Labor Supply Response to Income Cutoffs of Health Insurance in the Massachusetts Reform*  

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Abstract

This paper analyzes the labor supply response to income cutoffs of a subsidized health insurance program in the Massachusetts reform. Subsidies in the program are based on household income and have explicit income cutoffs. This feature creates nonlinear budget constraints for the households' consumption, and potentially distorts their income and labor supply. I test the existence of income manipulation using the regression discontinuity approach. Using data from the American Community Survey, I find clear evidence of income manipulation around the cutoffs of 150 percent and 300 percent Federal Poverty Level (FPL). The manipulation around the 150 percent FPL, which is the first cutoff and falls between plans with zero and non-zero out-of-pocket premiums, is concentrated among the self-employed. The manipulation around the 300 percent FPL, which is the cutoff with the largest cost difference for enrollees, is concentrated among wage workers. Based on the discontinuity evidence, I estimate the elasticity of labor supply with respect to wage rate, and calculate the welfare loss due to the subsidized program.

Keywords: Massachusetts Health Reform, Health Insurance Subsidy, Labor Supply Response

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1 Introduction

Massachusetts enacted a comprehensive health care reform in 2006, which then served as a template for the national health care reform in 2010 through the Affordable Care Act (ACA). There were several new provisions implemented to extend health insurance coverage in both reforms. One of them is a public program that provides subsidies to low- and middle-income households to reduce their premium contribution and cost-sharing. These subsidized programs involve large numbers of enrollees as well as huge amounts of government funding. The Congressional Budget Office (2011) projected that there will be approximately 8 million enrollees receiving subsidies in the national reform, and that the impact of the subsidies and related spending on the federal budget deficit would keep increasing for years, from $23 billion in 2014 to $137 billion in 2021.

The labor supply response of the population who are potentially affected by this provision is important to both policymakers and researchers in at least three aspects. First, eligibility of the program is based on family income, and people may manipulate their income in order to be eligible for the subsidy, so the projection of the number of enrollees is essential in the sense of estimating whether the budget is enough to support and sustain the program. Having a larger eligible population will affect the costs and the efficiency of redistribution. According to a report published by the Health Connector, the authority in charge of the program in Massachusetts, in 2006 the legislative conferees estimated the spending for the subsidized program would be $725 million in fiscal
year 2009, and the real spending turned out to be $805 million. They claimed that the difference came from the number of eligible enrollees for the program.

The second aspect is the labor supply effect. Change of labor supply is the main method to change income if people have the incentive to manipulate it. People can work fewer hours or even quit jobs in order to decrease income. Therefore both the intensive and extensive margin in the labor market may be affected by the subsidized program.

The third issue is the effect of the change of individual characteristics of those in the publicly funded programs. The incentive to manipulate income is affected by individual characteristics, such as health status, and the condition of characteristics can be different from policymakers’ original projections. This feature will further affect both the size of subsidies (for example, a sick population costs more than a healthy population), and program designs such as premiums and benefits.

In this paper, I investigate the behavioral response to the subsidized program in the Massachusetts reform, and use the results to project the impact of the subsidized program in the national reform. There are four specific goals to this research.

First, I investigate the regulations of the program in the Massachusetts reform, and evaluate people’s incentives to manipulate their incomes. The subsidies of the program are based on explicit household income cutoffs, so it generates a piecewise subsidy schedule. There are four income cutoffs: 150 percent
of the Federal Poverty Level (FPL), 200 percent FPL, 250 percent FPL, and 300 percent FPL. People with household incomes more than 300 percent FPL are not eligible for the subsidized program. Households with incomes in different ranges enroll in different insurance plans that vary at two dimensions: the out-of-pocket premium and the generosity. Generally speaking, the plans for low-income households have a lower out-of-pocket premium and are more generous than the plans for middle-income households. I estimate that the cost difference between the plans above and below the cutoffs of 150 percent FPL, 200 percent FPL, 250 percent FPL, and 300 percent FPL are $546, $643, $468, and $1,468 per year per person, respectively. Based on the plan information, I conclude that people with incomes around the cutoffs indeed have incentives to manipulate their income in order to be eligible for higher subsidies.

Second, I provide empirical evidence of the income manipulation using the data from the American Community Survey (ACS). A Regression Discontinuity (RD) estimation method is applied to test for a discontinuity of income distribution, which I interpret as evidence of income manipulation. The approach, developed by McCrary (2008), is based on the assumption that the density of the income would be continuous at the cutoffs without program intervention, and the density is likely to be discontinuous when people are able to manipulate their income. I find significant discontinuity around 150 percent FPL, which is the first cutoff, and 300 percent FPL, which is the cutoff with the largest cost difference. By investigating data for sub-groups, I find that the discontinuity
around the 150 percent FPL cutoff is concentrated by the self-employed, and the discontinuity around the 300 percent FPL is concentrated by the wage workers. The results show no discontinuity at other income cutoffs.

Third, I construct a structural model to estimate the labor supply elasticity. The model is based on the utility function used by Seaz (2010), and I extend it by adding uncertainty about wage income to his model. I derive an expression to show that utility maximization effort levels are affected by the labor supply elasticity and other observables and parameters. Since the effort level decides the income level when I assume wage rate is fixed, the expression is applied empirically to estimate labor supply elasticity using the income distribution and other information. I estimate the labor supply elasticity and the variation of income at all income cutoffs, and for different groups of population. I find that the labor supply elasticity is around zero for all types of workers, which means that the labor supply is inelastic with respect to the change of wage rate.\(^1\) I also find that the standard deviation of the income is about 0.1 percent of total income in the measure of FPL. For a single person, the FPL is about $10,000, so the standard deviation of income is about $10 for a household with a single person.

Fourth, I discuss the method of simulating the welfare impact of the Massachusetts reform and projecting the behavioral response of the national reform.

\(^1\)The zero labor supply elasticity does not mean there is no income manipulation. People have incentive to manipulate their income when the income is less than the cutoff plus the cost difference. The elasticity affects further ranges of income that are affected by the program, as well as the optimal effort level people choose.
For the Massachusetts reform, I calculate welfare loss based on different subsidy schedules. Based on the size of the subsidy for each type of household, I calculate the magnitude of income manipulation at each cutoff. The behavioral response of the whole population is then calculated by aggregating the impact of income manipulation at all cutoffs and for all households. This method incorporates the variation of the income cutoffs, the subsidies, and the income distributions, so it can be applied both nationwide and to separate states with different policies.

My work contributes to understanding the impact of the Massachusetts health reform and the national reform. A large body of work in health economics analyzes effects of different features of the Massachusetts reform (Ericson and Starc (2012), Chan and Gruber (2010), Chandra et al. (2010), Graves and Gruber (2012), Hackmann et al. (2012), Kolstad and Kowalski (2010 and 2012), Long et al. (2010), and Miller (2012)), such as premium change, the elasticity of plan choice, and the impact of the reform on young adults. This paper is the first research investigating the labor supply response to the subsidized program for low- and middle-income households on the health reform.

This study also contributes to the literature on the incentive effects of the U.S. welfare system and the labor supply effects of health insurance. Moffitt (1992) provided a review on the effects of welfare programs, including Medicaid, on work incentives, welfare dependency, family structure, migration, and inter-generational transmission of dependency. Winkler (1991) found that Medicaid
had disincentive effects on female head labor supply, and Moffitt and Wolfe (1992) found significant negative effects of Medicaid benefits on the employment rate. This conclusion is consistent with previous findings that incentives are negatively affected by the welfare benefit. Gruber and Madrian (2004) provided a critical review of the empirical literature on the relationship between health insurance, labor supply, and job mobility, and they concluded that health insurance is an important factor in labor supply decisions of secondary earners.

