases to Appendix C.2.

The solutions to the profit maximization problem of plan 2, on the other hand, can be derived by substituting the subscript 2 for 1 in all cases, since the two plans play a symmetric simultaneous-move game. Therefore, I do not present plan 2's equilibrium solutions here.

- **Case 1: $P_1 \geq$ subsidy cap, $P_2 \leq$ subsidy cap**

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 $\tilde{P}_1 = P_1 - .72(w_1 P_1 + w_2 P_2)$ and $\tilde{P}_2 = .25P_2$, respectively. The Lagrangian function of plan 1's profit maximization problem can be written as:

$$\mathcal{L}(P_1, \lambda) = (P_1 - C_1)D_1 + \lambda(.96(w_1 P_1 + w_2 P_2) - P_2).$$

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

$$P_1 = C_1 + \frac{1}{\beta_1(1 - .72w_1)(1 - S_1)}, \tag{2.15}$$

where

$$S_1 = \frac{\exp(\alpha_1 - \beta_1(P_1 - .72(w_1 P_1 + w_2 P_2)))}{\exp(\alpha_1 - \beta_1(P_1 - .72(w_1 P_1 + w_2 P_2))) + \exp(\alpha_2 - .25\beta_2 P_2)}. \tag{2.16}$$

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:

$$P_1^* = C_1 + \frac{1 + W(x)}{\beta_1(1 - .72w_1)}, \tag{2.17}$$

$$S_1^* = \frac{W(x)}{1 + W(x)}, \tag{2.18}$$

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

When the constraint binds, the corner solution in this case is then $P_2 = .96(w_1 P_1 + w_2 P_2)$, or $\dfrac{P_2}{P_1} = \dfrac{.96w_1}{1 - .96w_2}$. Plugging the above expression into plan 1's market share expression in (2.16), we derive the following corner solution:

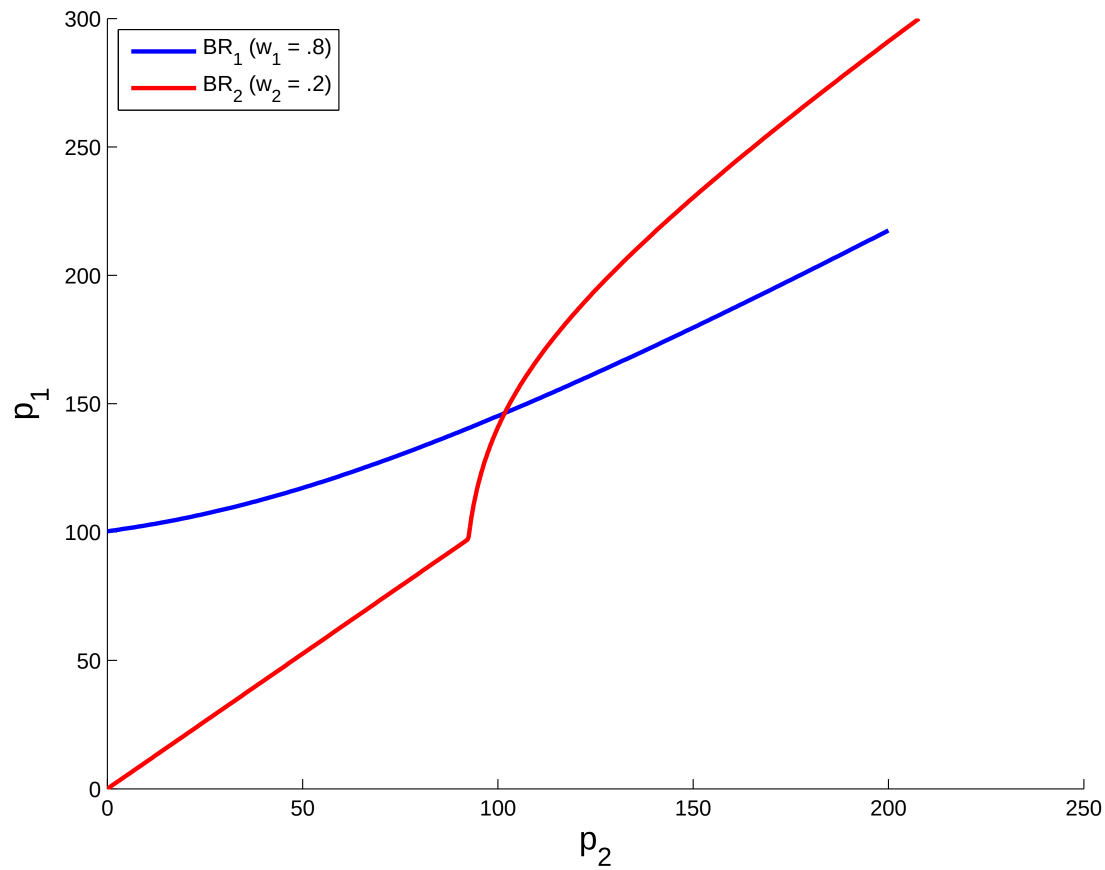
$$P_1^* = \frac{1 - .96w_2}{.96w_1} P_2, \tag{2.19}$$

$$S_1^* = \frac{\exp(\alpha_1 - \beta_1((1 - .72w_1)\frac{1-.96w_2}{.96w_1} P_2 - .72w_2 P_2)))}{\exp(\alpha_1 - \beta_1((1 - .72w_1)\frac{1-.96w_2}{.96w_1} P_2 - .72w_2 P_2))) + \exp(\alpha_2 - .25\beta_2 P_2)}. \tag{2.20}$$

When drawing the best response functions, in addition to using the same parameter values as in Section 2.3.2 before the subsidy policy change, I assume $w_1 = .8$ and $w_2 = .2$, since the lagged global market shares now enter the equilibrium conditions. Figure 2.3 shows the best response functions of plan 1 and plan 2 as well as their equilibrium price levels when plan 1 prices above the subsidy cap and plan 2 prices below.

Next I reassign $w_1 = w_2 = .5$, and keep all the other parameter values the same. The new equilibrium price levels of the two plans are illustrated in Figure 2.4, with both best response functions shrinking a little bit compared to Figure 2.3. 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 than the previous case, when plan 1 has a larger market share ($w_1 = .8$) and plan 2 has a smaller market share ($w_2 = .2$).

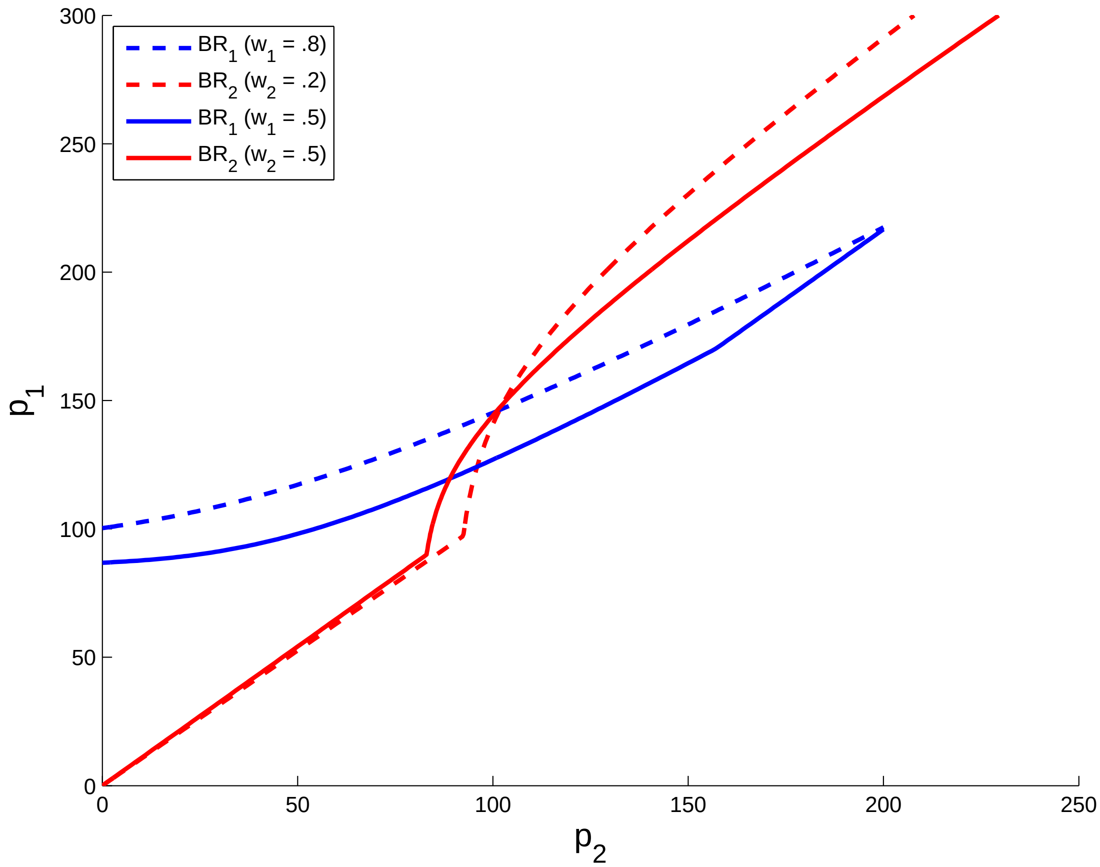
Figure 2.3: Equilibrium Prices of the Two Plans After 1999
(subsidy cap = $.96(w_1P_1 + w_2P_2)$, $P_1 \geq$ subsidy cap, $P_2 \leq$ subsidy cap)



2.4 Comparative Statics

From the best response functions of health plans, we can derive comparative statics describing how optimal prices, or premiums, change with respect to the following three market conditions: 1) consumer price sensitivity, 2) local competition, and

Figure 2.4: 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)



3) global market share of the health plan.

2.4.1 No Subsidy

- **Price Sensitivity**

As mentioned in section 2.3, the solutions to the profit maximization problem of plan 1 and plan 2 are symmetric. Due to this reason, I consider plan 1's first order condition only. We know from equation (2.7) that

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

where $x = \dfrac{\exp(\alpha_1 - 1 - \beta_1 C_1)}{\exp(\alpha_2 - \beta_2 P_2)}$.

To obtain comparative statics in terms of consumer price sensitivity, I take the first partial derivative of the equilibrium price of plan 1 (P_1^*) with respect to its plan-specific price response parameter (β_1):

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

The partial derivative is negative since $W(x)$ is greater than zero when x is positive, and all the other parameters in the above equation are positive as well. This result is expected since the more price-sensitive consumers are, the less likely plans are to raise prices. By symmetry, we reach a negative sign for plan 2's comparative static in consumer price sensitivity.

- **Local Competition**

The impact of local competition on insurance premiums comes from prices charged by other plans, which in turn affects a plan's market share. If there are multiple plans in the market, an increase in the price of one plan can lead to an increase in the price of others, and if that is the case, we call these plans strategic complements.

To find out whether the plans are strategic complements or substitutes, I take the first partial derivative of the equilibrium price of plan 1 (P_1^*) from equation (2.7) with respect to the price of plan 2 (P_2):

$$\frac{\partial P_1^*}{\partial P_2} = \frac{\beta_2}{\beta_1} \frac{W(x)}{1 + W(x)} > 0.$$

Since the sign is positive, we conclude that the health plans are strategic complements in this market.

When there are multiple plans in the market, under Bertrand competition, firms compete on prices. It is thus reasonable to think that the larger the total number of plans in the market, the more downward pressure there is on plan premiums. Since plans are strategic complements, when one plan lowers its premium, all other plans would lower their premiums as well. Therefore, we would expect the total number of plans in a market to be negatively correlated with premium levels and growth rates.[5]

- **Market Share**

Equation (2.5) shows the FOC of plan 1 when there is no subsidy. The equilibrium price and market share are determined simultaneously in this static model.

[5]One can derive similar results assuming Cournot competition in the health insurance market.

In order to analyze how market share affects equilibrium prices, we need a measure for the plan's previously existing market share, which does not enter the equilibrium equations when there is no subsidy. Later, however, when the subsidy policy is dependent on the previous market share of plans, we will be able to derive the comparative statics for lagged market share.

