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ABSTRACT

The prevalence of obesity has been rising dramatically in the U.S., leading to poor health and rising health care expenditures. The role of policy in addressing rising rates of obesity, however, is controversial. Policy recommendations for interventions intended to influence body weight decisions often assume the obesity creates negative externalities for the non-obese. We build on earlier work demonstrating that this argument depends on two important assumptions: 1) that the obese do not pay for their higher medical expenditures through differential payments for health care and health insurance, and 2) that body weight decisions are responsive to the incidence of medical care costs associated with obesity. In this paper, we test the latter proposition – that body weight is influenced by insurance coverage - using two approaches. First, we use data from the Rand Health Insurance Experiment, in which people were randomly assigned to varying levels of health insurance, to examine the effect of generosity of insurance coverage on body weight along the intensive coverage margin. Second, we use instrumental variables methods to estimate the effect of type of insurance coverage (private, public and none) on body weight along the extensive margin. We explicitly address the discrete nature of the endogenous indicator of health insurance coverage by estimating a nonlinear instrumental variables model. We find weak evidence that more generous insurance coverage increases body mass index. We find stronger evidence that being insured increases body mass index and obesity.

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Introduction

Adult obesity is a thorny problem. Several studies document rising obesity prevalence in the U.S. (See Mokdad et al., 1999; Mokdad et al., 2003). Economists have argued that the primary cause of increasing obesity prevalence are: (1) a falling relative price of food; (2) a technologically-induced shift away from physically demanding work; and (3) a decline in time spent on food production at home (see Lakdawalla and Philipson, 2002; Cutler, Glaeser and Shapiro, 2003; and Anderson, Butcher, and Levine 2003).[1] As most view these fundamental changes in the economy as desirable and would not want to undo them, developing public policy to address the root causes of rising obesity prevalence is difficult, if not entirely problematic.

Nevertheless, the health care and other costs associated with obesity are enormous. For example, Wolf and Colditz (1994) estimate that over $68 billion annually are lost annually in increased health care costs and job absenteeism as a result of obesity in the U.S. The morbidity and accounting costs associated with obesity have led public health experts (such as Nestle, 2003, Brownell and Horgen, 2003, Sturm 2002) to advocate vigorous public intervention, including regulation of fast food establishments and taxes on nutritionally-questionable foods.

The economic justification for the sorts of policy interventions, such as taxes on food, favored by some of these authors rests on the idea that when one person becomes obese, many other people pay the cost. In economic jargon, there are negative externalities from body weight decisions that lead to obesity. If external costs are high, then public welfare can be improved by interventions that change the incentives adults face when making decisions about bodyweight. If external costs are small, then adults pay fully for their

[1] There are, of course, many other non-economic determinants of bodyweight, including genetic predispositions to obesity and non-rational impulses (such as myopic decision making and lack of self-control) that prevent optimal bodyweight control. These are unlikely explanations for the observed trends in bodyweight, even if they help explain baseline levels. There is certainly no evidence that we are more irrational or have different genes than our parents or grandparents.

bodyweight decisions and public interventions aimed at decreasing bodyweight can play only a limited role in improving public welfare.[2]

The main mechanism by which obesity imposes external costs is through pooled health insurance. In a health insurance pool with inadequately risk-adjusted premiums, one person's increase in body weight really is everyone else's business, since obesity often leads to higher medical expenditures. In this paper, we describe a model of this negative obesity externality associated with health insurance.[3] The main insight of this model is that measuring the obesity externality involves more than just measuring the subsidy to obese individuals induced by health insurance. The welfare loss due to the obesity externality depends upon both the size of the subsidy and upon the extent to which bodyweight decisions are distorted on the margin by the subsidy—that is, does coverage with pooled health insurance cause enrollees to gain weight? If the answer is no and there is no moral hazard of this sort caused by insurance coverage, then the subsidy induced by one person's obesity would simply represent a transfer from the thinner individuals his insurance pool to the obese person, with no net effect on social welfare.