Saez (2010) is the study closest to my research. He focuses on the behavioral response at the kink points generated by the U.S. tax schedule, and finds the bunching evidence around the first kink point of the Earned Income Tax Credit. He also uses the bunching evidence to estimate compensated elasticity of reported income with respect to the marginal tax rate. His model is designed for a continuous subsidy schedule and cannot be directly applied to cases with a discontinuous subsidy schedule. My model thus contributes to the literature on estimation of labor supply elasticity under a discontinuous subsidy schedule. There are two differences between the Saez (2010) model and the model I use in this paper. First, his approach requires a subjective setting on the bandwidth in which bunching occurs. In my approach, I directly establish a maximum likelihood estimation (MLE) model and estimate it, which eliminates the subjective factors involved. Second, he assumes that people are not aware of the income uncertainty they face, while in my model, I assume that people are aware of the income uncertainty and hence try to manage the risk of not receiving the
subsidy by further lowering their labor supplies.

Other studies focus on the behavioral response at the kink points generated by other public programs. Friedberg (2000) finds that the Social Security earnings test creates a non-linear budget set for those who receive Social Security benefits; the non-linear feature causes people to bunch just below the kink. Friedberg (2000) uses the bunching evidence to estimate the labor supply elasticity of working hours with respect to wage and income. Brown (2006) works on the California teacher’s pension benefit and estimated the elasticity of retirement age with respect to the price of retirement. My work is similar to theirs in the sense that I focus on the behavioral response of a policy that creates nonlinear budget sets, although the estimation strategy I apply is different from what they use.

The paper is organized as follows. Section 2 introduces the policy of the welfare programs in Massachusetts reform. Section 3 presents the graphical evidence of the income manipulation. Section 4 shows the structural model and estimation results on elasticity. Section 5 discusses the welfare impact and the implications for national reform. Section 6 concludes.
2 Subsidized Health Insurance Program in the Massachusetts Health Reform

In the Massachusetts reform, people are required to purchase a plan if they are verified affordable, or they have to pay a penalty. In 2007, the penalty was $219, and in later years the penalty was up to 50 percent of the lowest cost health insurance premium available through the Health Connector.\(^2\) Three programs are provided to the non-elderly population who are not covered by the Employer Sponsored Health Insurance: MassHealth, Commonwealth Care (CommCare), and Commonwealth Choice (CommChoice). MassHealth is the Medicaid program in Massachusetts that provides free health insurance to low-income individuals. CommCare is a subsidized program through which individuals with low and medium income are able to purchase government-subsidized plans. CommChoice is the unsubsidized program. People who are not eligible for either MassHealth or CommCare can purchase a plan in CommChoice and pay the full premium. This paper focuses on the CommCare program.

There were 165,000 enrollees in the CommCare program by the end of March 2009, and the spending for the program was $805 million in fiscal year 2009. There are several plans provided by different insurance firms in each category. For example, in 2011 there were five plans provided separately by BMC HealthNet, CeltiCare, Fallon Community, Neiborhood, and Network. The plans in the

\(^2\)The information on the regulation in the health reform comes from reports published by the Division of Health Care Finance and Policy (2008-2010), and the Massachusetts Health Connector and the Department of Revenue (2007-2009).
same category vary at several dimensions, such as provider network and premium. In order to make the choices comparable, I focus on the plans with the lowest premium in each category, which are actually all from the same insurance firm. There are four income cut-offs if enrollees choose the cheapest plan: 150 percent of the FPL, 200 percent FPL, 250 percent FPL, and 300 percent FPL, and therefore there are four income categories generated: 0-150 percent FPL, 150-200 percent FPL, 200-250 percent FPL, and 250 percent-300 percent FPL.³ People with household incomes more than 300 percent FPL are not eligible for CommCare.

Table 1 shows the cost difference for people in various income ranges should they obtain a plan in the program. The out-of-pocket premium and cost-sharing are the two main characteristics that vary across those income categories. The amount of the premium is shown in the first row. In October 2008, the full premium is $396 per month for plan in all categories, and enrollees’ out-of-pocket premiums are $0, $39, $77, and $116 per month if their household incomes are within 0-150 percent FPL, 150-200 percent FPL, 200-250 percent FPL, and 250 percent-300 percent FPL, respectively. If household incomes are more than 300 percent of FPL, people are only eligible for plans in the unsubsidized market, CommChoice, or pay a penalty. In 2007, the penalty was $219 per person. Since 2008, the penalty is up to 50 percent of the lowest cost health insurance premium available through the market. In CommChoice three types of plans

³In 2008, the FPL for a family with a single person was $10,400, and the amount increases by $3,600 with a next person included in the family.
are provided with different generosities: Bronze, Silver, and Gold plans. The
generosity of the 250-300 percent plan in CommCare is between the Bronze and
the Silver plans in CommChoice, so individuals need to pay $199 (the premium
of the Bronze plan with the lowest cost) to $277 (the premium of the Silver plan
with the lowest cost) per month in order to obtain a comparable plan.\footnote{Premiums are the lowest priced plans available for a 35-year-old individual living in Boston. Data are rounded to the nearest whole dollar.}

The amount of cost-sharing is shown in the second row of Table 1. Plans vary
at several dimensions, such as copayment, coinsurance rate, and out-of-pocket
maximum. For example, in 2011, the plan for 100 percent-150 percent FPL has
no copayment, no coinsurance, and a $200 maximum out-of-pocket payment for
drugs, while the plan for 200 percent-250 percent FPL has a copayment range
from $15 to $250, according to different services, 10 percent coinsurance for
medical equipment, and an $800 maximum out-of-pocket payment for drugs.
Generally speaking, the plans in lower income categories are more generous
than those in higher income categories. Some assumptions are needed in order
to estimate the amount of out-of-pocket cost enrollees bear; the details are
shown in Appendix A1. For a typical consumer, the amount of cost-sharing is
$0, $78, $265, and $265 per year if their household incomes are within 0-150
percent FPL, 150-200 percent FPL, 200-250 percent FPL, and 250 percent-300
percent FPL, respectively.

Therefore, the total out-of-pocket costs for consumers are $0, $546, $1,189,
and $1,657 in four plan tiers, and the cost difference is estimated for a typical
enrollee between plans at each income cutoff. The difference is $546, $643, $468, and $1,468 at the cutoff 150 percent FPL, 200 percent FPL, 250 percent FPL, and 300 percent FPL, respectively. They are shown in the third and fourth rows of Table 1. The cost differences provide enough incentive for people with a household income around those cutoffs to lower their income. For example, the 150 percent FPL was $21,000 for a family of two in 2008. If both family members need to purchase plans from the CommCare program, the cost difference can be as high as $1,092 per year. If their household income is between $21,000 and $22,000, without considering other effects, such as the disutility of working, they have the incentive to manipulate their income below $21,000 in order to enroll in the plans for 0-150 percent FPL.