2.4.2 With Subsidy

- **Price Sensitivity**

When the employer offers a capped premium subsidy to its health plan enrollees, consumers exhibit different price sensitivity levels for plans above and below the subsidy cap. Intuitively, consumers pay only 25 cents for each $1 increase in gross premium for plans below the subsidy cap, due to the fact that their insurance premiums are subsidized at the 75% margin. For plans above the subsidy cap, however, a $1 increase in gross premium is fully borne by the consumer.

Mathematically, we can compare plan 1's best response function when it prices below or above the subsidy cap, holding plan 2's price constant. For example, we can look at case 1 and case 4 before 1999, when there exists a capped employer premium subsidy and plan 2 prices below the subsidy cap. Judging from equation (2.13) and equation (C.6) in Appendix C.1, we find that plan 1's price sensitivity parameter becomes $.25\beta$ when plan 1 prices below the subsidy cap in case 4, compared to above the cap in case 1, while holding plan 2 pricing below the cap. The new comparative static in terms of price sensitivity, $\frac{\partial P_1^*}{\partial \beta_1}$, remains negative when there is an employer subsidy. Therefore, the existence of a proportional employer subsidy gives insurance plans an incentive to charge higher gross premiums when pricing below the subsidy cap than above.

- **Local Competition**

Under the existence of an employer subsidy scheme, health plans still remain as strategic complements to each other. Taking the first partial derivative of each plan's equilibrium price with respect to the other plan's premium, I derive a positive sign for the comparative static, $\frac{\partial P_i^*}{\partial P_j}$, under all cases considered in sections 2.3.2 and 2.3.3.

It is possible that the downward pressure on premiums increases as more plans enter the market. Additionally, that pressure can vary depending on whether the market is composed of plans mostly above or below the subsidy cap. If most of the plans price above the subsidy cap in a market, the market is considered a high-cost market. Conversely, if most of the plans price below the subsidy cap in a market, in which case a consumer only pays 25% of an additional dollar raised by the health plan, it is deemed a low-cost market. Feldman et al. (2002) hypothesize that competition matters more in high-cost markets whereas it would have a a smaller impact in low-cost markets.

- **Market Share**

Before the subsidy policy change in 1999, the current market share of a health plan is co-determined in the model along with its premium, and the subsidy cap does not depend on the market share of the non-"Big Six" plans. After 1999, however, the new subsidy cap is determined by the lagged enrollment-weighted average of all the newly submitted premium bids. Therefore, I expect lagged plan enrollment size, or lagged market share, to play a role in plans' pricing behavior after 1999.

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.

For illustrative purposes, I derive the closed form solution to the first partial derivative of plan 1's price (P_1^*) with respect to its lagged market share (w_1) from equation (2.17). When plan 1 prices above the subsidy cap and plan 2 prices below,

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

where $x = \dfrac{\exp(\alpha_1 - 1 - \beta_1(1 - .72w_1)C_1)}{\exp(\alpha_2 - (.25\beta_2 + .72w_2\beta_1)P_2)}$.

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.

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

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

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

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. As a result, the smaller the plan is, the more it raises its own price to keep up with the subsidy cap. Taken together, the comparative statics of the above-cap plan 1 and the below-cap plan 2 discussed above explain the reason why we observe lower equilibrium prices in Figure 2.4, when the two plans share the market equally than when plan 1 enjoys a larger market share than plan 2.

2.5 Policy Experiment

Keeping the same parameter values described in Section 2.3.2, I conduct a policy experiment to see how the new subsidy policy could change the equilibrium prices of the two plans in the market.

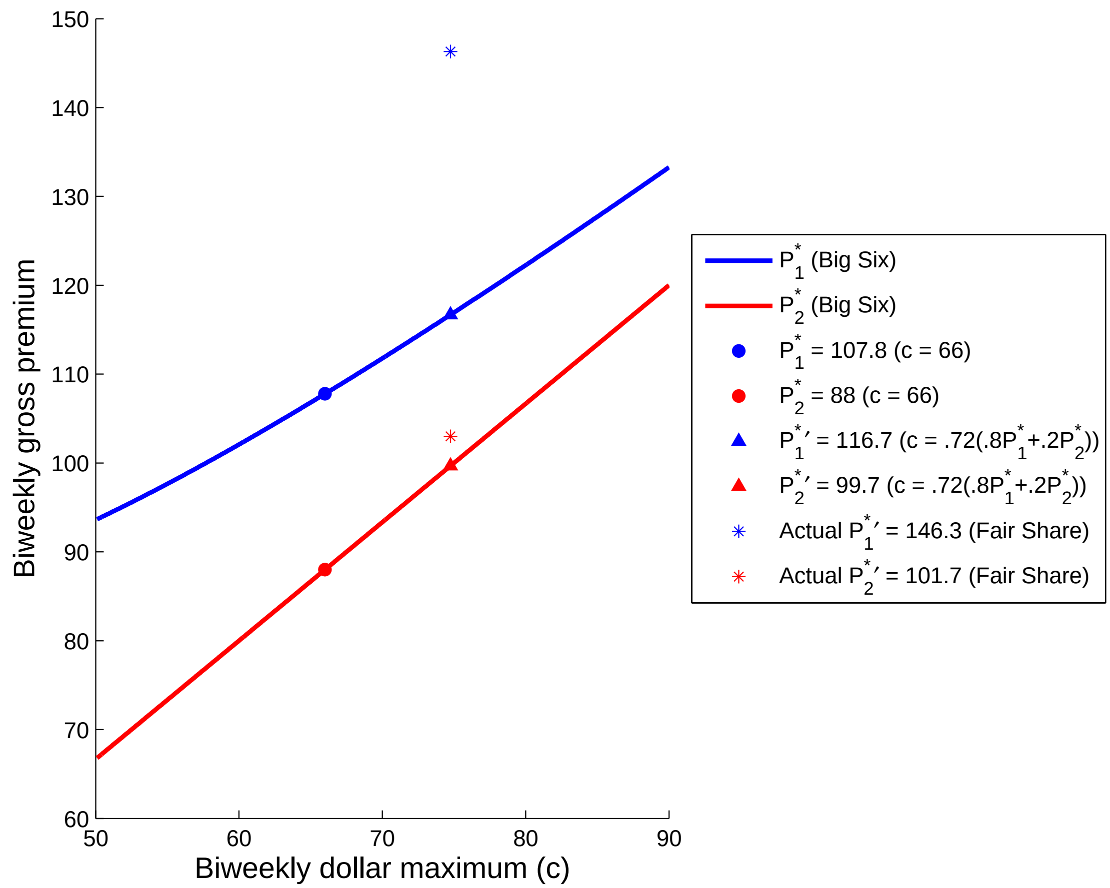
As shown in Figure 2.5, I first plot both plans' equilibrium prices with respect to the exogenous dollar maximum c before 1999 and indicate them with red and blue lines, under the constraint that plan 1 prices above the subsidy cap and plan 2 prices below.[6]

Second, I set $c = 66$, which is the actual 1998 biweekly dollar maximum level in the FEHB program, and indicate the equilibrium prices P_1^* and P_2^* with red and blue circles under the pre-1999 "Big Six" subsidy policy.

Third, I 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 $w_2 = .2$, I derive the new dollar maximum

[6]Before the policy change in 1999, for the equilibrium price of plan 2, I assume $P_2^* = c/.75$. Then given both c and P_2^*, I can derive P_1^* based on plan 1's best response function.

Figure 2.5: Equilibrium Prices of the Two Plans Under Different Policies



$c' = .72(.8P_1^* + .2P_2^*)$, and indicate the "naive" equilibrium price levels $P_1^{*\prime}$ and $P_2^{*\prime}$ with red and blue triangles. The reason I 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'.

However, as shown in Section 2.3.3, after the policy change in 1999, the two plans now choose their price levels taking into account the fact that the dollar maximum is now a function of their own prices. As a result, their best response functions are different from the pre-1999 case and dependent on their lagged market shares w_1 and w_2. In Figure 2.5, I indicate the actual equilibrium price levels after 1999 with red and blue stars (*), given the same parameter values used before. In this case, the equilibrium price levels of both plans are higher than the "naive" prices after we let the plans internalize the maximum employer contribution.

Chapter 3

Market Incentives and Pricing Behavior in Health Insurance: Empirical Evidence

3.1 Data and Summary Statistics

The data set I use to empirically analyze the pricing behavior among health insurance plans is provided by the Office of Personnel Management, who oversees the FEHB program. It contains information on characteristics of all self-only health plans offered in the FEHB program from years 1991-2011. Although the subsidy policy change applies to both federal civilian employees and annuitants in self-only as well as family plans, I 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.[1]

Each year, OPM contracts with over 200 plans. A health plan in a certain year

[1] FEHB 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.

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 FEHB. 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.

Table 3.1 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, given 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 3.1 plots the growth rate of real premiums along with the average number of health plans per state in the previous year, which shows a strong negative correlation between the two variables.

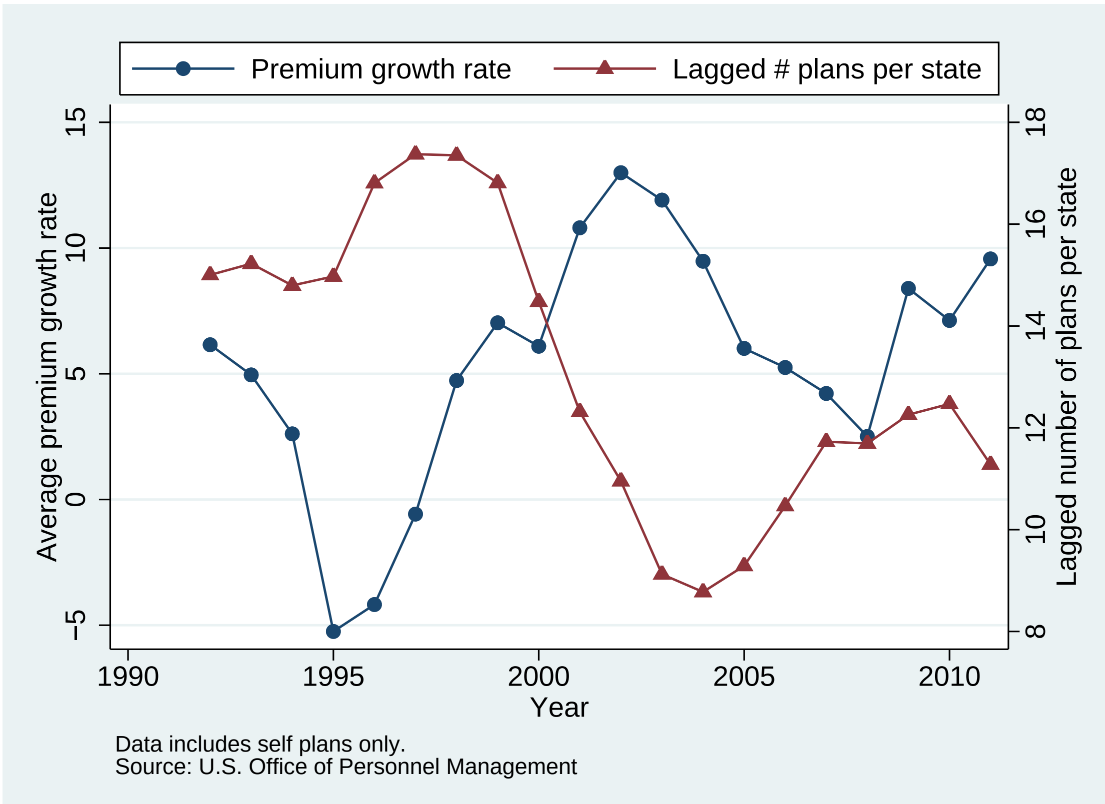
Over time, the percentage of plans who price below the subsidy cap decreased (see Figure 3.2), meaning more plans have caught up with the subsidy cap and are taking full advantage of the employer premium contribution. Table 3.2 tabulates the real premium growth rate of plans who priced below versus above the subsidy

Table 3.1: Mean Statistics for Self Plan Characteristics

Year	Annual Premium (Nom $)	Dollar Max (Nom $)	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

Source: OPM

Figure 3.1: Premium Growth vs. Number of Plans



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.