Despite the importance of this parameter—the health insurance elasticity of body weight—to the welfare economics of obesity, there has been scant work in the economics literature on the topic. The one exception is a paper by Markowitz and Rashad (2007) who find a zero elasticity of insurance coverage on body weight or obesity rates. These authors rely on the size of a firm where an individual works as an instrument for insurance coverage in their body weight regressions. We extend this work along three dimensions. First, we measure separate elasticities for the extensive margin (people gaining or losing insurance altogether and the intensive margin (insurance becoming more generous insurance). In principle, these elasticities may be different, and as we show in the concluding section of the paper, they have different policy implications. Second, we distinguish different elasticities for public and private

[2] Cawley (2004) provides a detailed discussion of possible market failures related to obesity.
[3] See Bhattacharya and Sood (2007) for a full description of this model.

insurance coverage for our estimates of the elasticity along the extensive margin. Finally, we adopt econometric methods that account for the discrete nature of the insurance coverage variable.

1 Background

Americans are increasingly overweight or obese.[4] The proportion of adults classified as obese increased from 12.0% in 1991 to 20.9% in 2001 (Mokdad et al., 1999; Mokdad et al., 2003). Obesity is associated with an increased risk for a number of serious chronic conditions, including diabetes, hypertension, heart disease, and stroke (Sturm, 2002). In this section, we provide a brief review of the large literature on the consequences of obesity for expected health care expenditures. We also provide a review of the smaller literature on the external costs of obesity induced by health insurance.

1.1 Obesity and health care expenditures

Not surprisingly, expected health care expenditures are higher for obese individuals than for normal weight individuals. A large number of studies document this fact. The vast majority of these studies use convenience samples consisting of individuals from a single employer or a single insurer (Elmer et al. 2004, Bertakis and Azari 2005, Burton et al. 1998, Raebel et al 2004). There are also studies of obesity related medical expenditure differences in an international setting. Both Sander and Bergemann (2003), in a German setting, and Katzmarzyk and Janssen (2004), in a Canadian setting, find higher medical expenditures for obese people.

There are a few studies that use nationally representative data. Finkelstein, et al. (2003) use data from the linked National Health Interview Survey (NHIS) and Medical Expenditure Panel Survey (MEPS). They estimate that annual medical expenditures are $732 higher for obese than normal weight individuals. From

[4] Body mass index (BMI) is the standard of bodyweight in the medical literature. BMI is weight, measured in kilograms, divided by height, measured in meters, squared. Individuals with a BMI between 25 and 30 are considered overweight, while those with a BMI of 30 or more are considered obese (National Institute on Health, 1998). Henceforth, we use BMI and bodyweight interchangeably.

an accounting viewpoint, approximately half of the estimated $78.5 billion in medical care spending in 1998 attributable to excess bodyweight was financed through private insurance (38%) and patient out-of-pocket payments (14%). Sturm (2002), using data from the Health Care for Communities (HCC) survey, finds that obese individuals spend $395 per year more than non-obese individuals on medical care. Thorpe et al (2004) also use MEPS data, but they are interested in how much of the $1,100 increase between 1987 and 2000 in per-capita medical expenditures is attributable to obesity. Using a regression model to calculate what per-capita medical expenditures would have been had 1987 obesity levels persisted to 2000, they conclude that about $300 of the $1,100 increase is due to the rise in obesity prevalence.

This is a large literature, which space constraints prevent us from surveying in more detail. The many studies that we do not discuss here vary considerably in generality—some examine data from a single company or from a single insurance source—though they all reach the same qualitative conclusion that obesity is associated with higher medical care costs.[5]

1.2 External costs of obesity associated with health insurance

Despite the extensive literature on medical expenditure differences, very few studies attempt to estimate the degree to which health insurance coverage leads to subsidies for the obese. Some studies have attempted to estimate how much of obesity related medical costs are subsidized by public insurance. Finkelstein, Ruhm and Kosa (2005), in a literature review of the causes and consequences of obesity, estimate that "the government finances roughly half the total annual medical costs attributable to obesity. As a result, the average taxpayer spends approximately $175 per year to finance obesity related medical expenditures among Medicare and Medicaid recipients." To arrive at this conclusion, they rely on a study by Finkelstein, Fiebelkorn, and Wang (2004), who calculate state and federal level estimates of Medicare and Medicaid expenditures attributable to obesity. Another study, conducted by Daviglus et al (2004),