3 Regression Discontinuity on Income Distribution

3.1 Methodology

Several other works use traditional histogram techniques to show graphical evidence of manipulation of earnings, such as Saez (2010) and Friedberg (2000). However, I apply another approach, Regression Discontinuity (RD), in this analysis since it focuses on the change in the income distribution before and after the implementation of the subsidized program, not a static status of the income distribution. Another benefit of the RD estimation is that it allows for point
estimation and inference.

This approach was developed by McCrary (2008) and is based on the assumption that the density of the income would be continuous at the cutoffs without program intervention, and that the density is likely to be discontinuous when people are able to manipulate their income. As McCrary (2008) states, the estimation proceeds in two steps. In the first step, a finely gridded histogram is obtained. In the second step, the histogram is smoothed by using local linear regression separately on either side of the cutoff. Specifically, McCrary (2008) proposes a formal test on the hypothesis that the discontinuity of the “running variable” at the cutoff is zero. The test is based on an estimator for the discontinuity, $\theta$, which is defined as the log difference between the left limit and the right limit of the density at the cutoff of the running variable. Specifically, the form is

$$\theta = \ln \lim_{I \downarrow c} f(I) - \ln \lim_{I \uparrow c} f(I) \equiv \ln f^+ - \ln f^-$$

where $I$ is the running variable (in my case, income), $f(\cdot)$ is the density function,
and \( c \) is the cutoff. The parameter \( \hat{\theta} \) is estimated as

\[
\hat{\theta} \equiv \ln \hat{f}^+ - \ln \hat{f}^-
\]

\[
= \ln \left\{ \sum_{x_j > c} K(\frac{X_j - c}{h}) \frac{S_{n,2}^+ - S_{n,1}^+ (x_j - c)}{S_{n,2}^+ S_{n,0}^+ - (S_{n,1}^+)^2} Y_j \right\}
\]

\[
- \ln \left\{ \sum_{x_j < c} K(\frac{X_j - c}{h}) \frac{S_{n,2}^- - S_{n,1}^- (x_j - c)}{S_{n,2}^- S_{n,0}^- - (S_{n,1}^-)^2} Y_j \right\}
\]

where \( S_{n,k}^+ = \sum_{X_j > c} K((X_j - c)/h)(X_j - c)^k \) and \( S_{n,k}^- = \sum_{X_j < c} K((X_j - c)/h)(X_j - c)^k \).

McCrary (2008) proves that the \( \hat{\theta} \) has the following normal distribution if certain conditions are satisfied:

\[
\sqrt{nh}(\hat{\theta} - \theta) \overset{d}{\rightarrow} N(B, \frac{5}{24}(\frac{1}{f^+} + \frac{1}{f^-}))
\]

where \( B = \frac{H}{20}(-\frac{f''^+}{f^+} - -\frac{f''^-}{f^-}) \), \( n \) is the number of observations, \( h \) is bandwidth, and \( h^2 \sqrt{nh} \rightarrow H \in [0, \infty) \).

### 3.2 Data

This paper uses data from the American Community Survey (ACS), which is part of the Decennial Census Program by the U.S. Census Bureau.\(^5\) It includes

\(^5\)To my knowledge, ACS is the only available data that is large enough to support this analysis, since it
monthly rolling samples of households. Nationally-representative data have been available each year since 2000. I use the sample from 2005 and 2008 that includes observations in both pre-reform and post-reform periods. The survey selected 1-in-100 sample households from the population; the sample size in Massachusetts is around 27,000 households (65,000 individuals) each year. I exclude individuals under the age of 19, who would be eligible for Medicaid if their household income is below 300 percent FPL, and individuals older than 64, who would be eligible for Medicare. I also exclude individuals with very high income (above 1,500 percent FPL) who would not be affected by the program. Samples from Connecticut and other years are also included for the robustness check.

Figure 1 shows the histograms of income distribution by FPL in 2005, which is the pre-reform period, and in 2008, the post-reform period, for the income range 0-500 percent FPL. The blue columns show the frequency of people with incomes just below each cutoff.

Table 2 shows the descriptive statistics for the population in Massachusetts in 2005 and 2008 separately. The number of observations is 36,358 in 2005 and 36,231 in 2008. Mean age and household income are presented in the table, as well as the percentage of the population that falls in the income ranges of the subsidized program. The table also shows the statistics on sub-group focuses on income distribution. The ideal data is the income tax data from the IRS, which has both a large enough sample size and less measurement error than the ACS data. However, the full sample income tax data was not available during the time I was finishing the project. The analysis can be replicated using the tax data when it is available in the future.
populations by working status (wage worker, self-employed, and unemployed) and age (young being 19-35 and old being 36-64). In 2005 the distribution of income for the wage worker group is almost the same as that of the self-employed, while in 2008 a larger fraction of the self-employed population has an income below 150 percent FPL than the case for the wage workers.

### 3.3 Graphical Evidence

Figure 2 reports the RD estimation at the first income cutoff of 150 percent FPL in Massachusetts in 2005 (Figure 2A) and 2008 (Figure 2B). The x-axis is the income level as percent of FPL, and the y-axis is the income density. Dots represent the density at each income level from 0 percent to 1,500 percent FPL. The curves are the local linear regression estimates using a triangle kernel based on the income density. The 95 percent of confidence interval is also shown. The optimal binsize and bandwidth are selected automatically by the program provided by McCrary (2007). Figure 2A shows the results in 2005 when the program had not been implemented, and there is no significant discontinuity at the cutoff. The estimation on \( \hat{\theta} \), which is the log difference of the density limit from above and below the cutoff, is 0.034 with a standard deviation of 0.046, so the hypothesis that the discontinuity is zero at the cutoff of 150 percent in 2005 cannot be rejected. In contrast, in Figure 2B there is clear evidence of discontinuity at the cutoff in 2008 after the program is implemented. It shows
that the left limit of the log density is higher than the right limit at the cutoff. The estimation on $\hat{\theta}$ is -0.198 with a standard deviation of 0.046, therefore the hypothesis that the discontinuity is zero at the cutoff is rejected. Examining the results in both years, it is concluded that the income manipulation exists that some people lowered their incomes below the cutoff in the post-reform period.

One concern of the analysis is that the income manipulation may be caused by other policy changes. There are indeed other programs introduced during the same period that may create incentives for income manipulation. However, according to my knowledge, there is no program that generates the same income cutoffs that CommCare does. Therefore, the behavioral response is likely caused by the subsidized program if I observe the discontinuity only around the income levels that are cutoffs of the subsidized program. For this reason, I run the RD estimation at each income level. I estimated $\hat{\theta}$ in 2005 and 2008, denoted as $\hat{\theta}_{05}$ and $\hat{\theta}_{08}$, as well as the standard deviation, denoted as $\hat{\sigma}_{05}$ and $\hat{\sigma}_{08}$. Figure 3 shows the results. The x-axis is the income level as percent of FPL, and the y-axis is the estimation of $\hat{\theta}$. The top figure is for 2005 and the bottom figure is for 2008. The solid line reports the RD estimation on $\hat{\theta}$ at every integer point of the income ranging from 50 percent FPL to 500 percent FPL, which means that each point in the figure represents an RD estimation. The 95 percent confidence interval is also reported using dotted lines based on the estimation of the standard deviation.