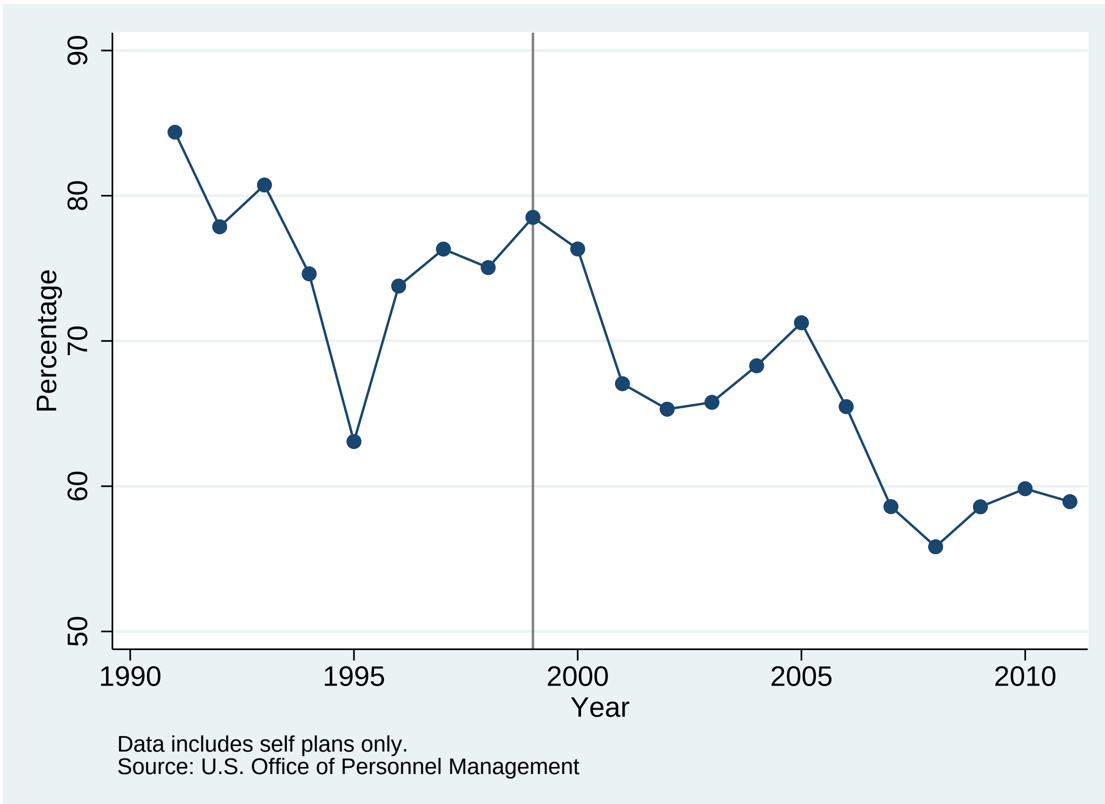
One concern is that plans below the subsidy cap could grow faster than plans above merely due to their lower base premium. Therefore, I also graph the average premium change for plans above and below the subsidy cap over time in Figure 3.3, which shows that plans below did increase their premiums more on average

Table 3.2: 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: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

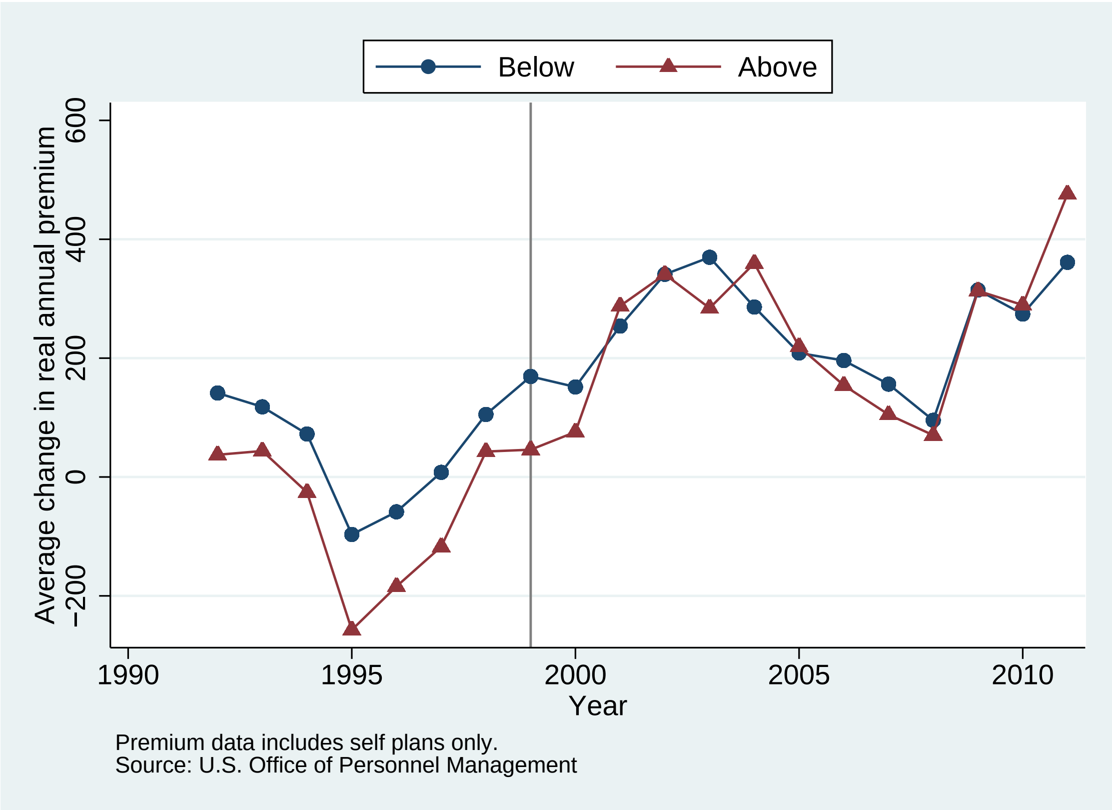
Figure 3.2: Percentage of Plans Below the Subsidy Cap



than those above, although that difference diminished after 1999.

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

Figure 3.3: Premium Change Below and Above the Subsidy Cap



3.2 Empirical Strategy

In order to examine the impact of a capped subsidy policy on premium growth, I propose three different regression specifications, each focusing on a separate channel through which the employer subsidy policy can affect the pricing strategies among health plans.

The impact from local competition is taken into account in all specifications by introducing the lagged number of plans existing in a local market as well as a plan's lagged local market share.

- **Price Sensitivity**

First, I look at whether the policy affects plans below or above the subsidy cap differently. As seen in Table 3.2, the difference in growth rate between plans below and above the subsidy cap diminished after the policy change, but without controlling for other explanatory variables, we cannot draw the conclusion that the policy change was responsible for this dampened relationship.

Using ordinary least squares (OLS) regression, I estimate the first baseline regression model in the following form:

$$\begin{aligned}\Delta P_{jst} = \beta_0 + \beta_1\ Post_t + \beta_2\ Below_{js,t-1} + \beta_3\ Below_{js,t-1} \times Post_t \\ + \beta_4\ Plans_{s,t-1} + \beta_5\ LocalShare_{js,t-1} + X'_{jst}\Gamma + \theta_s + \epsilon_{jst}\end{aligned} \tag{3.1}$$

The unit of observation in the equation above is plan j in state s and year t. Since I am interested in the effect of the subsidy policy on plan premium changes (rather than premium levels) over time, the dependent variable, ΔP_{jst}, is the first difference in real biweekly gross premium of each plan, i.e. $\Delta P_{jst} = P_{jst} - P_{js,t-1}$.

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 $t-1$. I 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 $t-1$.[2]

Notice that all the explanatory variables mentioned above, except for the $Post_t$ dummy, are lagged variables in year $t-1$ compared to the rest of the variables. The reason for this specification is that when plans submit their premium bids for year t in April of year $t-1$, they do not yet have the market-specific characteristics such as the number of plans in year t available to them. As a result, I assume they decide how much to increase premium next year based on the existing information in the current 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, I collect plan benefits and quality measures from the annual *Guide to Federal Employees Health Benefits Plans* distributed by OPM, and introduce 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, I include state fixed effects, described by θ_s, to control for time-invariant state-specific characteristics.

The coefficient β_2 in equation (3.1) tells us whether plans below the subsidy cap do grow faster than plans above, and β_3 indicates whether after the subsidy policy

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

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, I introduce the distance of how far away the plan's lagged gross premium is from last year's subsidy cap into the equation, 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:

$$\begin{aligned}\Delta P_{jst} = \beta_0 &+ \beta_1\ Post_t + \beta_2\ Below_{js,t-1} + \beta_3\ Below_{js,t-1} \times Post_t \\ &+ Distance_{js,t-1} \times \{\beta_4\ Below_{js,t-1} \times Pre_t \\ &+ \beta_5\ Above_{js,t-1} \times Pre_t + \beta_6\ Below_{js,t-1} \times Post_t \\ &+ \beta_7\ Above_{js,t-1} \times Post_t\} + \beta_8\ Plans_{s,t-1} \\ &+ \beta_9\ LocalShare_{js,t-1} + X'_{jst}\Gamma + \theta_s + \epsilon_{jst}\end{aligned} \tag{3.2}$$

The dummy variables $Below_{js,t-1}$ and $Above_{js,t-1}$ indicate whether plan j in state s prices below or above the subsidy cap, and $Distance_{js,t-1}$ tells us how far its gross premium is from the subsidy cap in year $t-1$. The dummy Pre_t is an indicator for whether the year is before 1999. Compared to the baseline specification, equation (3.2) has the added independent variables estimated by β_4 through β_7, which gives us a closer look at how plans' premium increase decisions are affected by their current price level relative to the subsidy cap before and after the policy change.

- **Market Share**

Next I 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, I 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, I specify the third estimation equation as follows:

$$\begin{aligned}
\Delta P_{jst} = \beta_0 &+ \beta_1\ Post_t + \beta_2\ Below_{js,t-1} + \beta_3\ Below_{js,t-1} \times Post_t \\
&+ GlobalShare_{js,t-1} \times \{\beta_4\ Below_{js,t-1} \times Pre_t \\
&+ \beta_5\ Above_{js,t-1} \times Pre_t + \beta_6\ Below_{js,t-1} \times Post_t \\
&+ \beta_7\ Above_{js,t-1} \times Post_t\} + \beta_8\ Plans_{s,t-1} \\
&+ \beta_9\ LocalShare_{js,t-1} + X'_{jst}\Gamma + \theta_s + \epsilon_{jst}
\end{aligned} \tag{3.3}$$

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 FEHB program who enroll in self-only plans.[3] Comparing equation (3.3) with (3.1), I am 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, I do not include year fixed effects. In order to account for macroeconomic shocks such as advances in medical technology and an aging population, I need to introduce some time trends. As a result, for all three specifications, I 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, I also try including plan code fixed effects in lieu of state fixed effects.

Another way to control for time-varying plan benefits changes is to introduce state-by-year fixed effects, assuming all the plans in the same local market share some general trend in terms of changes in benefits and coverage. However, given

[3] I choose the denominator to be the total number of federal civilian enrollees in the FEHB program 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, my measure is an approximation of the program-wide market share since our plan data does not include those for postal workers.

the sample size of my data set of around 5700 observations, including state-by-year fixed effects would introduce around 1000 dummy variables, if we multiply the 50+ states by 20 years from 1992-2011, which would significantly decrease the degrees of freedom in my regression estimation.

3.3 Results

3.3.1 Regression Results

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 3.2, the consumer sensitivity OLS estimates in Table 3.3 from regression equation (3.1) 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.[4] After 1999, however, the average biweekly increase seen in

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

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.

Table 3.3: Premium Level Change: Consumer Sensitivity

	Basic	Linear Trend	FE (1)	FE (2)
Post	10.56***	10.80***		
	(0.731)	(0.786)		
Below	5.923***	5.686***	5.028***	7.920***
	(0.501)	(0.515)	(0.490)	(0.713)
Below × Post	−4.612***	−4.064***	−3.223***	−2.525***
	(0.793)	(0.789)	(0.750)	(0.913)
Plans	−0.276***	−0.198***	−0.118***	−0.0507
	(0.0365)	(0.0411)	(0.0449)	(0.0563)
LocalShare	3.002***	2.887***	2.216**	8.955***
	(0.857)	(0.889)	(0.892)	(2.068)
Plan Controls	*Yes*	*Yes*	*Yes*	*Yes*
Plan Code FE				*Yes*
State FE	*Yes*	*Yes*	*Yes*	
Year FE			*Yes*	*Yes*
N	5746	5746	5746	5746
adj. R^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.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

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 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 I 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 3.4, 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 3.3.