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[5] Some of the studies we reviewed, but arbitrarily do not discuss here include Bungam et al. (2003); Musich et al. (2004); Quesenberry, Jr. et al. (1998); Thompson et al. (2001); and Wang et al. (2003).

links together data from a sample of Chicago area workers in the labor force between 1967-73, to Medicare claims records from the 1990s. They estimate substantial obesity related differences in Medicare expenditures. For example, women workers who were obese between 1967 and 1973 spent $176,947 in the 1990s on Medicare, while analogous non-obese, non-overweight female workers spent $100,431 in undiscounted costs. Obese male workers spent $125,470, while non-obese non-overweight male workers spent $76,866.

However, estimating how much of obesity related medical costs are financed by public insurance is merely an accounting exercise and not sufficient for calculating the true economic subsidy for obesity. Conceptually, calculating the size of the subsidy also requires estimating payments by obese and non-obese individuals for enrolling in health insurance in addition to the expected benefits of enrollment. Roughly speaking, obese and non-obese people alike pay for Medicare when they are under 65 and spend (receive benefits) when they are older.[6] Since obese people work, earn, are taxed, and die at different rates than non-obese people, looking at Medicare expenditure differences alone will paint a misleading picture of the Medicare subsidy for the obese.

Calculating the obesity subsidy induced by private insurance also requires estimating both payments for health insurance and medical expenditures. Since private insurance is typically provided in an employment setting, it is not enough to look at premiums for health insurance paid by employers and employees.[7] The key question is whether employers adjust the cash wages of obese workers with health insurance in order to account for the higher cost of insuring these workers. Although theory predicts that employers would have incentives to do so (Rosen 1986), in practice, it is not clear that they would be

[6] For example, McClellan and Skinner (1999, 2005) and Bhattacharya and Lakdawalla (2005), in estimating Medicare progressivity, estimate lifetime profiles of tax receipts for Medicare as well as Medicare expenditures.

[7] For employees enrolling in the same insurance plan, premiums do not depend upon bodyweight (see Keenan et al., 2001), so in that case, there are no obesity related payment differences. However, when employers offer multiple health plans, obese workers may tend to select into a different set of plans than their thinner colleagues. In that case, premiums may differ.

able to make these adjustments.[8] According to Gruber (2000), "…the problems of preference revelation in this context are daunting; it is difficult in reality to see how firms could appropriately set worker specific compensating differentials."

As is the case with Medicare, however, there is very little research on obesity related payment differences in a private insurance settling. An important exception is Bhattacharya and Bundorf (2005), who find some evidence that obese workers receive lower pay than non-obese workers primarily at firms that provide health insurance.

In related work, Keeler et al (1989) and Manning et al. (1991), using data from the RAND Health Insurance Experiment (RAND HIE) and from the National Health Interview Survey (NHIS), report estimates of lifetime medical costs attributable to physically inactivity (rather than obesity): "At a 5 percent rate of discount, the lifetime subsidy from others to those with a sedentary life style is $1,900." Though they label this estimate the "external cost of physical inactivity," like the rest of the literature they focus on physical inactivity related medical expenditure differences, while ignoring payment differences that occur outside experimental settings in their calculation of the subsidy.