It is possible that other programs have already distorted the income distri-
bution, so I focus on the change of income distribution between the pre-reform period and the post-reform period, not the static distribution at a given year. I define the difference of two \( \hat{\theta}_s \), \( \hat{\theta}_{diff} \), as \( \hat{\theta}_{diff} = \hat{\theta}_{08} - \hat{\theta}_{05} \), and the standard deviation of \( \hat{\theta}_{diff} \) as \( \hat{\sigma}_{diff} \). The samples from the two years are not correlated, since they are selected independently each year, so \( \hat{\sigma}_{diff} \) is calculated as

\[
\hat{\sigma}_{diff}^2 = \hat{\sigma}_{05}^2 + \hat{\sigma}_{08}^2.
\]

Figure 4 reports the estimation results for \( \hat{\theta}_{diff} \) between samples from 2005 and 2008. The x-axis is the income level as percent of FPL, and the y-axis is the estimation of \( \hat{\theta}_{diff} \). The value of \( \hat{\theta}_{diff} \) is shown in a solid line and the 95 percent confidence interval is shown in dotted lines. There is clear evidence of discontinuity at the cutoffs of 150 percent FPL and 300 percent FPL. 150 percent FPL is the first income cutoff, and Saez (2010) also finds bunching evidence at the first kink point of the Earned Income Tax Credit. In addition, 150 percent FPL is the income cutoff that falls between two types of plans with zero out-of-pocket premiums and $39 out-of-pocket premiums per month. Several previous studies state that people put a greater weight on premium than any other factors when choosing a plan (Abluck & Gruber (2011)), and people prefer to choose the cheapest plan (Ericson and Starc (2012)). This shows that people are sensitive to the choice between the free (cheapest) plan and the non-free plan. 300 percent FPL is the cutoff with the largest cost difference for a typical enrollee. There are costs of manipulating income, so people will change their incomes only when the incentives are large enough. This figure shows no significant discontinuity at other income levels within the range.
I also analyze the discontinuity for various sub-samples: the wage workers versus the self-employed, and the young (ages 19-35) versus the old (ages 36-64). Figure 5 shows the estimation results by working status. The left figure is for the wage workers and the right figure is for the self-employed. There is significant discontinuity around the 300 percent FPL cutoff for wage workers and at the cutoffs between 150 percent-200 percent FPL for the self-employed, and the magnitude of the discontinuity is larger for the self-employed than the wage workers. It is harder for wage workers to lower their incomes, so I only observe the manipulation at the cutoff with the largest cost difference. There are two possible explanations for the larger magnitude of the discontinuity for the self-employed than that for the wage workers. First, the self-employed have higher demand for the subsidized program than the wage workers because many of them are not covered by the Employer Sponsored Health Insurance. Second, it is easier for the self-employed to control their income than it is for wage workers. Both factors contribute to higher incentives for the self-employed to manipulate their income. For people with different age statuses, I expect to see a larger response for the old, since the older population would have a larger incentive to manipulate the income than would the young. This is because the old tend to be sicker than the young, so the same insurance plans are more valuable for the old. Figure 6 shows the results by age. The left figure is for the young and the right figure is for the old. I observe the discontinuity at the cutoffs of 150 percent FPL and 300 percent FPL for both samples, and find that
the two groups behave similarly to each other.

One concern of the application of this approach is that the estimation is based on the assumption that the density is continuous at other income levels. In my analysis there are multiple income cutoffs. The subsidized program itself generates four cutoffs, and other programs also generate income cutoffs, such as Medicaid. When I test the hypothesis of discontinuity at a specific cutoff, the results are affected if the income density is discontinuous at other income cutoffs. Two ways can address this problem.

First, according to the estimation strategy, the significance of the discontinuity test at a specific cutoff is weakened by any discontinuity at other income cutoffs caused by people’s behavioral response of changing their income to a lower level. Figure 7 conceptually shows the income density estimation with two income cutoffs and illustrates how the discontinuity at one cutoff affects the test at the other. The dashed line represents the income density in the pre-reform period when there is no subsidized program, so the density is smooth at the cutoffs. The solid line represents the income density in the post-reform period when income manipulation at the two cutoffs exists. The target is to test the hypothesis of the discontinuity at cutoff B. If the density at cutoff A is smooth, the density estimation at cutoff B is shown as the solid black line. However, if the density at cutoff A is discontinuous, the density estimation to the left of cutoff B becomes smaller, as shown in the solid gray line. A triangle kernel is applied to the estimation. When estimating the density at the left
of cutoff B, the decreased impact from the right of cutoff A is larger than the increased impact from the left of cutoff A. The test of the discontinuity at the cutoff B becomes less significant when the income density is discontinuous at cutoff A. The impact is similar when cutoff A is located to at the right of cutoff B, since the density estimation at the right of cutoff B is increased.

Second, I also vary the bandwidth of the kernel estimation to check the sensitivity of the impact from the other cutoffs. The bandwidth for the previous analysis is chosen automatically by the program provided by McCrary (2007), and is around 150 percent FPL. Another two bandwidths, 100 percent FPL and 50 percent FPL, are selected in the estimation and the results are shown in Figure 8. I find that the discontinuity at 150 percent FPL and 300 percent FPL is significant in each case.

Two other types of robustness checks are done in order to verify the causality between the subsidized program and the income discontinuity. One is the RD estimation in the control state, Connecticut, where the population has a similar demographic distribution to the population in Massachusetts. Figure 9 shows the estimation results on $\hat{\theta}_{diff}$ between 2005 and 2008 in Connecticut. There are slight discontinuities around the cutoffs 100 percent FPL, 125 percent FPL, 150 percent FPL, and 300 percent FPL, which may be due to other policy changes between the two periods, but the magnitude of the discontinuities is smaller than that in Massachusetts. Figure 10 shows the the estimation results on $\hat{\theta}_{diff}$ using samples from other years. The left figure shows the results between 2005
and 2007, and the right figure shows the results between 2005 and 2009. I do not find significant discontinuity at the 150 percent cutoff in other years, but the discontinuity at the 300 percent FPL is consistent through the years.

4 Elasticity Estimation

In this section, I construct a structural model to estimate the labor supply elasticity with respect to wage rate. The goal of my approach largely resembles that in Saez (2010), in that both try to assess the elasticity of labor supply. There are two major differences in methodology, however. First, Saez (2010) observes a bunching pattern in the distribution of income and establishes a correspondence between elasticity and this pattern. This approach requires a subjective setting on the bandwidth in which bunching occurs. In my approach, I directly establish an MLE model and estimate it. This eliminates subjective factors involved in Saez (2010). Second, Saez (2010) assumes that when agents choose their labor supply level, they are unaware of the income uncertainty they face, and hence choose the level so that the expectation of their incomes lies exactly below the cutoff. At the same time, he argues that in reality there is an uncertainty that affects the actual income agents receive. Agents do not rationally expect to be able to control their income. In my model, I assume that people are aware of the income uncertainty they face and hence try to manage the risk of not receiving the subsidy by further lowering their labor
supplies. From the perspective of a researcher, I am able to detect the degree of uncertainty in my model.

In the following part, Section 4.1 shows the model, Section 4.2 shows the estimation strategy, and Section 4.3 provides the estimation results.

4.1 Structural Model

Suppose there is a population of heterogeneous agents. Each agent $i$ has an ability of $b_i$. An agent has a utility function of two components, income $I_i$ and labor $z_i$. Her utility can be represented by a quasi-linear and iso-elastic function that has the same form as the utility function used by Saez (2010),

$$v_i(I_i, z_i) = I_i - \frac{b_i}{1 + \frac{1}{\varepsilon}} \left( \frac{z_i}{b_i} \right)^{1+\frac{1}{\varepsilon}},$$

where $\varepsilon$ is the labor supply elasticity.