In terms of global market share, the results in Table 3.5 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.

In all three specifications, the regression coefficients do not change much across different models as indicated by each separate column. In column two I include separate linear time trends for before and after the policy change, in column three I present estimates including year fixed effects, and in column four I drop state fixed effects and include plan code fixed effects instead. It is possible that plans

Table 3.4: Premium Level Change: Distance from the Subsidy Cap

	Basic	Linear Trend	FE (1)	FE (2)
Post	10.49***	10.31***		
	(1.119)	(1.173)		
Below	2.007**	2.033**	1.601*	2.175**
	(0.975)	(0.976)	(0.920)	(1.087)
Below × Post	−2.160*	−1.540	−1.320	−0.554
	(1.187)	(1.188)	(1.116)	(1.310)
Distance × Below × Pre	0.196***	0.187***	0.170***	0.363***
	(0.0239)	(0.0240)	(0.0222)	(0.0397)
Distance × Above × Pre	−0.133	−0.126	−0.130	−0.286**
	(0.0868)	(0.0874)	(0.0860)	(0.112)
Distance × Below × Post	0.0245*	0.00113	0.0237*	0.160***
	(0.0128)	(0.0144)	(0.0140)	(0.0367)
Distance × Above × Post	−0.0670*	−0.0763*	−0.0713**	−0.182***
	(0.0369)	(0.0389)	(0.0347)	(0.0439)
Plans	−0.262***	−0.196***	−0.116**	−0.0360
	(0.0381)	(0.0424)	(0.0471)	(0.0649)
LocalShare	2.582***	2.281**	1.779**	7.167***
	(0.847)	(0.889)	(0.897)	(2.034)
Plan Controls	Yes	Yes	Yes	Yes
Plan Code FE				Yes
State FE	Yes	Yes	Yes	
Year FE			Yes	Yes
N	5746	5746	5746	5746
adj. R^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.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 3.5: Premium Level Change: Global Market Share

	Basic	Linear Trend	FE (1)	FE (2)
Post	10.55***	10.78***		
	(0.741)	(0.802)		
Below	6.007***	5.775***	5.106***	8.070***
	(0.506)	(0.520)	(0.496)	(0.712)
Below × Post	−4.571***	−4.009***	−3.121***	−2.425***
	(0.810)	(0.806)	(0.763)	(0.936)
GlobalShare × Below × Pre	−6.633	−2.664	2.241	−3.862
	(5.258)	(5.857)	(5.164)	(18.43)
GlobalShare × Above × Pre	19.96	25.49	24.65	42.93*
	(18.74)	(17.99)	(15.26)	(24.29)
GlobalShare × Below × Post	−18.15	−22.44**	−28.02***	−40.12
	(11.12)	(10.69)	(10.50)	(40.88)
GlobalShare × Above × Post	7.433**	8.333**	10.83***	19.58**
	(3.691)	(4.004)	(3.824)	(8.652)
Plans	−0.277***	−0.198***	−0.116***	−0.0560
	(0.0365)	(0.0411)	(0.0449)	(0.0563)
LocalShare	2.925***	2.759***	2.001**	8.675***
	(0.923)	(0.951)	(0.935)	(2.139)
Plan Controls	*Yes*	*Yes*	*Yes*	*Yes*
Plan Code FE				*Yes*
State FE	*Yes*	*Yes*	*Yes*	
Year FE			*Yes*	*Yes*
N	5746	5746	5746	5746
adj. R^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.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

of the same plan code but different option code (high or standard) tend to follow the same pricing strategy over time, therefore I estimate clustered standard errors of the coefficients by allowing correlation within the same plan code.

In addition, I 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 3.3 and 3.5, 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 3.4 could be understated.

As a result, I 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 3.4 and are statistically significant, with the only difference being coefficients having larger magnitudes.

3.3.2 Counterfactual Simulation

In the following counterfactual analysis, I simulate the trajectory of the average annual gross premium in the FEHB program had the pre-1999 subsidy policy remained in effect, or had the health plans not changed their pricing strategies facing the new subsidy policy.[5] First, I estimate the following regression model

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

using the pre-1999 data set, with the same set of plan control variables (X_{jst}) mentioned in Section 3.2 as well as both state (θ_s) and year (η_t) fixed effects:

$$\begin{aligned}\Delta P_{jst} = \beta_0 + \beta_1\ Below_{js,t-1} + Distance_{js,t-1} \times \{\beta_2\ Below_{js,t-1} \\ + \beta_3\ Above_{js,t-1}\} + \beta_4\ Plans_{s,t-1} + \beta_5\ LocalShare_{js,t-1} \\ + X'_{jst}\Gamma + \theta_s + \eta_t + \epsilon_{jst}\end{aligned} \tag{3.4}$$

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, I 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.[6]

In the post-1999 prediction equation, I use the simulated real gross premiums to produce the counterfactual subsidy cap, in order to determine independent variables such as $Below_{js,t-1}$ and the two interaction terms that involve $Distance_{js,t-1}$. Based on either the pre-1999 "Big Six" formula or the post-1999 "Fair Share" formula, I first calculate the counterfactual subsidy cap, then determine whether the

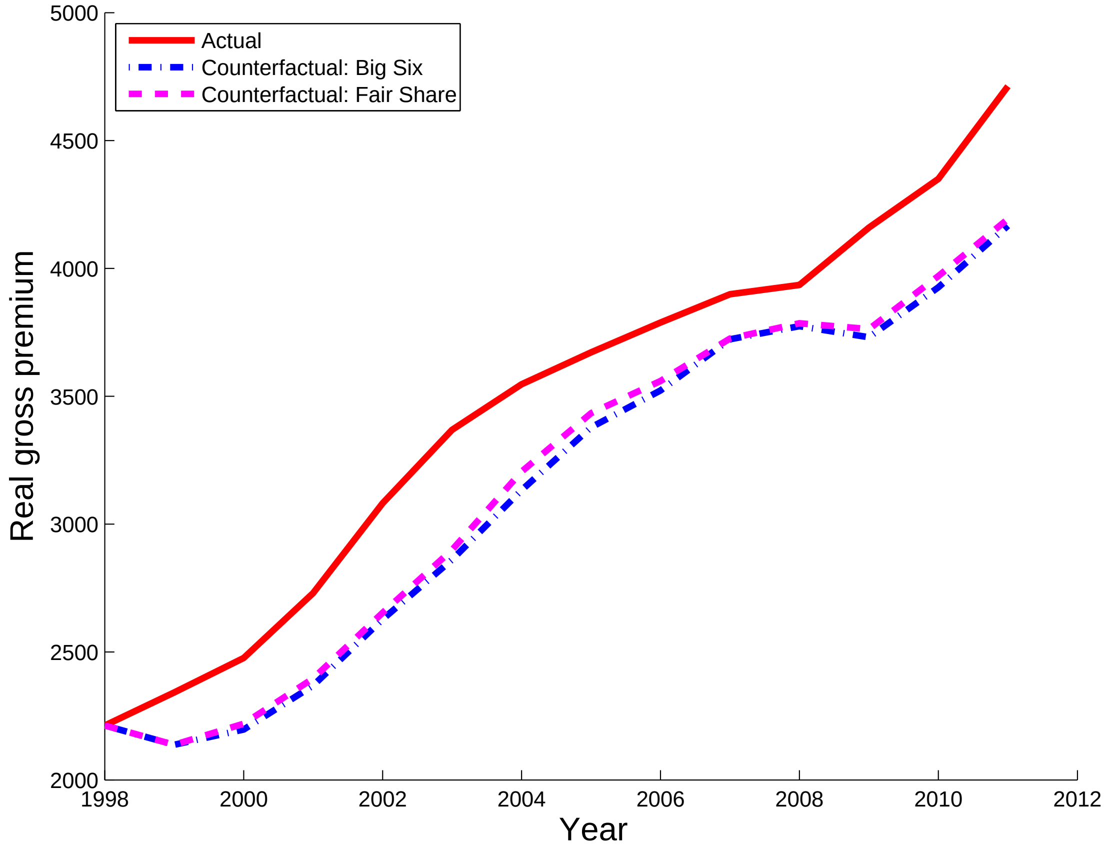
[6]Before 2008, I took the average growth rates for large firms with 5,000 or more workers. After 2008, however, only growth rates for large firms with 200 or more workers are reported.

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, I use the actual data from years 1999-2011. The regression coefficients are taken directly from equation (3.4) above in order to maintain the pre-1999 data generating process.

Figure 3.4 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 FEHB program would have been around 10% less than observed after 1999.

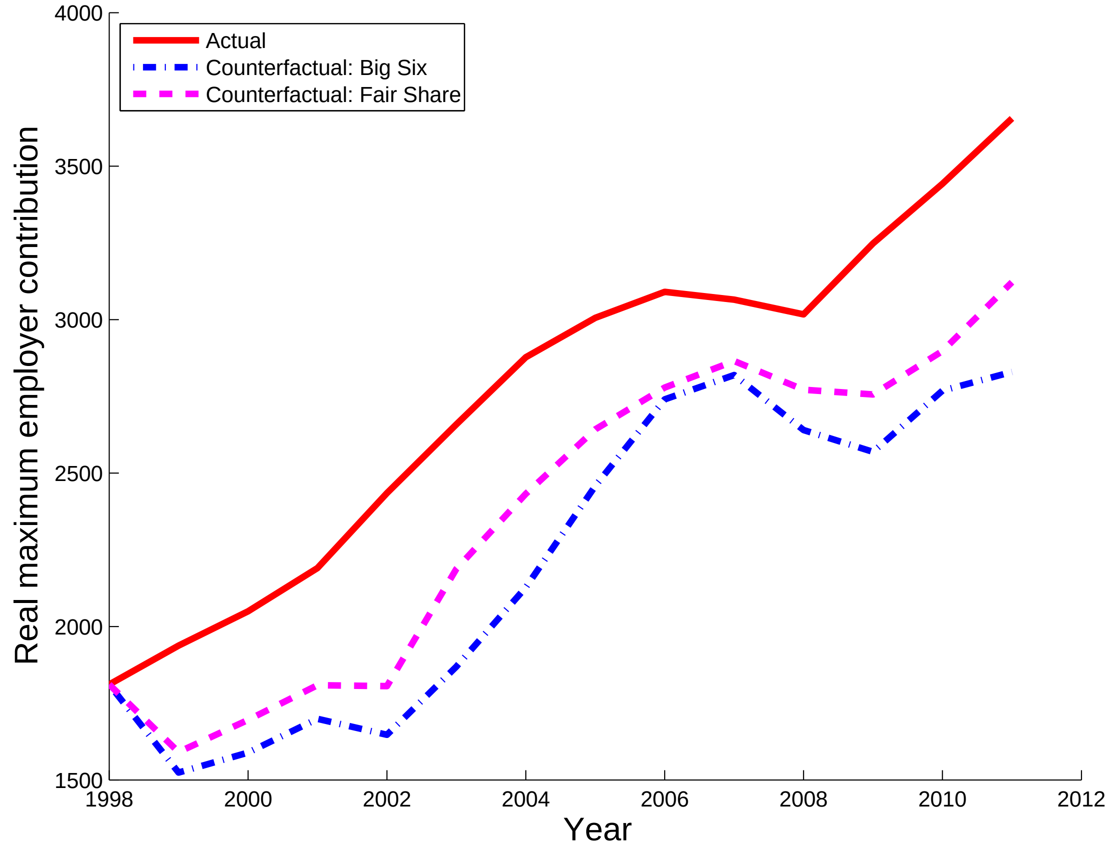
I also plot the maximum annual employer contribution in real dollars after 1999 under different scenarios in Figure 3.5. The actual dollar maximum consistently surpasses the counterfactual maximum employer contribution, meaning that health plans would have faced a lower subsidy cap had they maintained the same pricing strategies or behaviors as before 1999, while facing either the “Big Six” or the “Fair Share” formula after 1999.