2 A Model of the Social Costs of Obesity

The model timeline in Figure 1 illustrates the basic setup of the model. Each consumer starts with an initial endowment of weight W_0. This endowment might be seen as reflecting the consumer's genetic propensity to be overweight

[8] The literature on medical expenditure associated obesity costs has a parallel and often intersecting literature on the labor market productivity costs associated with obesity (often these latter costs are called "indirect" costs of obesity). The theory of compensating wage differentials has important implications for whether these labor market costs are external; that is, whether obese individuals pay for lower productivity levels (such as through more sick days) associated with their bodyweight, or someone else pays. This theory suggests that obese workers will pay for lower productivity through reduced wages. The economics literature on obesity related wage differences—for example, Register and William (1990), Pagan and Davila (1997), and Cawley (2000)—unanimously finds that obese workers earn lower wages than their thinner colleagues, and that these differences are equal to or greater than the wages differences that would arise from measurable productivity differences. Hence, both theory and evidence suggest that these "indirect" costs of obesity are not external.

or obese, and in any case it cannot be chosen by the consumer. In the first stage consumers decide how much weight to lose, ω. Weight loss (exercising, dieting) gives consumers some disutility but has two associated benefits: (1) it increases productivity, consequently raising consumer income and (2) it improves health (more precisely, it decreases the probability of falling sick).[9] Falling sick entails additional medical care expenditures, but since consumers are insured, they are reimbursed for all of these additional medical care expenditures. In the second stage, nature reveals a health shock with i = 1…N points of support.[10] Each type of health shock entails additional medical expenses, M_i. Consumers first observe this health shock and then decide how much to consume. The consumers' problem is to maximize expected utility by jointly choosing weight change (ω) and a consumption plan $\{C_i\}_{i=1}^{N}$ for each of the N possible health states:

$$(1) \qquad \max_{\omega,\{C_i\}_{i=1}^{N}} EU = \sum_{i=1}^{N} \pi_i \left(W_0 - \omega\right) U\left(C_i\right) - \Phi\left(\omega\right)$$

where $U\left(C_i\right)$ represents utility from consumption**;** $\pi_i\left(W_0 - \omega\right)$ is the probability of health state *i* given weight $\left(W_0 - \omega\right)$; C_i is the consumption in health state *i*; and, $\Phi\left(\omega\right)$ is the disutility from weight loss.

We divide our analysis now into two cases: (1) health insurance pools risk across people with heterogeneous risk (so that premiums do not change with bodyweight); and (2) people pay the risk-adjusted premiums for their own bodyweight. The primary difference between these cases manifests itself in consumer budget constraints.

2.1 Risk pooling

[9] The model can also be interpreted as a model of weight gain, with a reinterpretation of the source of disutility from this gain (diminished body image, perhaps). The main point is that a change in weight away from the optimum choice induces disutility.

[10] The results of the model are similar when health shocks are permitted to be continuous, but the solution technology is less transparent.

In this case, health risk is pooled across people of different bodyweight. As long as the pool size is large enough, a single individual's medical expenditures will have a negligible effect on the common premium, $\bar{P}$, charged to everyone in the pool. Hence, from the point of view of each individual, premiums are taken as fixed, and the budget constraint is:

$$(2) \qquad I\left(W_0+\omega\right)=C_i+\bar{P}\ \forall \mathrm{i}$$

In (2), $I\left(W_0+\omega\right)$ is the income earned by an individual who weighs $W_0+\omega$. By allowing income to depend upon weight, we are modeling the effect of health on labor market productivity. We assume that $I'(.)>0$.

The budget constraint specifies that in each health state *i*, income equals expenditures on consumption and health insurance premiums. An immediate consequence of (2) is that consumption is identical in each health state, which makes sense since consumers are fully insured against medical expenditures.

The consumer's problem is to maximize expected utility, (1), subject to the budget constraint, (2). We solve the consumer's problem using standard discrete numerical programming methods. In the first step, taking the amount of weight and as given, we calculate the optimal demand for consumption in each health state. Inputting the optimal consumption plan in the utility function gives the maximum utility attainable in each health state. In the second stage, we choose weight to maximize expected utility given optimal consumption in each health state.

Plugging the budget constraint into (1), we reformulate the consumers' problem in the second stage:

$$(3) \qquad \max_{\omega} EU=U\left(I\left(W_0-\omega\right)-\bar{P}\right)-\Phi\left(\omega\right)$$

The first order condition for the consumer's maximization problem is:

$$(4) \qquad -I'\left(W_0-\omega^*\right)U'\left(I\left(W_0-\omega^*\right)-\overline{P}\right)-\Phi'\left(\omega^*\right)=0$$

Here, ω^* is the consumer's optimal weight in the pooling case. The first term in equation (4) is the marginal gain from weight loss; it is entirely due to the marginal increase in income from increased productivity arising from weight loss (scaled by the marginal utility of consumption). In equilibrium, consumers will lose weight until the marginal gain from weight loss equals the marginal disutility from weight loss.