There are two potential sources of income: the wage income, $W_i$, and the subsidy, $S_i$:

$$I_i = W_i + S_i.$$

The expected wage income is proportional to labor, with wage rate $w$. A disturbance of $e_i$ also contributes to the wage income. The total wage income is
\[ W_i = wz_i + e_i, \]

where the error term \( e_i \) has normal distribution, \( e_i \sim N(0, \sigma^2) \), and is i.i.d.

A subsidy of \( a_i \), depending on family characteristics, is granted when the wage income is below an income cutoff, \( I^* \):

\[
S_i = \begin{cases} 
  a_i & \text{if } W_i \leq I^* \\
  0 & \text{if } W_i > I^* 
\end{cases}.
\]

Therefore the expected utility can be deduced as

\[
Eu_i(z_i) = Ev_i(I_i(z_i), z_i) = wz_i + P(e_i \leq I^* - wz_i) \cdot a_i - \frac{b_i}{1 + \frac{1}{\varepsilon}} \left( \frac{z_i}{b_i} \right)^{1 + \frac{1}{\varepsilon}}.
\]

When there is no subsidy, i.e., \( a_i = 0 \), the first-order condition (F.O.C.) is

\[
w = (1 + \frac{1}{\varepsilon}) \cdot \frac{1}{b_i} \cdot \frac{b_i}{1 + \frac{1}{\varepsilon}} \cdot \left( \frac{z_i}{b_i} \right)^{\frac{1}{\varepsilon}}.
\]  

Re-arranging equation (1) yields \( \varepsilon = \frac{\partial \ln z_i}{\partial \ln w} \), which shows that \( \varepsilon \) is the elasticity of labor with respect to the wage.

I focus on the impact of subsidy to labor supply, so it is convenient to set \( w = 1 \). In this case, the labor supply is \( z = b \) when there is no subsidy, which means that people will make their effort levels equal to their abilities when there
is no subsidy.

Where there is a subsidy, the utility function is deduced as

\[ Eu_i(z_i) = Ev_i(I_i(z_i), z_i) = z_i + \Phi\left(\frac{I^* - z_i}{\sigma}\right) \cdot a_i - \frac{b_i}{1 + \frac{1}{\varepsilon}} \left(\frac{z_i}{b_i}\right)^{1+\frac{1}{\varepsilon}}. \]

Maximize utility function using F.O.C., and it becomes

\[ 1 + \left(\phi\left(\frac{I^* - z_i}{\sigma}\right)(-1)\right) \cdot a_i - \frac{b_i}{1 + \frac{1}{\varepsilon}} \left(1 + \frac{1}{\varepsilon}\right) \left(\frac{z_i}{b_i}\right)^{\frac{1}{\varepsilon}} = 0 \]

\[ \Rightarrow 1 - \phi\left(\frac{I^* - z_i}{\sigma}\right) a_i - \left(\frac{z_i}{b_i}\right)^{\frac{1}{\varepsilon}} = 0. \quad (2) \]

The optimal effort level \( z \) is implicitly determined by equation (2), and is determined jointly by \((\varepsilon, \sigma, b, a, I^*)\). \((\varepsilon, \sigma)\) are the parameters I estimate, and \(I^*\) is the income cutoff of the subsidized program that is exogenous in the model. \(\varepsilon, \sigma\) and \(I^*\) are the same for all the population, and the ability and the subsidy, \(b\) and \(a\), are family-specific characteristics. There is no explicit function \(z(b, a|\varepsilon, \sigma, I^*)\) that maximizes this utility function, but it can be numerically solved, and I denote it as \(z(b, a)\) for short.

4.2 Estimation Strategy

MLE is used to estimate the parameters. Assume the distribution of ability, \(g(b)\), is stable over time. The density function of a family, with characteristics \(x_i\) and an income \(I_i\), is
\[ f_i(I; g(\cdot), \sigma, \varepsilon, x_i) = \int_0^\infty g(b) \cdot \phi\left( \frac{I_i - z(b, a(x_i))}{\sigma} \right) db. \]

Hence the likelihood function is

\[ l(\sigma, \varepsilon, g(\cdot)|I, x) = \frac{1}{N} \sum_{i=1}^N \ln \int_0^\infty g(b) \cdot \phi\left( \frac{I_i - z(b, a(x_i))}{\sigma} \right) db. \]

In practice, it is hard to identify the whole shape of \( g(\cdot) \). Instead, I assume that the ability is distributed on a set of discrete points \( \{b_1, b_2, \ldots, b_j, \ldots, b_J\} \).

The probability of ability being \( b_j \) is \( g_j \), and I denote \( z_j(a) = z(b_j, a) \) and \( g = \{g_1, g_2, \cdots, g_j, \cdots, g_J\} \), then the likelihood function becomes

\[ l(\sigma, \varepsilon, g|I, x) = \frac{1}{N} \sum_{i=1}^N \ln \sum_{j=1}^J g_j \cdot \phi\left( \frac{I_i - z_j(a(x_i))}{\sigma} \right). \]

Of the people with eligible income, only a fraction, \( p \), of them are affected by the program, so the log likelihood function becomes

\[ l(\sigma, \varepsilon, g|I, x) = \frac{1}{N} \sum_{i=1}^N \ln \sum_{j=1}^J g_j \cdot \left[ p \phi\left( \frac{I_i - z_j(a(x_i))}{\sigma} \right) + (1 - p) \phi\left( \frac{I_i - b_i}{\sigma} \right) \right]. \]

with constraints \( \sigma > 0 \) and \( \varepsilon > 0 \).

The ability distribution \( g \), the labor supply elasticity \( \varepsilon \), and the income variation \( \sigma \) are estimated based on the income distribution \( I \), the subsidy \( a \), and the family characteristics \( x \).
4.3 Empirical Estimation and Results

The subsidy, or the cost difference between different plans, \( a \), is determined by the program regulation and family characteristics. I estimate the cost difference at each income cutoff for a typical individual based on the policy in Section 2. The cost difference varies by the family structures as well. For example, the benefit of lowering the income below the cutoff doubles for a family with two adults enrolling in the program as compared to a family with only one adult enrolling in the program.\(^6\) In the model, the income is valued not by absolute dollar amount, but in the percentage of FPL, and the cost difference is valued in FPL as well. The FPL is adjusted by the family size, so the cost difference is affected by the family size too. Based on the number of adults in a family and the family size, I calculate the cost difference at each income cutoff for families with different structures. The results are shown in Table A.

I estimate the fraction of people who were enrolled in the subsidized program, CommCare, in the selected sample using statistics published by the government. The total sample in the ACS in 2008 is 64,921, and the selected sample used in this analysis is 36,231, so 55.81 percent of the population is included. In 2008, the total population in Massachusetts is 6.469 million, so the selected sample represents 3.610 million. According to the reports published by the Division of Health Care Finance and Policy, as of December 31, 2008, there

\(^6\)The cost difference is not affected by the number of children in a family, because children with family income below 300 percent FPL are eligible for Medicaid.
were 162,725 enrollees in the CommCare program, which equals 4.51 percent of the represented population. There was a total of 16.2 percent of individuals in the selected sample with a household income between 150 percent and 300 percent FPL. If all people with incomes below 150 percent FPL all enrolled in Medicaid, the percentage of people who were enrolled in the CommCare program in the selected sample is 27.84 percent.