Figure 3.4: Actual Vs. Counterfactual Average Annual Real Gross Premium



Finally, Figures 3.6 and 3.7 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

Figure 3.5: Actual Vs. Counterfactual Maximum Employer Contribution



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 FEHB program 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 FEHB program 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 3.6: Actual Vs. Counterfactual Average Annual Employee Contribution

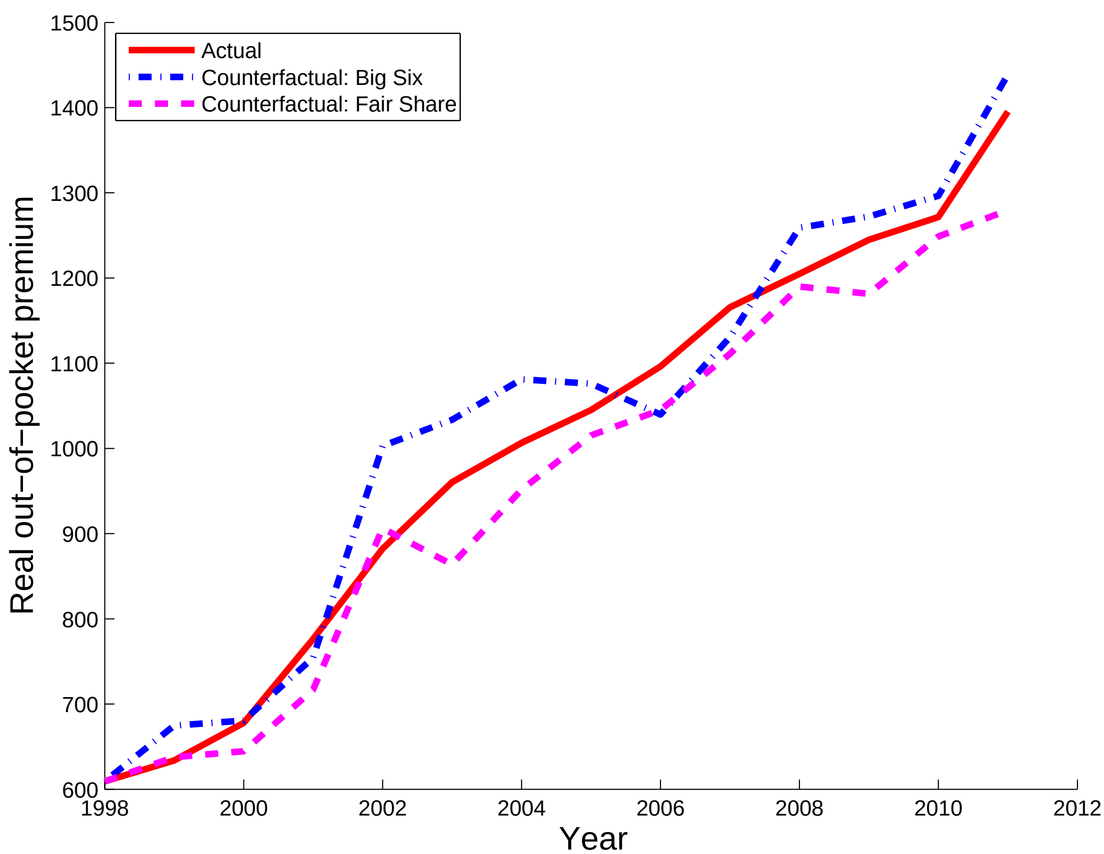
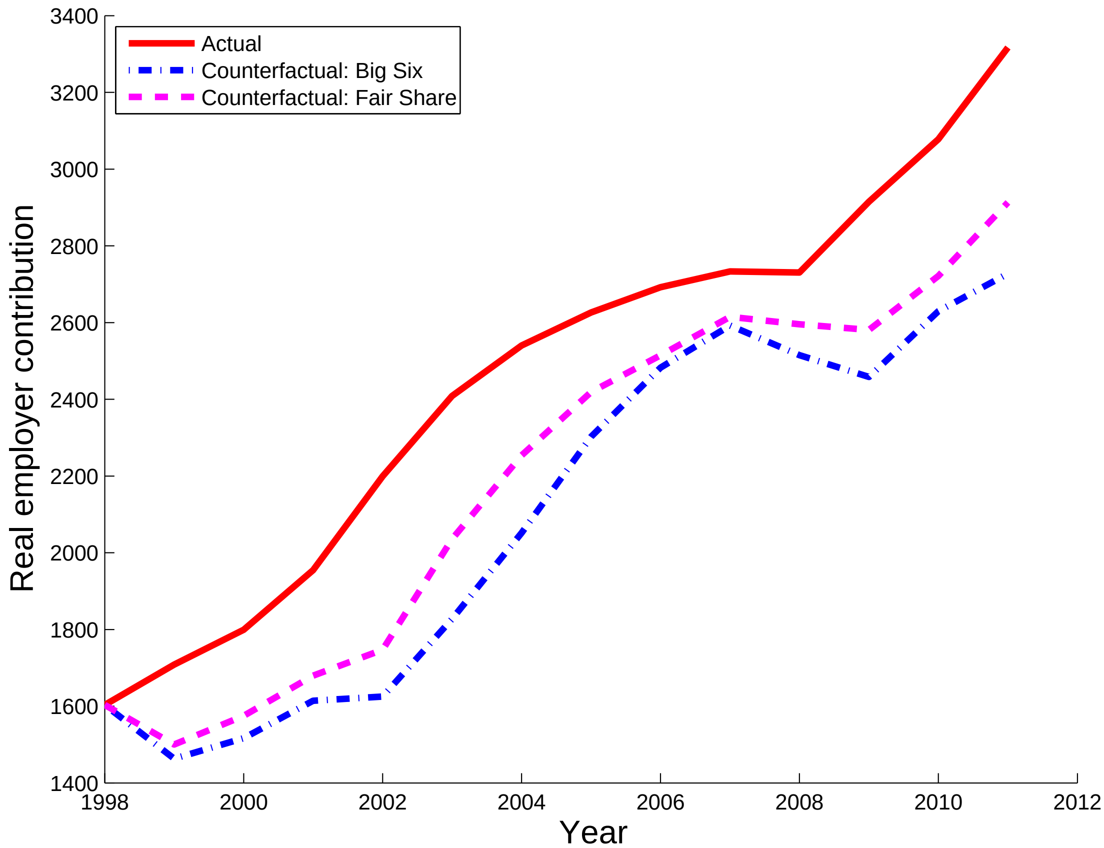


Figure 3.7: Actual Vs. Counterfactual Average Annual Employer Contribution



3.4 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, I present several extensions and robustness checks to complement the main results.

3.4.1 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, I 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 3.6 through 3.8, and are very similar to those described in Section 3.3.

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

Table 3.6: Premium Growth Rate: Consumer Sensitivity

	Basic	Linear Trend	FE (1)	FE (2)
Post	8.261***	11.07***		
	(0.580)	(0.728)		
Below	6.374***	6.021***	5.222***	8.056***
	(0.499)	(0.510)	(0.479)	(0.716)
Below × Post	−2.703***	−2.507***	−1.551**	−1.453*
	(0.645)	(0.645)	(0.603)	(0.778)
Plans	−0.172***	−0.147***	−0.0920**	−0.0471
	(0.0322)	(0.0349)	(0.0369)	(0.0478)
LocalShare	1.592**	1.584**	1.120	6.858***
	(0.722)	(0.708)	(0.713)	(1.563)
Plan Controls	*Yes*	*Yes*	*Yes*	*Yes*
Plan Code FE				*Yes*
State FE	*Yes*	*Yes*	*Yes*	
Year FE			*Yes*	*Yes*
N	5746	5746	5746	5746
adj. R^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 3.7: Premium Growth Rate: Distance from the Subsidy Cap

	Basic	Linear Trend	FE (1)	FE (2)
Post	9.113***	11.24***		
	(0.818)	(0.946)		
Below	1.738**	1.734**	1.234	2.065**
	(0.824)	(0.817)	(0.756)	(0.927)
Below × Post	−0.331	−0.699	−0.377	0.199
	(0.951)	(0.960)	(0.892)	(1.098)
Distance × Below × Pre	0.299***	0.281***	0.260***	0.471***
	(0.0316)	(0.0321)	(0.0296)	(0.0484)
Distance × Above × Pre	−0.0661	−0.0680	−0.0721	−0.199***
	(0.0573)	(0.0563)	(0.0545)	(0.0742)
Distance × Below × Post	0.0605***	0.0730***	0.0922***	0.239***
	(0.0127)	(0.0134)	(0.0129)	(0.0358)
Distance × Above × Post	−0.0711***	−0.0662***	−0.0626***	−0.147***
	(0.0207)	(0.0201)	(0.0178)	(0.0255)
Plans	−0.138***	−0.134***	−0.0805**	−0.0233
	(0.0342)	(0.0371)	(0.0397)	(0.0575)
LocalShare	1.474*	1.600**	1.268*	6.614***
	(0.759)	(0.743)	(0.754)	(1.705)
Plan Controls	Yes	Yes	Yes	Yes
Plan Code FE				Yes
State FE	Yes	Yes	Yes	
Year FE			Yes	Yes
N	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.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

afterward, among 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.

3.4.2 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, I 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. As discussed in Section 2.4.2, the hypothesis is that competition matters less in low-cost markets where most of the plans are below the subsidy cap.

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

$$\begin{aligned}
\%\Delta P_{jst} = \beta_0 &+ \beta_1 \; Post_t + \beta_2 \; Below_{js,t-1} + \beta_3 \; Below_{js,t-1} \times Post_t \\
&+ \beta_4 \; Plans_{s,t-1} + \beta_5 \; PercBelow_{s,t-1} \\
&+ \beta_6 \; Plans_{s,t-1} \times PercBelow_{s,t-1} \\
&+ \beta_7 \; LocalShare_{js,t-1} + X'_{jst}\Gamma + \epsilon_{jst}
\end{aligned} \tag{3.5}$$

Table 3.8: Premium Growth Rate: Global Market Share

	Basic	Linear Trend	FE (1)	FE (2)
Post	8.284***	11.08***		
	(0.592)	(0.739)		
Below	6.460***	6.111***	5.294***	8.202***
	(0.505)	(0.517)	(0.486)	(0.722)
Below × Post	−2.648***	−2.466***	−1.466**	−1.400*
	(0.659)	(0.659)	(0.613)	(0.803)
GlobalShare × Below × Pre	0.268	−0.869	3.446	−5.280
	(3.884)	(3.813)	(3.796)	(11.38)
GlobalShare × Above × Pre	27.66	28.78	24.77*	39.09*
	(19.18)	(18.56)	(13.77)	(23.73)
GlobalShare × Below × Post	−27.10***	−23.35**	−26.41***	−34.47
	(9.411)	(9.088)	(9.356)	(39.58)
GlobalShare × Above × Post	7.278**	6.959**	9.019***	14.12**
	(3.052)	(2.930)	(2.812)	(6.964)
Plans	−0.171***	−0.146***	−0.0898**	−0.0505
	(0.0322)	(0.0350)	(0.0370)	(0.0479)
LocalShare	1.480*	1.470*	0.930	6.684***
	(0.766)	(0.755)	(0.744)	(1.638)
Plan Controls	*Yes*	*Yes*	*Yes*	*Yes*
Plan Code FE				*Yes*
State FE	*Yes*	*Yes*	*Yes*	
Year FE			*Yes*	*Yes*
N	5746	5746	5746	5746
adj. R^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.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Compared to the baseline model in equation (3.1), 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, I 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 3.9, 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.

Table 3.9: Premium Growth Rate: Low- Versus High-Cost Markets

	Basic	FE (1)	FE (2)
Post	8.789***	8.644***	
	(0.535)	(0.584)	
Below	5.601***	5.714***	5.067***
	(0.519)	(0.523)	(0.494)
Below × Post	−2.658***	−2.893***	−1.643***
	(0.633)	(0.643)	(0.601)
Plans	−0.123**	−0.266***	−0.0635
	(0.0559)	(0.0746)	(0.0719)
PercBelow	−0.704	3.211***	1.608
	(0.938)	(1.096)	(1.032)
Plans × PercBelow	0.126*	0.108	−0.0377
	(0.0687)	(0.0790)	(0.0741)
LocalShare	0.540	1.626**	1.128
	(0.713)	(0.733)	(0.723)
Plan Controls	Yes	Yes	Yes
State FE		Yes	Yes
Year FE			Yes
N	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.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

3.5 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 employer premium contribution schemes on the pricing strategies of health plans. Using a subsidy policy change that occurred in the largest employer-sponsored health insurance program in the U.S., the Federal Employees Health Benefits Program, I study whether and how the employer premium contribution scheme affects health plan pricing.