If the insurance market is in competitive equilibrium, then premiums will be actuarially fair. They will equal the expected medical expenses for individuals in the insurance pool:

$$(5) \qquad \overline{P}=\sum_{i=1}^{N}\pi_i\left(W_0-\omega^*\right)M_i$$

Equation (4) also shows that since consumers are fully insured against medical expenses, the only incentive for weight loss is the increase in income due to weight loss. Thus, when insurance premiums do not depend on weight, consumers do not view the reduction in medical expenditures as an additional benefit of weight loss when making decisions about bodyweight. Insurance induces a form of moral hazard with respect to weight loss incentives since the benefits of weight loss are not fully internalized by the consumer. As a consequence, weight loss creates a positive externality for everyone else in the insurance pool, since it lowers their health insurance premiums.[11] Because this benefit is not fully captured by the consumer losing the weight, insured people will tend to lose less weight than would be optimal. By contrast, the productivity benefits of weight loss are fully internalized as changes in productivity lead to an increase in consumer income.

[11] This argument is developed in more detail in Appendix A.

2.2 Risk-adjusted insurance

We now turn to the case where health insurance premiums adjust to reflect the weight choice of consumers. In contrast to the previous case, where the premium is taken as fixed, consumers now face a risk-adjusted schedule of health insurance premiums that depends upon their own bodyweight. In the context of employer provided insurance this could be achieved by wage reductions for obese employees, or simply by offering premium rebates to individuals who lose weight. In this case, the budget constraint is given by:

$$(6) \qquad I\left(W_0-\omega\right)=C_i+P\left(W_0-\omega\right) \quad \forall \mathrm{i}$$

Here, $P\left(W_0-\omega\right)$ is the health insurance premium for an individual who weighs $W_0-\omega$. Again, if the insurance market is competitive, premiums will be actuarially fair. Hence, they will be an increasing function of weight, reflecting the increase in expected medical expenses:

$$(7) \qquad P\left(W_0-\omega\right)=\left(\sum_{i=1}^{N}\pi_i\left(W_0-\omega\right)M_i\right)$$

The consumers' problem in this case can be reformulated as:

$$(8) \qquad \max_{\omega} EU=U\left(I\left(W_0-\omega\right)-P\left(W_0-\omega\right)\right)-\Phi\left(\omega\right)$$

The first order condition for the consumer's maximization problem is:

$$(9) \qquad -\left[I'\left(W_0-\omega^{**}\right)-P'\left(W_0-\omega^{**}\right)\right]U'\left(I\left(W_0-\omega^{**}\right)-P\left(W_0-\omega^{**}\right)\right)-\Phi'\left(\omega^{**}\right)=0$$

Here, ω^{**} is the consumer's optimal weight in the risk-adjusted case. Clearly, (9) is necessary for ω^{**} to be individually optimal, but whether it is also socially optimal depends upon what is meant by social optimality. Suppose EU is the expected utility of the representative consumer in the economy, and all individuals start with the same initial weight, W_0. In that (unrealistic) case, ω^{**} can be said to be socially optimal, since the full social costs of bodyweight decisions are internalized. In the Appendix, we consider a more realistic case where W_0 differs across individuals in the population. We show that, aside from transfers that do not depend upon final weight, $W_0 - \omega^{**}$, equation (9) is a necessary condition for the social optimum.

It is instructive to compare the first order condition in (9) with the analogous condition in (4) when there was a single risk pool. Both equations have a single term reflecting the marginal costs of weight loss: $\Phi'(.)$. However, equation (9) has two terms, $I'(.)$ and $P'(.)$, reflecting the marginal benefit of weight loss accruing from an increase in productivity and a decrease in the health insurance premium. By contrast, equation (4) has only a single term reflecting the marginal productivity benefit of weight loss: $I'(.)$. Thus, when premiums reflect individual health risk, consumers have two incentives for weight loss—productivity gains and lower health insurance premiums. In this case, there is no moral hazard induced by health insurance and consumer bodyweight decisions.