Table 3 displays the estimation results at each income cutoff for various samples: whole population, wage worker inclusive, wage worker only, self-employed inclusive, and self-employed only. I include observations within 30 percent FPL around the cutoff in each estimation. The first column shows the number of observations in each scenario. The second column shows the estimation and standard deviation of the labor supply elasticity. I find that the elasticity is almost zero in all the scenarios, which means that the population is inelastic with respect to the change in wage rate.

Although the estimation of the elasticity is zero, this does not mean that people do not have incentive to manipulate their income. Figure 11 illustrates the income ranges affected by the program under different values of labor supply elasticities. According to the model, people with incomes between the income cutoff $I^*$ and the income cutoff plus the subsidy $I^* + a$ will lower their income, even when their labor supplies are inelastic to the wage rate. People with incomes on the cutoff and slightly below the cutoff still have the incentive to control it because they want to keep their income below the cutoff in order to
continue to be eligible for the higher subsidy, regardless of unpredictable changes to income. The elasticity affects the income range within which people have an incentive to lower their income. The higher the subsidy, the more people with incomes above \( I^* + a \) will lower their income. The elasticity also affects the selection of the optimal effort level. The higher the elasticity, the lower the optimal effort will be chosen.

One possible reason for the zero elasticity is that I do not have a large enough sample including those who manipulate their income. The model assumes that everyone is aware of the cutoff regulation of the program and has the ability to alter their income. However, in practice, only some of them are aware of the program and know the cutoffs, and only some of them are able to lower their income even if they have the incentive to do so.

The third column shows the estimation and the standard deviation of the variation of income. The estimation results are around 0.10 for all the scenarios, which is interpreted as 0.1 percent of FPL. For a single person, the FPL is about $10,000, so the standard deviation is about $10. This result means the income variation does not have a large effect on the income manipulation of the subsidized program.

5 Welfare Impact and Implications for the National Reform

It is straightforward that due to the supply side response to the policy, total
production, and hence social welfare, decreases. The dollar value of total welfare loss in Massachusetts, $\Delta I$, can be calculated by multiplying four figures:

$$\Delta I = P \cdot \bar{d} \cdot \alpha \cdot \beta.$$  \hspace{1cm} (3)

In equation (3), $P$ is the population in Massachusetts whose income in 2005 fell between 0 percent FPL and 1500 percent FPL. As calculated in the last section, this figure is 3.610 million.

$\bar{d}$ is the average income change for individuals who actually manipulate their income. The average income changes differ by household structures, specifically, by household size and number of adults in the household. According to the data, two types of family structures, the single person family and the family with two adults, cover more than 60 percent of all samples. According to Table A, the subsidy equals the 5.3 percent FPL for a single person family at the cutoff of 150 percent FPL. Based on the estimation results of the structure model, people with incomes between 149.8 percent and 156.5 percent FPL will change their income to 149.8 percent FPL. Without much loss of accuracy, I assume that people are uniformly distributed within this range so the average income decrease is 3.4 percent FPL. In 2008, the FPL for a single-person family is $10,400, so the average income decrease for singles is $348. Similarly, for two-person families, the subsidy is 7.8 percent FPL, and the affected range is between 149.7 percent and 159.7 percent FPL, so the average income decrease is 10.0 percent FPL. The FPL for couples is $14,000, and the average income
decrease is $700 per household and $350 per individual. Since the two types of households are roughly equally weighted, the average income decrease is $350 per individual with income around 150 percent FPL who actually change the income. The calculation for the 300 percent FPL is similar and the result is $751 per individual.

\( \alpha \) is the percentage of people within the selected sample who have an incentive to manipulate their income as predicted by the model. By calculating the maximization problem for agents of each income, I can determine the range of incomes that is affected by each cutoff. As illustrated above, the range of income that is affected can be predicted by the structural model, and hence \( \alpha \) can be easily estimated by its frequency in the data.

\( \beta \) is the percentage of people who actually change their labor supplies within the range affected. To estimate this value, I calculate the relative difference of \( \alpha \) in 2005 and 2008 and calculate the difference between MA and CT. Specifically,

\[
\beta = \frac{\alpha_{CT,2008} - \alpha_{CT,2005}}{\alpha_{CT,2005}} = \frac{\alpha_{MA,2008} - \alpha_{MA,2005}}{\alpha_{MA,2005}}
\]

Table 4 shows the calculation of \( \beta \) for the 150 percent FPL cutoff. Table 5 shows the welfare loss for the 150 percent FPL and 300 percent FPL cutoffs. The reason I only include these two cutoffs is that the other two cutoffs do not have significant evidence of manipulation. As a result, the total welfare loss due to manipulation is $2.78 million.

For a prediction of the national reform, the new cost difference should be
calculated based on the regulations of the ACA, and the impacted income ranges will be estimated based on the new cost difference and the parameters I estimate. The rest of the process is similar to the welfare calculation, and both the size of the population that is affected by the reform and the welfare loss can be estimated. This methodology incorporates various regulations on the subsidy, such as income cutoffs and cost differences, as well as income distributions, so it can be applied both nationwide and to specific states.

6 Conclusion and Discussion

My analysis has found substantial evidence of income discontinuity at the cutoffs of 150 percent FPL and 300 percent FPL of the subsidized program in the Massachusetts reform. The 150 percent FPL is the first cutoff and the cutoff between plans charging enrollees zero premiums and some amount of out-of-pocket premium; this discontinuity is concentrated among the self-employed. The 300 percent FPL is the cutoff with the largest cost difference, and the discontinuity at this cutoff is concentrated among the wage workers. I conclude that the discontinuity is caused by the subsidized program by doing the RD test at each income level, and by doing the same analysis on a control state and other years in Massachusetts.

I construct a model with income uncertainty to estimate labor supply elasticity as well as income variation. The results suggest that the two factors have
very little impact on the behavioral response to the subsidized program. I simulate the impacted income range under different levels of cost difference based on the estimation results. This simulation is helpful to calculate the welfare loss and to make the projection of the behavioral response to the national reform, and I suggest a methodology to do so. The methodology incorporates various income cutoffs, cost differences, and income distributions, so it can be applied to states with different policy regulations.

Both the Massachusetts reform and the national reform generate welfare loss due to the piecewise subsidy schedule of the programs. One potential improvement is to make the out-of-pocket premium proportional to income, similarly to how rent is charged by many public housing programs for low income families. Under the new schedule, people will no longer have incentives to manipulate their income, and the same budget can be generated from the enrollees if the fraction is selected properly.

The framework of the estimation on elasticity and income variation I propose can be applied to other contexts where a program generates nonlinear budget sets, such as Medicaid and the schedules in the income tax system. A contribution of the framework is that I assume uncertainty of income in the model. People are not always able to perfectly control their income, and I do not observe them controlling their income exactly at the cutoffs. The feature of uncertainty allows the model to predict that people will put the target income lower than the cutoffs, which is closer to how people behave in practice.
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[17] Congressional Budget Office. CBO’s Analysis of the Major Health Care Legislation

in Massachusetts: Key Indicators. Technical Report February, Division of Health Care
Finance and Policy, 2008-2010.