With the help of a simplified analytical framework featuring differentiated products, I show that there are two market incentives that 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, using the capped employer contribution scheme in the FEHB program as an example, I 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.

Taken together, both market incentives contribute to higher insurance premiums in the FEHB program.

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 FEHB program.

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.

Chapter 4

Capped Premium Subsidies and Adverse Selection: A Closer Look

4.1 Introduction

In the previous chapter, I focus on the supply side of the FEHB market and show that a capped employer premium contribution scheme does provide health plans with different market incentives in terms of their pricing strategies. The plan premiums we observe, however, are influenced both by the supply and the demand side of the market. In an open enrollment health insurance program such as the FEHB market, adverse selection occurs when healthy individuals with low risks choose more moderate and sometimes suboptimal plans, so that they can separate themselves from the high-risk pool. As a result, high-risk individuals are more likely to choose plans with more generous coverage.

Previous literature has indicated that employer premium contribution schemes can affect adverse selection patterns. As mentioned in Section 1.2.1, a fixed contribution scheme, such as one equating the subsidy cap to the lowest plan premium, induces significant adverse selection (e.g., Cutler and Reber, 1998; Florence and Thorpe, 2003). Depending on the design of the employer contribution scheme, however, certain subsidy policies can also reduce adverse selection. In a theoretical framework building on the model of Rothschild and Stiglitz (1976), Selden (1999) suggested that in the presence of a capped premium subsidy, adverse selection can be mitigated without generating excessive plan coverage. Later, using 1996 cross-sectional data from the FEHB program, Gray and Selden (2002) empirically examined the relationship between adverse selection and capped premium subsidies, confirming that a higher premium subsidy in the FEHB program helps reduce adverse selection.

In light of the literature mentioned above and the subsidy cap policy change in 1999, I use a panel data set of health plan enrollment choices of federal civilian employees from 1997-2000 – two years before and after the policy change – to take a closer look at the effect of capped premium subsidies on adverse selection. Analyzing enrollment choices in the FEHB program will help us determine whether the overall premium increase we observe could also be attributed to changes in consumer choice patterns, such as whether there exists more adverse selection under the new "Fair Share" subsidy policy.

The results confirm previous findings on the dampening effect of a higher employer premium subsidy cap on adverse selection. The overall level of adverse selection, approximated by the different premium levels enrollees select based on their age, does not change significantly over time, which suggests that the subsidy policy change moving from the "Big Six" to the "Fair Share" formula does not have a discernible impact on enrollee choices.

4.2 Background

The notion of adverse selection stems from information asymmetry, where one party in a transaction has more or better information than the other. Adverse selection widely exists in insurance markets, such as one that deals with health insurance. For instance, it is common to observe that healthy people tend to pick cheaper health plans like managed care, whereas people with higher health risks choose more generous plans.

Rothschild and Stiglitz (1976) first developed a theoretical framework to analyze adverse selection in the insurance market. Information asymmetry occurs because insurance buyers know more about their own risks than the insurance company, who cannot distinguish between high- versus low-risk consumers. In the real world, however, adverse selection can occur even when insurance companies can observe individual risks but are not able to price accordingly. For example, in employer-sponsored health insurance markets, the employer must offer the same premium to all individuals who choose to enroll in a certain plan, and cannot price discriminate based on observed demographic characteristics such as age. One way to make high-risk buyers reveal themselves is for the insurance company to offer different types of plans, so that a separating equilibrium could be reached where high-risk individuals choose plans with higher premiums and low-risk buyers pick more moderate plans. Such an equilibrium is not the first-best solution, since low-risk individuals choose to purchase suboptimal insurance in order to avoid cross-subsidizing high-risk consumers.

Most recently, Einav and Finkelstein (2011) presented a graphical framework to help people understand selection in insurance markets, potential government interventions, and the corresponding welfare issues. Through drawing the marginal cost and average cost curves along the demand curve, they point out that inefficiency arises from adverse selection because the market equilibrium depends on the relationship between average cost and demand, whereas efficiency is determined by the relationship between marginal cost and demand. When adverse selection exists, the marginal cost curve always lies below the average cost curve, thus generating welfare loss. Furthermore, they show that if insurance coverage is subsidized by, for example, a positive lump sum subsidy toward the insurance premium, the welfare loss will be unambiguously lower.

There has been a substantial amount of empirical work on information asymmetry. Einav et al. (2010) give a broad overview of empirical models and analyses on insurance markets, including how to estimate individual insurance demand and aggregate welfare distortions under adverse selection. In terms of documenting adverse selection in health insurance markets, most have focused on the association between coverage and risk after controlling for observables.[1] The methodologies used to uncover the coverage-risk relationship vary widely across different insurance markets based on the type of insurance analyzed, such as how exclusive it is. Chiappori and Salanié (2013) describe the various empirical methods used in recent literature to test the coverage-risk relationship.

In order to theoretically analyze the impact of premium subsidies on adverse selection in the health insurance market. Selden (1999) built on the model of Rothschild and Stiglitz to allow premium subsidies to the consumers. They find that it is possible to reach a separating equilibrium under a linear premium subsidy that Pareto dominates the market outcome with no subsidies. Furthermore, a capped linear subsidy, such as the premium contribution scheme adopted in the FEHB program, could potentially relax the incentive compatibility constraints on plan choice for low-risk consumers, hence achieving a more equitable pooling equilibrium and reducing adverse selection.

In the context of the FEHB program, due to data limitation on enrollee demographic characteristics, the variables that can be used to approximate health

[1] For a detailed literature review, see, for example, Cutler and Zeckhauser (2000), Cutler (2002), and Cohen and Siegelman (2010), among others.

risks are age and gender. Previous research interested in adverse selection in the FEHB program has mostly looked at how the average enrollee age differs across plans (e.g., Gray and Selden, 2002; Florence and Thorpe, 2003). Despite the lack of detailed demographic information, the FEHB program does provide us with ample geographic price variation in terms of the premium subsidies enrollees receive, which presents itself as a great data source for analyzing the impact of premium subsidies on adverse selection.

Using enrollee health plan choices in the 1996 FEHB program, Gray and Selden (2002) find that a capped premium subsidy scheme can help control adverse selection in the employer-sponsored health insurance market. Their empirical strategy is to exploit the fact that even though there is a constant nominal subsidy cap across all geographic regions in the FEHB program, the *real* value of the subsidy cap varies greatly across local markets in the U.S. due to different price levels. A state with a high cost of living might see most of its plans pricing above the nation-wide subsidy cap, which in my sample period, is determined either by a simple average of the "Big Six" plans or a weighted average of all FEHB plans. Using the natural experiment arising from price variations across local markets, they expect that the coverage-risk relationship, which is measured by the premium-age relationship in the FEHB program, would be the strongest in markets where the subsidy cap is the lowest, if a higher subsidy helps reduce adverse selection.

4.3 Data and Summary Statistics

I use health insurance enrollment choices of federal civilian employees under 65 years old to complement the health plan data set described in Section 3.1, although due to data limitation, I do not observe individual enrollment choices after year 2000. Since the policy change occurred at the start of 1999, I take two years before and after the policy change (1997-2000) to analyze adverse selection among enrollees who chose self-only plans.

As shown in Table 4.1, during years 1997-2000, the average age of federal civilian employees under 65 who enrolled in self-only plans was 45 years old, the percentage of female enrollees was 55%, and the average education level was 10 years, all of which did not change much over time. The average nominal salary increased over time, and so did the average premium level. Since the maximum employer contribution (dollar max) was derived from plan premiums based on either the "Big Six" or the "Fair Share" formula, it increased at the same pace as average premium. Over time, the percentage of enrollees who chose FFS plans increased by 1-2%, whereas the percentage choosing high-option plans dropped from the original 61% to 55% in 2000.

In terms of the coverage-risk relationship among enrollees in the FEHB program, following Gray and Selden (2002), I examine the relationship between the gross premium of the health plan enrollees choose, which is an indicator for in-

Table 4.1: Mean Statistics for Enrollee Characteristics

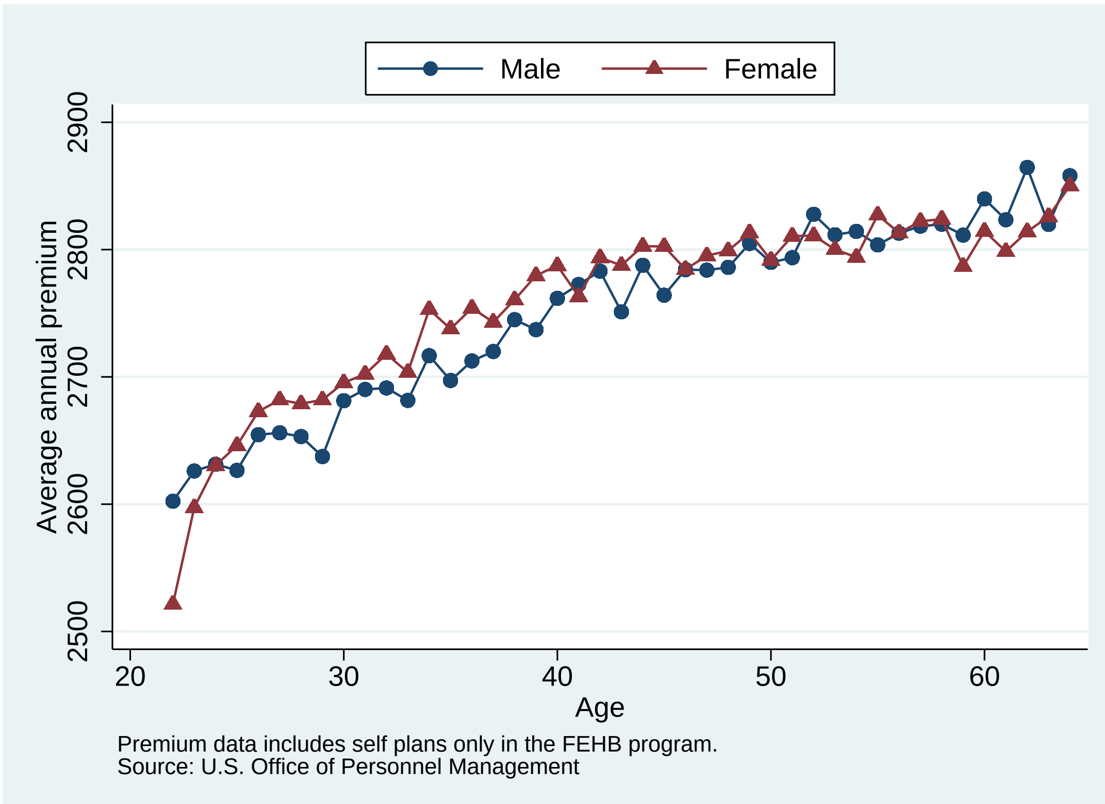
Year	Age (Yrs)	Female (%)	Education (Yrs)	Salary ($)	Premium ($)	Dollar Max ($)	FFS (%)	High Option (%)
1997	44.02	55.05	9.78	43,036	2,114	1,634	55.27	61.24
1998	44.50	55.12	9.82	44,786	2,268	1,715	55.47	59.40
1999	45.02	55.20	9.83	46,976	2,497	1,874	56.64	57.21
2000	45.37	55.35	9.85	49,703	2,732	2,050	57.93	54.86
Mean	44.72	55.18	9.82	46,098	2,400	1,816	56.32	58.21

Source: OPM

surance coverage under competitive conditions, and their age at the time of enrollment, which is an observable characteristic that approximates health risks. In order to avoid depicting variation in insurance premiums due to differences in cost of living or inflation over time, as an illustration, Figure 4.1 plots the relationship between nominal annual gross premium and enrollee age among federal employees aged 22-64 located in Washington, DC in year 2000. I observe a positive correlation between age and premium among both male and female enrollees, although after an upward climb during ages 22-40, both lines flatten out somewhat.