2.3 Deadweight loss from the obesity externality

In this section, we show that the size of the loss in social welfare from the obesity externality under pooled premiums depends upon both the fact that expected health expenditures are higher for the obese and also upon how responsive people would be in their weight loss decisions to a switch from pooled to risk-adjusted premiums. This calculation is important because, while there is a lot of empirical evidence that obese people are more likely to have higher medical care expenditures than non-obese people, there is no empirical evidence on whether pooled insurance causes obesity or weight gain. Whether the rise in obesity prevalence is a public health crisis, or merely a private crisis for many people, depends on the evidence on both quantities.

We start with the expression for expected utility, evaluated at the optimum under risk-adjusted insurance:

$$(10) \quad EU\left(\omega^{**}\right) = U\left(I\left(W_0 - \omega^{**}\right) - P\left(W_0 - \omega^{**}\right)\right) - \Phi\left(\omega^{**}\right)$$

We have imposed the condition that consumption does not vary with health outcome since consumers are fully insured under both cases.

Next, we consider a first order Taylor series approximation of (10) around ω^*, which is optimal weight loss under pooled insurance:

$$(11) \quad EU\left(\omega^{**}\right) \approx EU\left(\omega^{*}\right) + \left.\frac{\partial EU}{\partial \omega}\right|_{\omega^*}\left(\omega^{**} - \omega^{*}\right)$$

The deadweight loss (*DWL*) from the obesity externality is the change in expected utility resulting from pooling. Equation (11) suggests an approximation to this quantity:

$$(12) \quad DWL = EU\left(\omega^{**}\right) - EU\left(\omega^{*}\right) \approx \left.\frac{\partial EU}{\partial \omega}\right|_{\omega^*} \Delta\omega$$

Here, $\Delta\omega \equiv \omega^{**} - \omega^{*}$ is difference between optimal weight under risk-adjusted and pooled risk cases. Since weight is socially optimal in the risk-adjusted case, $\Delta\omega$ also reflects the degree to which weight choice differs from socially optimal when pooling pertains.

Using a first order Taylor series approximation, the dead weight loss (DWL) in expected utility terms due to the obesity externality is:

(13) $$DWL \approx \left\{ U'\left(I\left(W_0 - \omega^*\right) - P\left(W_0 - \omega^*\right)\right)\left[-I'\left(W_0 - \omega^*\right) + P'\left(W_0 - \omega^*\right)\right] - \Phi'\left(\omega^*\right)\right\} \Delta\omega$$

Substituting the first order condition in equation (4) in equation (13) yields a simple expression for the dead weight loss from the obesity externality:

(14) $$DWL \approx U'(.)P'\left(W_0 - \omega^*\right)\Delta\omega$$

Equation (14) shows that the deadweight loss is proportional to two crucial factors: the extent to which bodyweight deviates from the optimal due to pooled health insurance when individuals do not bear the full medical care costs of obesity, $\Delta\omega$, and the responsiveness of medical care expenditures to changes in weight, $P'\left(W_0 - \omega^*\right)$. The dead weight loss from the obesity externality is zero if individual weight choice does not respond to subsidies for obesity or if medical expenditures do not change with bodyweight.

While several estimates of $P'\left(W_0 - \omega^*\right)$ are available from the public health and economics literatures there is no work that quantifies $\Delta\omega$. To estimate $\Delta\omega$, ideally we would like to know: (1) bodyweight under pooled insurance when the consumer is shielded from the medical care costs of obesity and (2) under risk-adjusted premiums when the individual faces the full medical care costs of obesity. Unfortunately, we can observe the former but not the latter as very few insurance plans risk rate insurance premiums based on obesity. Therefore, to estimate the latter quantity we rely on two other margins that affect the extent to which individuals bear the medical care costs of obesity. First, we examine whether consumers with more generous insurance, who are partially shielded from medical care costs of obesity, are heavier than those with less generous insurance. Next we examine, the effect of insurance status on the extensive margin, that is, whether the uninsured, who face the full medical care costs of obesity, are lighter than the insured.