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Table 1: Out-of-Pocket Cost Difference for People in Different Income Ranges

<table>
<thead>
<tr>
<th>Income (% of FPL)</th>
<th>0-150</th>
<th>150-200</th>
<th>200-250</th>
<th>250-300</th>
</tr>
</thead>
<tbody>
<tr>
<td>OOP Premium</td>
<td>$0</td>
<td>$39*12</td>
<td>$77*12</td>
<td>$116*12</td>
</tr>
<tr>
<td>OOP Cost-sharing</td>
<td>$0</td>
<td>$78</td>
<td>$265</td>
<td>$265</td>
</tr>
<tr>
<td>Total OOP Cost</td>
<td>$0</td>
<td>$546</td>
<td>$1,189</td>
<td>1,657</td>
</tr>
<tr>
<td>Cost Difference</td>
<td>$546</td>
<td>$643</td>
<td>$468</td>
<td>$1,468</td>
</tr>
</tbody>
</table>
Table 2: Descriptive Statistics for the Population in Massachusetts in 2005 and 2008 in ACS

<table>
<thead>
<tr>
<th>Age</th>
<th>2005 All</th>
<th>2005 Working Status</th>
<th>2008 All</th>
<th>2008 Working Status</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N</td>
<td>% of the Whole</td>
<td>Wage Worker</td>
<td>Self-employed</td>
</tr>
<tr>
<td></td>
<td>36,358</td>
<td>100.0%</td>
<td>30,047</td>
<td>3,227</td>
</tr>
</tbody>
</table>

**Age**

| Mean | 42.2 | 41.4 | 46.3 | 46.7 |
| 95% CI | 39.6 | 39.7 | 42.7 | 43.7 |

**Young (19-35)**

<table>
<thead>
<tr>
<th>31.4%</th>
<th>34.1%</th>
<th>16.1%</th>
<th>20.9%</th>
</tr>
</thead>
</table>

**Old (36-64)**

<table>
<thead>
<tr>
<th>68.6%</th>
<th>65.9%</th>
<th>83.9%</th>
<th>79.1%</th>
</tr>
</thead>
</table>

**Household Income**

<table>
<thead>
<tr>
<th>Mean</th>
<th>$78,134</th>
<th>$80,181</th>
<th>$82,872</th>
<th>$53,229</th>
</tr>
</thead>
<tbody>
<tr>
<td>Std. Dev.</td>
<td>$52,638</td>
<td>$51,418</td>
<td>$56,289</td>
<td>$53,932</td>
</tr>
</tbody>
</table>

**Below 150% FPL**

<table>
<thead>
<tr>
<th>10.9%</th>
<th>8.8%</th>
<th>8.8%</th>
<th>33.9%</th>
</tr>
</thead>
</table>

**150-200% FPL**

<table>
<thead>
<tr>
<th>4.8%</th>
<th>4.5%</th>
<th>4.9%</th>
<th>8.2%</th>
</tr>
</thead>
</table>

**200-250% FPL**

<table>
<thead>
<tr>
<th>5.2%</th>
<th>4.9%</th>
<th>6.3%</th>
<th>7.1%</th>
</tr>
</thead>
</table>

**250-300% FPL**

<table>
<thead>
<tr>
<th>6.1%</th>
<th>6.0%</th>
<th>6.5%</th>
<th>7.0%</th>
</tr>
</thead>
</table>

**Above 300% FPL**

<table>
<thead>
<tr>
<th>72.9%</th>
<th>75.8%</th>
<th>73.5%</th>
<th>43.7%</th>
</tr>
</thead>
</table>

* The sample only includes the population within the ages of 19-64 and household income 0-1500 percent FPL.
** The calculation of the mean of household income on the individual level, so I put greater weights on larger households than the calculation on the individual level.
Table 3: Estimation Results on Elasticity and Income Variation at Each Income Cutoff

<table>
<thead>
<tr>
<th>Income cutoff</th>
<th>Worker type</th>
<th>N</th>
<th>Elasticity, ε</th>
<th>Standard Deviation of Income, σ</th>
</tr>
</thead>
<tbody>
<tr>
<td>150</td>
<td>All</td>
<td>3946</td>
<td>0.013</td>
<td>0.10</td>
</tr>
<tr>
<td>(120-180)</td>
<td>Wage Worker Inclusive</td>
<td>2167</td>
<td>0.014</td>
<td>0.10</td>
</tr>
<tr>
<td></td>
<td>Wage Worker Only</td>
<td>2001</td>
<td>0.014</td>
<td>0.10</td>
</tr>
<tr>
<td></td>
<td>Self-employed Inclusive</td>
<td>340</td>
<td>0.012</td>
<td>0.09</td>
</tr>
<tr>
<td></td>
<td>Self-employed Only</td>
<td>174</td>
<td>0.012</td>
<td>0.08</td>
</tr>
<tr>
<td>200</td>
<td>All</td>
<td>3928</td>
<td>0.000</td>
<td>0.10</td>
</tr>
<tr>
<td>(170-230)</td>
<td>Wage Worker Inclusive</td>
<td>2558</td>
<td>0.015</td>
<td>0.10</td>
</tr>
<tr>
<td></td>
<td>Wage Worker Only</td>
<td>2321</td>
<td>0.002</td>
<td>0.10</td>
</tr>
<tr>
<td></td>
<td>Self-employed Inclusive</td>
<td>448</td>
<td>0.001</td>
<td>0.09</td>
</tr>
<tr>
<td></td>
<td>Self-employed Only</td>
<td>211</td>
<td>0.012</td>
<td>0.09</td>
</tr>
<tr>
<td>250</td>
<td>All</td>
<td>3893</td>
<td>0.000</td>
<td>0.10</td>
</tr>
<tr>
<td>(220-280)</td>
<td>Wage Worker Inclusive</td>
<td>2791</td>
<td>0.004</td>
<td>0.10</td>
</tr>
<tr>
<td></td>
<td>Wage Worker Only</td>
<td>2470</td>
<td>0.015</td>
<td>0.09</td>
</tr>
<tr>
<td></td>
<td>Self-employed Inclusive</td>
<td>518</td>
<td>0.016</td>
<td>0.09</td>
</tr>
<tr>
<td></td>
<td>Self-employed Only</td>
<td>197</td>
<td>0.011</td>
<td>0.08</td>
</tr>
<tr>
<td>300</td>
<td>All</td>
<td>3968</td>
<td>0.000</td>
<td>0.10</td>
</tr>
<tr>
<td>(270-330)</td>
<td>Wage Worker Inclusive</td>
<td>3128</td>
<td>0.000</td>
<td>0.10</td>
</tr>
<tr>
<td></td>
<td>Wage Worker Only</td>
<td>2775</td>
<td>0.000</td>
<td>0.10</td>
</tr>
<tr>
<td></td>
<td>Self-employed Inclusive</td>
<td>555</td>
<td>0.014</td>
<td>0.09</td>
</tr>
<tr>
<td></td>
<td>Self-employed Only</td>
<td>202</td>
<td>0.012</td>
<td>0.09</td>
</tr>
</tbody>
</table>
Table 4: The Calculation of Percentage of Population Who Actually Changed Income