Since OPM sets the same nation-wide nominal level for maximum employer premium contribution every year, people in different states, such as New York versus Wyoming, potentially face different levels of *real* employer subsidy. Many plans in a high-cost state such as New York might end up pricing above the subsidy cap, whereas plans in rural Wyoming could all be below the cap. Following Gray

Figure 4.1: Premium-Age Relationship Among DC Enrollees in 2000



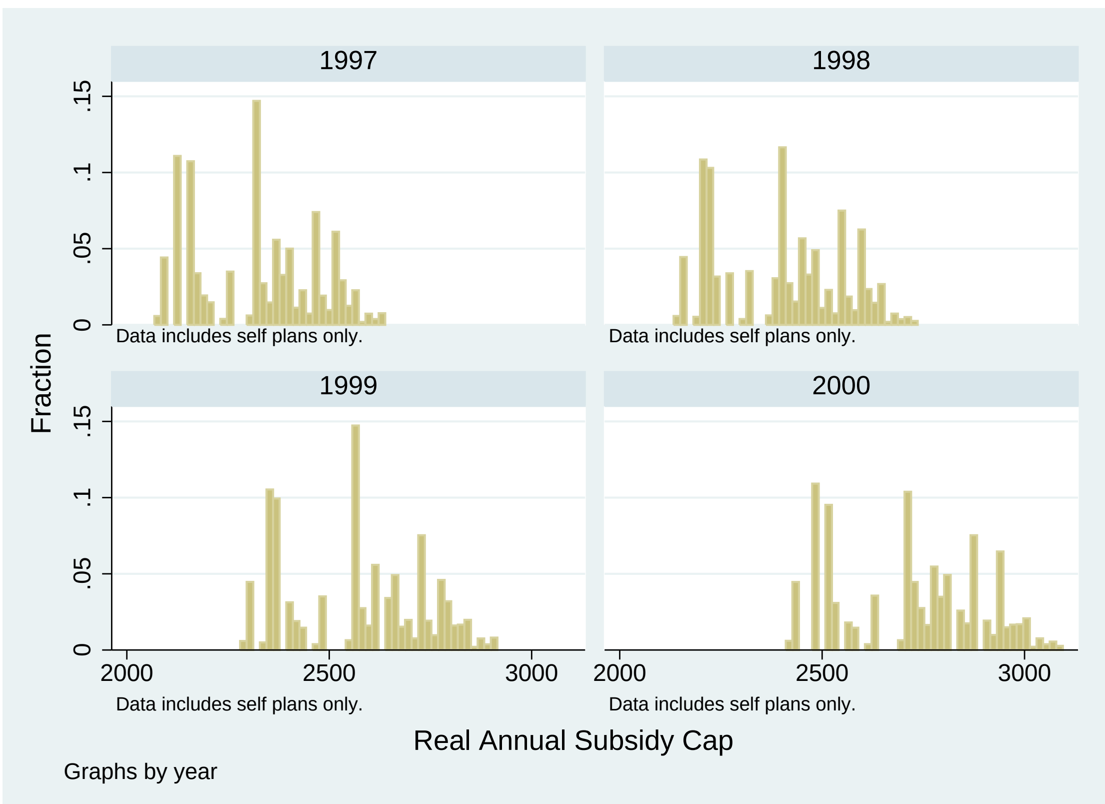
and Selden (2002), I convert the nominal dollars into real values using a price index, the Geographic Practice Cost Index (GPCI) published by the Centers for Medicare and Medicaid Services (CMS).[2] Since CMS only publishes the GPCI on their website as early as year 2000, and the index does not change drastically over time, I use the GPCI in year 2000 to convert the nominal plan premiums and subsidy caps for all four years during 1997-2000. Based on the year 2000 GPCI locality code, the finest geographic area to which I could assign a unique price

[2]The GPCI is a geographic price adjustment index that takes the weighted average of the relative value of work (52%), practice expense (44%), and malpractice (4%) in a local area.

index was at the state level.

As a result, nominal health plan premiums and the subsidy cap in the same state are converted using a single GPCI value. Figure 4.2 shows the distribution of the real annual subsidy cap (dollar max/.75) faced by all enrollees, deflated by GPCI (to control for geographic price variation) as well as CPI (to control for inflation over time) in all four years. The standard deviation of the real annual subsidy cap ranges from 150 in year 1997 to 175 in year 2000, which suggests that there is a fair amount of variation in medical care prices across states.

Figure 4.2: Distribution of Real Annual Subsidy Cap



4.4 Empirical Strategy

In order to look at whether the degree of adverse selection changes over time, I need a measure for risk segmentation, which I approximate by looking at the different premium levels enrollees select based on their age. If adverse selection occurs in the FEHB program, we would expect the coefficient on the age variable to be positive, meaning that older (presumably less healthy) people are more likely to select more expensive plans with generous coverage, after taking into account other demographic characteristics such as gender, education, and salary. According to Polzer (1998), a plan attracting primarily high-risk enrollees can cost several times as much for approximately the same level of benefits as a plan made up of healthier enrollees.[3]

Using ordinary least squares (OLS) regression, I first estimate a baseline regression model similar to Gray and Selden (2002), in order to confirm the effect of the subsidy cap on adverse selection.

$$\begin{aligned} \ln P_{ist} = \beta_0 + \beta_1 \ln Age_{ist} + \beta_2 \ln Cap_{st} + \beta_3 \ln Age_{ist} \times \ln Cap_{st} \\ + X'_{ist}\Gamma + \epsilon_{ist} \end{aligned} \tag{4.1}$$

The unit of observation in the equation above is individual i in state s and year t.

[3] An example would be Aetna's high- and standard-option plan in the FEHB program, which did not differ much in terms of actuarial values, but the high-option plan's premium was more than twice as high as the standard-option plan.

The dependent variable, $\ln P_{ist}$, is the natural logarithm of the real biweekly gross premium of individual i's health plan. The Age_{ist} variable describes individual i's age in state s and year t. The Cap_{st} variable stands for the real biweekly subsidy cap in state s and year t, which is state-specific since the GPCI value varies at the state level.

The coefficient β_3 on the interaction term between Age and Cap is the key parameter of interest, since it tells us how much the degree of adverse selection ($\frac{\partial P}{\partial Age}$) changes with the real subsidy cap level ($\frac{\partial^2 P}{\partial Age \partial Cap}$).

The control variables X_{ist} include individual demographic characteristics (gender, education, and salary) as well as the total number of self-only plans in the individual's local health plan market. I do not include any health plan benefits or quality measures since they are the resulting outcomes of the individual's choice and hence endogenous.

As a separate variant of the baseline model, I include state fixed effects to control for time-invariant state-specific characteristics. When I include both state and year fixed effects, however, the variable Cap needs to be dropped due to collinearity. In doing so, I take advantage of the panel structure of the data set and introduces more controls than the cross-sectional regression model in Gray and Selden (2002).

Furthermore, I look at whether the degree of adverse selection changed during the sample period 1997-2000, two years before and after the implementation of the subsidy cap policy change. Compared to equation (4.1), the newly added variables of interest here are the interaction terms between *Age* and the year dummies, which capture changes in adverse selection over time:

$$\begin{aligned} \ln P_{ist} = \beta_0 + \beta_1 \ln Age_{ist} + \ln Age_{ist} \times \{\beta_2 \ \mathbb{1}(1998) + \beta_3 \ \mathbb{1}(1999) \\ + \beta_4 \ \mathbb{1}(2000)\} + \beta_5 \ln Cap_{st} + \beta_6 \ln Age_{ist} \times \ln Cap_{st} \\ + X'_{ist}\Gamma + \epsilon_{ist} \end{aligned} \tag{4.2}$$

The policy change from a "Big Six" formula to a "Fair Share" formula affects the pricing strategies of health plans, as evidenced in the previous chapter. In theory, a health plan experiencing adverse selection would have to charge a higher premium to offset the cost of insuring less healthy individuals. However, it is not clear whether and how the subsidy policy change would affect consumers' choice of health plans, or adverse selection. The year dummies from 1998-2000 in equation (4.2) try to address this question.

4.5 Results

Table 4.2 presents the regression results from the first specification. The coefficient on the *Age* variable is positive and significant across different variants of the baseline model, meaning that we do observe adverse selection in the FEHB program among federal civilian employees with self-only plans. Since both the dependent variable, real plan premium, and the *Age* variable are in natural logarithm form, the coefficient on *Age* indicates that, on average, a 10% increase in age is associated with a 1-2% increase in the real premium of the chosen plan.

Table 4.2: Premium Subsidies and Adverse Selection

	Basic	FE (1)	FE (2)
lnAge	0.103***	0.138***	0.208***
	(0.0142)	(0.0138)	(0.0136)
lnCap	0.968***	0.913***	
	(0.0117)	(0.0114)	
lnAge × lnCap	−0.0244***	−0.0314***	−0.0472***
	(0.00309)	(0.00303)	(0.00298)
Controls	Yes	Yes	Yes
State FE		Yes	Yes
Year FE			Yes
N	1843561	1843561	1843561
adj. R^2	0.707	0.724	0.734

Notes: The dependent variable is the natural logarithm of individuals' real biweekly plan premium. Additional control variables include individual demographic characteristics as well as the number of health plans in the local market. Robust standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

It is not surprising that the average level of plan premiums chosen by enrollees moves at the same pace as the subsidy cap – with a coefficient estimated at around one – since the subsidy cap in year t is determined by plan premiums in year t, whether it is based on a "Big Six" or "Fair Share" formula. Similar to Gray and Selden (2002), I find that a higher subsidy cap helps reduce adverse selection, given the coefficient on the interaction term between *Age* and *Cap* is negative and significant.

The change in adverse selection over time, however, is less conclusive as shown in Table 4.3. In all three columns, the three coefficients on interaction terms involving year dummies are negative and significant, meaning that compared to the base year (1997), there was less adverse selection among enrollees in subsequent years, possibly due to a higher subsidy cap. However, the magnitudes of the coefficients on all year dummies are very small compared to the coefficient on the *Age* variable in the base year, especially when I include state and year fixed effects.

Thus, I do not observe more adverse selection among enrollees after the subsidy policy change in 1999. In the meantime, the effect of premium subsidies on adverse selection changed little when compared to Table 4.2. I expect to reach a more conclusive finding if I have more years of enrollment data, in which case I will be able to observe the long-run impact of the subsidy policy change.[4]

As a robustness check, instead of looking at the premium-age relationship, I use a dummy variable FFS as the dependent variable – indicating whether or not the individual's chosen health plan is FFS – and run a linear probability model using the same regression specifications as before. FFS plans are generally more expensive than managed care plans since they offer more coverage and benefits, which is more attractive to older people with higher health risks. It turns out that

[4]A Freedom of Information Act data request on federal employee enrollment choices in the FEHB program has been sent to OPM, and I am hoping to receive the data in the future.

Table 4.3: Adverse Selection Over Time

	Basic	FE (1)	FE (2)
lnAge	0.0658***	0.169***	0.170***
	(0.0140)	(0.0186)	(0.0186)
lnAge × $\mathbb{1}$(1998)	−0.0147***	−0.0134***	−0.0110***
	(0.0000569)	(0.000218)	(0.000843)
lnAge × $\mathbb{1}$(1999)	−0.0108***	−0.00791***	−0.0157***
	(0.0000627)	(0.000649)	(0.000930)
lnAge × $\mathbb{1}$(2000)	−0.0117***	−0.00738***	−0.00367***
	(0.0000729)	(0.00101)	(0.00109)
lnCap	1.001***	0.993***	
	(0.0115)	(0.0176)	
lnAge × lnCap	−0.0150***	−0.0371***	−0.0372***
	(0.00305)	(0.00414)	(0.00414)
Controls	Yes	Yes	Yes
State FE		Yes	Yes
Year FE			Yes
N	1843561	1843561	1843561
adj. R^2	0.720	0.734	0.734

Notes: The dependent variable is the natural logarithm of individuals' real biweekly plan premium. Additional control variables include individual demographic characteristics as well as the number of health plans in the local market. Robust standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

all key parameters yield the same sign and significance level as those shown in Tables 4.2 and 4.3, telling a similar story about the effect of premium subsidies on adverse selection as well as enrollees' sorting pattern over time.

4.6 Conclusion

I look at the pattern of adverse selection in the FEHB program under a capped employer premium contribution scheme. Previous literature has suggested that the level of adverse selection can differ under various subsidy schemes, and a capped premium subsidy, depending on how high the cap is, can potentially alleviate adverse selection thanks to the contribution from the employer.