3 The Intensive Margin: Increasing Generosity of Coverage

Using data from the Rand Health Insurance Experiment (HIE), we are able to examine the effect of health insurance on body weight when people are randomly assigned to different levels of insurance coverage (the intensive margin). In the HIE, which was conducted in six areas of the country during the late 1970s and early 1908s, approximately 2,000 non-elderly families were assigned to differing levels of insurance coverage.[12] The purpose of the HIE was to determine the effects of patient cost sharing on medical care utilization and health. The participants were assigned to different fee-for-service plans that varied along two dimensions: the coinsurance rate (the fraction of billed charges paid by patients) and the maximum dollar expenditure (the maximum amount a family would spend on covered expenditures during a twelve month period). The coverage was comprehensive in the sense that it included nearly all types of medical care. Participants remained enrolled in their assigned plan and were followed for either three (70%) or five years.

The plans were characterized by four different coinsurance percentages – 0 (often referred to as "free care"), 25%, 50%, and 95% - and three levels of maximum out of pocket spending – 5%, 10%, and 15% of family income up to a maximum of $1000. In one plan, the MDE was set at $150 per individual and $450 per family (often referred to as the "individual deductible plan").[13] In this plan, the coinsurance rate was 95%. In our empirical work, we categorize plans based on their coinsurance rate and control for the MDE.[14] We categorize the individual deductible plan separately due to the more complicated structure of the MDE.

[12] This description of the HIE is based on information from Newhouse and the Insurance Experiment Group, 1993.
[13] The HIE also included an analysis of the effects of enrolling in an HMO on the study outcomes. Because it is difficult to measure the generosity of an HMO relative to a FFS plan, we drop these enrollees from the analysis.
[14] The coinsurance rate was constant across different types of services with one exception. In one plan, the coinsurance rate was 25% for all services except outpatient mental health and dental, which had a 50% coinsurance rate. We include this plan in the 25% coinsurance rate group.

In order to minimize participation bias, the investigators offered a participation incentive. The participation incentive for a given family was defined as "the maximum loss risked by changing to the experimental plan from existing coverage", and was intended to ensure that families were equally likely to participate independent of their prior health insurance status and the plan to which they were assigned

The study collected data on demographic and socioeconomic characteristics of enrollees as well as health status and medical care utilization both at baseline and during the experiment. This information included enrollee height and weight both at baseline and at exit, and we use these measures to calculate BMI at each point in time for each enrollee. We limit our analysis to adults (age>=21) and drop observations with missing data for key control variables (age, education, family income, race, gender, marital status, and self reported health status).

Table 1 presents data on body weight by plan type. We find no evidence of statistically significant differences by plan type in body weight, as measured by either BMI or obesity status, either at entry or at exit. In addition, we find no evidence of differences across the plans in changes in these measures. The directions of the differences between plans in changes in BMI, however, are consistent with the hypothesized effect. In other words, enrollees in the free plan experienced the largest change in BMI over the study period (0.59) and the difference in change in BMI between the free plan (0.59) and the 25% coinsurance plan (0.33) is statistically significant at $p<=0.06$.[15] The results are less consistent for the indicator of becoming obese. In this case, the differences across plans based on their level of cost sharing are not consistent across plans.

[15] This finding is consistent with results reported by the HIE which find that, while the difference in weight/height^2 at exit between enrollees in the free plan and enrollees in the other plans was not statistically significant, the direction of the effect favored the cost sharing plans (page 198, Newhouse and the Insurance Experiment Group, 1993).

In Appendix Table 1, we document some differences across the plans in enrollee characteristics despite random assignment. In particular, average family income varies across the plans, and correspondingly, the participation incentive as well. In addition, enrollee assignment to plans is not balanced by site.