<table>
<thead>
<tr>
<th>Year</th>
<th>State</th>
<th>0-1,500% FPL</th>
<th>149.7 - 159.7% FPL</th>
<th>α</th>
<th>% Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>2005</td>
<td>MA</td>
<td>36358</td>
<td>350</td>
<td>0.96%</td>
<td>0.96%</td>
</tr>
<tr>
<td>2008</td>
<td>MA</td>
<td>36231</td>
<td>282</td>
<td>0.78%</td>
<td>-19.15%</td>
</tr>
<tr>
<td>2005</td>
<td>CT</td>
<td>18919</td>
<td>163</td>
<td>0.86%</td>
<td>0.86%</td>
</tr>
<tr>
<td>2008</td>
<td>CT</td>
<td>18740</td>
<td>135</td>
<td>0.72%</td>
<td>-16.39%</td>
</tr>
</tbody>
</table>

Diff-in-Diff

2.76%

Table 5: The Calculation of Welfare Loss

<table>
<thead>
<tr>
<th></th>
<th>150% FPL</th>
<th>300% FPL</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>α</td>
<td>0.96%</td>
<td>3.27%</td>
<td></td>
</tr>
<tr>
<td>β</td>
<td>2.76%</td>
<td>2.76%</td>
<td></td>
</tr>
<tr>
<td>P</td>
<td>3,610,000</td>
<td>3,610,000</td>
<td></td>
</tr>
<tr>
<td>dc</td>
<td>$349.5</td>
<td>$751.3</td>
<td></td>
</tr>
<tr>
<td>Welfare Loss</td>
<td>$334,267</td>
<td>$2,447,700</td>
<td>$2,781,967</td>
</tr>
</tbody>
</table>
Figure 1: Individual Income Distribution by FPL in 2005 and 2008
Figure 2: RD Estimation at Cutoff 150 percent FPL in Massachusetts in 2005 and 2008

Figure 2A. 2005, binsize: 3.2, bandwidth: 141.7, \( \hat{\theta} \): 0.034 (0.046)

![Graph for 2005]

Figure 2B. 2008, binsize: 3.3, bandwidth: 143.7, \( \hat{\theta} \): -0.198 (0.046)

![Graph for 2008]

Note: The standard deviation of \( \hat{\theta} \) are shown in the parentheses.
Figure 3: RD Estimation on $\hat{\theta}$ in Massachusetts in 2005 and 2008

Note: The dotted line shows the 95 percent of confidence interval of the estimation of $\hat{\theta}$.

Figure 4: RD Estimation on $\hat{\theta}_{\text{diff}}$ between 2005 and 2008 in Massachusetts: Whole Population

Note: The dotted line shows the 95 percent of confidence interval of the estimation of $\hat{\theta}$.
Figure 5: RD Estimation on $\hat{\theta}_{diff}$ between 2005 and 2008 in Massachusetts: Wage Worker Versus Self-Employed

![Graph showing RD Estimation for Wage Workers and Self-Employed between 2005 and 2008 in Massachusetts.](image1)

Note: The dotted line shows the 95 percent confidence interval of the estimation of $\hat{\theta}$.

Figure 6: RD Estimation on $\hat{\theta}_{diff}$ between 2005 and 2008 in Massachusetts: Young (19-35) and Old (36-64)

![Graph showing RD Estimation for Young (19-35) and Old (36-64) in Massachusetts between 2005 and 2008.](image2)

Note: The dotted line shows the 95 percent confidence interval of the estimation of $\hat{\theta}$. 
Figure 7: Income Density with Two Cutoffs

Figure 8: RD Estimation on $\hat{\theta}_{diff}$ between 2005 and 2008: Bandwidth 100 and bandwidth 50
Figure 9: RD Estimation on $\hat{\theta}_{diff}$ between 2005 and 2008 in Connecticut: Whole Population

![RD Estimation on $\hat{\theta}_{diff}$ between 2005 and 2008 in Connecticut: Whole Population](image)

Note: The dotted line shows the 95 percent of confidence interval of the estimation of $\hat{\theta}$.

Figure 10: RD Estimation on $\hat{\theta}_{diff}$ between 2005 and 2007, and between 2005 and 2009 in Massachusetts: Whole Population

![RD Estimation on $\hat{\theta}_{diff}$ between 2005 and 2007, and between 2005 and 2009 in Massachusetts: Whole Population](image)

Note: The dotted line shows the 95 percent of confidence interval of the estimation of $\hat{\theta}$.
Figure 11: Income Ranges Affected under Different Labor Supply Elasticities

- **Zero Elasticity**
  \[ I^* \quad I^* + a \]

- **Small Elasticity**
  \[ I^* \quad I^* + a \]

- **Large Elasticity**
  \[ I^* \quad I^* + a \]
Appendix

A1. The Estimation of Plan Cost Difference among Different Income Categories

In this part I discuss the process of the estimation of the cost difference for the enrollees among the plans in different income categories. The cost difference comes from two parts: the difference of the out-of-pocket premium and the difference of the plan benefit. The information of the out-of-pocket premium for each plan is available so the former can be directly calculated from that. However, the plan benefit is person specific and is sensitive to the services the enrollees receive, so I can only roughly approximate the average plan benefit.

As I mentioned previously, the out-of-pocket premiums are $0, $39, $77 and $116 per month if their household incomes are within 0-150 percent FPL, 150-200 percent FPL, 200-250 percent FPL and 250 percent-300 percent FPL, respectively, and individuals need to pay $199 to $277 per month in order to obtain a comparable plan in the CommChoice if their household incomes are above 300 percent FPL. For the premium of the plans in the CommChoice, I select the mean of the two premiums, which is $238 per month. Therefore, the out-of-pocket premium differences per year at each income cutoffs are $468, $456, $468 and $1,464 at the cutoffs 150 percent FPL, 200 percent FPL, 250 percent FPL and 300 percent FPL, respectively.

The benefit differences are calculated based on the regulation of plan benefit and the estimation of the enrollees' total health care costs. There are three types of plans that are differentiated at plan benefit. The plans designed for the 0 percent-150 percent FPL has no copayment, zero insurance rates. The plans designed for the 150 percent-200 percent FPL has $10 copayment for the visit to primary care physician, $18 copayment for the visit to the specialist, $50 copayment for the inpatient stay and zero insurance rates. The plans designed for the 200 percent-300 percent FPL has $15 copayment for the visit to primary care physician, $22 copayment for the visit to the specialist, $250 copayment for the inpatient stay and zero insurance rate other than 10 percent for medical equipment. In addition, the plan
benefit varies on other characteristics too, such as the copayment on drug and the maximum out-of-pocket payment. I assume that the generosity of the plan in the CommChoice is the same as the plan for the 200 percent-300 percent FPL. In order to calculate the real plan benefit, I need to make assumption on a typical enrollee’s total spending and services per year. The plan cost is $4,752 per year, since the full plan premium is $396 per month. This amount is the cost covered by the plan and enrollees will pay a small fraction as out-of-pocket payments. I assume that the total cost is $5,000 per person per year, and the services includes one visit to primary care physician, one visit to the specialist and one event of inpatient stay. Therefore the typical person has to pay $0 if he enrolls the plan for the 0 percent-150 percent FPL, $78 for plan of the 150 percent-200 percent FPL and $265 for the plans above 200 percent FPL, and the benefit differences are $78 at the 150 percent FPL and $187 at the 200 percent FPL.

I sum the out-of-pocket premium difference and the plan benefit difference together, and the cost differences for a typical enrollee at each income cutoff are $546, $643, $468 and $1,468 at the cutoff 150 percent FPL, 200 percent FPL, 250 percent FPL and 300 percent FPL, respectively.
Table A. The cost difference as 1% FPL for families with different structures

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