Using FEHB enrollment choice data from years 1997-2000, two years before and after the subsidy policy change, I find empirical results that support the dampening effect of a higher employer premium subsidy cap on adverse selection, with magnitudes similar to those found in Gray and Selden (2002). In addition, the overall level of adverse selection remains relatively stable during the sample period 1997-2000, which suggests that at least in the short run, the subsidy policy change in 1999 does not have a significant demand-side effect on enrollee sorting patterns. Over time, if the subsidy cap becomes larger, we are more likely to see less adverse selection among enrollees in the FEHB program.

Chapter 5

Conclusion

This dissertation analyzes the effect of employer premium contribution schemes on both the supply and demand side of the health insurance market. Chapter 1 introduces the employer-sponsored health insurance market in the U.S., motivates why employer premium contribution schemes matter, and reviews previous findings in the literature. Chapters 2 and 3 focus on the supply-side effect of the premium subsidies, whereas Chapter 4 looks at the demand side.

In Chapter 2, I present an analytical framework to illustrate the effect of employer premium contribution schemes on health plan pricing. I model the employer-sponsored health insurance market as a differentiated-product oligopoly and study the pricing strategies of insurance plans before and after a policy change in employer premium contribution. I 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.

In Chapter 3, I confirm the theoretical predictions using 1991-2011 data before and after a premium contribution policy change that occurred in 1999 in the Federal Employees Health Benefits (FEHB) Program. Empirical results suggest that both market incentives mentioned above contribute to premium growth. Furthermore, I perform counterfactual analysis to show that average premium would have been 10% less than observed had the subsidy policy change not occurred in the FEHB program, and the federal government would have incurred 15% less in premium contribution.

Chapter 4 looks at how capped employer premium subsidies affect the level of adverse selection among consumers. Previous research suggests that the employer premium contribution scheme can exacerbate or mitigate the level of adverse selection among consumers. I find empirical evidence supporting the dampening effect of a higher employer premium subsidy cap on adverse selection. The overall level of adverse selection in the FEHB program, however, does not change significantly during 1997-2000. In the long run, as the subsidy cap grows larger, it should further mitigate adverse selection, which suggests that changes in premium levels cannot be attributed to higher risk segmentation among federal enrollees.

Admittedly, this study is limited by the data availability both on plan characteristics and employee enrollment choices. Future work would benefit from directly controlling for other time-varying plan characteristics that could potentially contribute to premium growth as well as a longer sampling period to analyze adverse selection. One possible future research topic suggested by this study is to look at the effect of employer premium contribution schemes on market competition, such as entry and exit, among health plans in a static or dynamic framework. In terms of market efficiency, more work is needed in understanding and finding mechanisms to alleviate information asymmetry in insurance markets.

Appendix A

Solving First Order Conditions

I present the steps to solving the FOCs of the two plans (plan 1 and plan 2) in my analytical framework before the policy change in 1999, when the subsidy cap was 60% of the gross premium of the exogenous "Big Six" plans. One can follow similar procedures to derive the FOCs of the plans after 1999.

Assume before 1999, the dollar maximum the employer can contribute to any health plan is c. When plan 1 prices above the subsidy cap, the net premium consumers pay for plan 1 is $\tilde{P}_1 = P_1 - c$. On the other hand, when plan 1 prices below the subsidy cap, consumers would pay $\tilde{P}_1 = .25P_1$. Similarly, consumers pay a net premium of $\tilde{P}_2 = P_2 - c$ or $.25P_2$ for plan 2 depending on whether plan 2 prices above or below the subsidy cap.

I solve for the case where plan 1 prices above, and plan 2 prices below the subsidy cap here ($\tilde{P}_1 = P_1 - c$ and $\tilde{P}_2 = .25P_2$), but one can follow similar steps to derive the solutions to other cases.

- **Plan 1's FOC**

Plan 1 chooses a gross premium P_1 to maximize its profit:

$$\pi_1 = P_1 D_1(\tilde{P}) - C_1 D_1(\tilde{P}), \tag{A.1}$$

where D_1 is the demand for plan 1, which depends on the net premium of both plan 1 and plan 2, and C_1 is its marginal cost.

If we normalize the market size to one, the demand for a health plan is equal to its market share, $D_1 = S_1$. Therefore, we can derive the FOC of the above profit-maximization problem as

$$P_1 = C_1 - \frac{S_1}{\frac{\partial S_1}{\partial P_1}}, \tag{A.2}$$

where $S_1 = \dfrac{\exp(\alpha_1 - \beta_1 \tilde{P}_1)}{\exp(\alpha_1 - \beta_1 \tilde{P}_1) + \exp(\alpha_2 - \beta_2 \tilde{P}_2)}$ is the market share of plan 1.

Substituting $\tilde{P}_1 = P_1 - c$ and $\tilde{P}_2 = .25P_2$ into plan 1's market share above,

$$S_1 = \frac{\exp(\alpha_1 - \beta_1(P_1 - c))}{\exp(\alpha_1 - \beta_1(P_1 - c)) + \exp(\alpha_2 - .25\beta_2 P_2)}.$$

After some algebra, we obtain

$$\frac{S_1}{\frac{\partial S_1}{\partial P_1}} = -\frac{1}{\beta_1(1 - S_1)},$$

which gives us the final FOC of plan 1:

$$P_1 = C_1 + \frac{1}{\beta_1(1 - S_1)}. \tag{A.3}$$

- **Plan 2's FOC**

By the same token, plan 2 chooses a gross premium P_2 to maximize its profit, and the FOC of its profit-maximization problem is

$$P_2 = C_2 - \frac{S_2}{\frac{\partial S_2}{\partial P_2}}, \tag{A.4}$$

where $S_2 = \dfrac{\exp(\alpha_2 - \beta_2 \tilde{P}_2)}{\exp(\alpha_1 - \beta_1 \tilde{P}_1) + \exp(\alpha_2 - \beta_2 \tilde{P}_2)}$.

Substituting $\tilde{P}_1 = P_1 - c$ and $\tilde{P}_2 = .25P_2$ into plan 2's market share above, and take the first partial derivative, we obtain

$$\frac{S_2}{\frac{\partial S_2}{\partial P_2}} = -\frac{1}{.25\beta_2(1 - S_2)},$$

which gives us the final FOC of plan 2:

$$P_2 = C_2 + \frac{1}{.25\beta_2(1 - S_2)}. \tag{A.5}$$

Appendix B

Solving Simultaneous Equations

I present the steps to solving the optimal price and market share of plan 1 expressed in equations (2.7) and (2.8), closely following the algebraic procedure implemented in Aravindakshan and Ratchford (2011). One can use the same method to solve for the optimal prices and market shares of health plans under different subsidy schemes.

Equations (2.5) and (2.6) illustrate the simultaneity problem between price and market share in logit models. Substituting the market share equation (2.6) into the price equation (2.5), I get

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

Note that

$$\begin{aligned} 1 - S_1 &= 1 - \frac{\exp(\alpha_1 - \beta_1 P_1)}{\exp(\alpha_1 - \beta_1 P_1) + \exp(\alpha_2 - \beta_2 P_2)} \\ &= \frac{\exp(\alpha_2 - \beta_2 P_2)}{\exp(\alpha_1 - \beta_1 P_1) + \exp(\alpha_2 - \beta_2 P_2)}, \end{aligned}$$

which means

$$\frac{1}{1-S_1} = \frac{\exp(\alpha_1 - \beta_1 P_1) + \exp(\alpha_2 - \beta_2 P_2)}{\exp(\alpha_2 - \beta_2 P_2)} \tag{B.2}$$

$$= 1 + \frac{\exp(\alpha_1 - \beta_1 P_1)}{\exp(\alpha_2 - \beta_2 P_2)}. \tag{B.3}$$

Therefore, I can simplify equation (B.1) into

$$P_1 = C_1 + \frac{1}{\beta_1} + \frac{\exp(\alpha_1 - \beta_1 P_1)}{\beta_1 \exp(\alpha_2 - \beta_2 P_2)}. \tag{B.4}$$

Now I multiply equation (B.4) by β_1 and then add α_1 on both sides,

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

After rearranging the above equation, I obtain

$$\alpha_1 - \beta_1 P_1 + \frac{\exp(\alpha_1 - \beta_1 P_1)}{\exp(\alpha_2 - \beta_2 P_2)} = \alpha_1 - 1 - \beta_1 C_1. \tag{B.5}$$

Taking the exponential on both sides of equation (B.5) and then divide both sides by $\exp(\alpha_2 - \beta_2 P_2)$:

$$\frac{\exp(\alpha_1 - \beta_1 P_1)}{\exp(\alpha_2 - \beta_2 P_2)} \exp\left(\frac{\exp(\alpha_1 - \beta_1 P_1)}{\exp(\alpha_2 - \beta_2 P_2)}\right) = \frac{\exp(\alpha_1 - 1 - \beta_1 C_1)}{\exp(\alpha_2 - \beta_2 P_2)}. \tag{B.6}$$

Recall that the Lambert W function is defined as the inverse function associated with $W(x)e^{W(x)} = x$. Assume $W = \dfrac{\exp(\alpha_1 - \beta_1 P_1)}{\exp(\alpha_2 - \beta_2 P_2)}$, and I can rewrite (B.6) as

$$W(x)e^{W(x)} = x,$$

where $x = \dfrac{\exp(\alpha_1 - 1 - \beta_1 C_1)}{\exp(\alpha_2 - \beta_2 P_2)}$.

Taking the natural logarithm of equation (B.6) on both sides and substitute in the newly defined $W(x)$, I get

$$\alpha_1 - \beta_1 P_1 - (\alpha_2 - \beta_2 P_2) + W(x) = \alpha_1 - 1 - \beta_1 C_1 - (\alpha_2 - \beta_2 P_2),$$

which simplifies to

$$\beta_1 P_1 = \beta_1 C_1 + 1 + W(x).$$

Solving for the optimal price P_1^*, I obtain the best response function of plan 1 in terms of plan 2's gross premium (P_2) presented in equation (2.7)

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

where $x = \dfrac{\exp(\alpha_1 - 1 - \beta_1 C_1)}{\exp(\alpha_2 - \beta_2 P_2)}$.

In order to solve for the optimal market share of plan 1 in equation (2.8), we can simply substitute $W(x)$ back into equation (B.3) and get

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

which gives us

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

Appendix C

Solving Remaining Profit Maximization Problems

C.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

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

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, I derive the best response function of plan 1 and its market share as follows in terms of P_2:

$$P_1^* = C_1 + \frac{1 + W(x)}{\beta_1}, \tag{C.2}$$

$$S_1^* = \frac{W(x)}{1 + W(x)}, \tag{C.3}$$

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

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: $\boldsymbol{P_1 \leq}$ subsidy cap, $\boldsymbol{P_2 \geq}$ 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

$$P_1^* = C_1 + \frac{1 + W(x)}{.25\beta_1}, \tag{C.4}$$

$$S_2^* = \frac{W(x)}{1 + W(x)}, \tag{C.5}$$

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

$$P_1^* = C_1 + \frac{1 + W(x)}{.25\beta_1}, \tag{C.6}$$

$$S_2^* = \frac{W(x)}{1 + W(x)}, \tag{C.7}$$

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

Since the simultaneous pricing game plan 1 and 2 play is symmetric, I 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.

C.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:

$$P_1 \geq .96(w_1 P_1 + w_2 P_2),$$

$$P_2 \geq .96(w_1 P_1 + w_2 P_2).$$

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:

$$\mathcal{L}(P_1, \lambda_1, \lambda_2)$$
$$= (P_1 - C_1)D_1 + \lambda_1(P_1 - .96(w_1 P_1 + w_2 P_2)) + \lambda_2(P_2 - .96(w_1 P_1 + w_2 P_2)).$$

The two corner solutions are $P_1 = .96(w_1 P_1 + w_2 P_2)$ and $P_2 = .96(w_1 P_1 + w_2 P_2)$, 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:

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

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 2.3.3 in the sense that plan 1 and plan 2 switch roles here as compared to case 1. The two inequality constraints are now:

$$P_1 \leq .96(w_1P_1 + w_2P_2),$$
$$P_2 \geq .96(w_1P_1 + w_2P_2).$$

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

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

$$P_1 \leq .96(w_1 P_1 + w_2 P_2),$$

$$P_2 \leq .96(w_1 P_1 + w_2 P_2).$$

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.

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