In Table 2, we determine whether the estimates of the effects of plan cost-sharing are influenced by these differences by controlling for them in multivariate models. The multivariate models also allow us to control for the enrollees' maximum dollar expenditure. We estimate models with two different dependent variables: BMI change per year (to control for differences across enrollees in their enrollment period) and an indicator of whether an individual became obese during the study period. We estimate three versions of each model. In the first, we control for plan characteristics only (the dummy variable indicating the coinsurance rate and the MDE). In the second, we add the controls for individual characteristics presented in Appendix Table 1. In the third, we control for both individual characteristics and aspects of study design including the site and the enrollee's participation incentive. We estimate the models using least squares. The results from the model of the probability of becoming obese are similar when we estimate a maximum likelihood logit model.

The results from the multivariate models are substantively similar to those from the unadjusted comparisons (Table 2). While people randomly assigned to plans with cost sharing experienced a smaller annual change in BMI during the experiment relative to those assigned to the free plan, the effect is statistically significant only in the case of the plan with the 25% coinsurance rate. And in this case, the effect is quite small. A 0.175 reduction in BMI represents less than 1% of BMI at entry among this group. Correspondingly, we do not find consistent evidence of differences by plan type in the probability of becoming obese during the study period. The direction of the effect varies by plan and none of the estimates are statistically significant.

4 The Extensive Margin: Insured vs. Uninsured

While the Rand data allow us to examine the responsiveness of body weight to a change in the generosity of coverage, the fact that everyone in the experiment had health insurance coverage leaves open the possibility of an effect along the extensive margin. In other words, the responsiveness of body weight to any insurance relative to none may be greater than the responsiveness to changes in the generosity of that coverage.

4.1 Methods

We use instrumental variables (IV) regressions to estimate the causal effects of private and public insurance coverage on body weight as measured by BMI and obesity status. If our instruments are valid, IV methods purge the estimates of confounding due to observable and unobservable characteristics. We first estimate linear instrumental variables model estimated via two stage least squares. These models are widely used and a powerful tools in such contexts. However, for nonlinear and limited dependent variable models in general, the linear IV model may either be inappropriate or not work well in practice. Specifically, in our case, although the outcomes of interest are either binary or linear, the endogenous regressors (dummy variables for private and public insurance) are limited dependent variables. A linear IV model would treat the endogenous regressors as if they were linear and unrelated, when in fact the insurance choices are mutually exclusive and exhaustive.

To address the discrete nature of our data, we next estimate a nonlinear instrumental variables model using latent factors to account for selection on unobservables. Our model respects the multinomial nature of the endogenous regressors as well as the binary or linear nature of the outcome. Specifically, we assume that the endogenous regressors have a multinomial logit form, while the outcome equations have logit and normal (linear) forms respectively. Then, latent factors are incorporated into the equations to allow for unobserved influences on insurance choice to affect outcomes and their joint distribution specified (Deb and Trivedi, 1997).

The main computational problem is that the joint distribution, which involves a multidimensional integral, does not have a closed form solution. This difficulty can be addressed using simulation-based estimation. Using normally distributed random draws for the latent variables, a simulated likelihood function for the data is defined and its parameters estimated using a Maximum Simulated Likelihood Estimator. Because of the complexity of our model and the large sample size, standard simulation methods are quite slow. Therefore, we adapt an acceleration technique that uses quasi-random draws based on Halton sequences. The formulation, estimation methods and exposition borrows heavily from Deb and Trivedi (2004).

The model is represented by 2 sets of equations. In the first set of equations, the insurance choices (private, public or uninsured) are represented by a multinomial logit model. The second equation, representing the outcome, is modeled as OLS (BMI as outcome) or logit (obese status as outcome) model. In this model, the choice of insurance and outcome are linked because insurance choices are regressors in the outcome module and because there are common unobservable (latent) factors.

Let y^* denote the propensity underlying the observed values of outcome, y (in the case of BMI, $y^* = y$). Let $private$ and $public$ be a binary variables representing public and private insurance coverage. The outcome equation is formulated as:

$$(15) \qquad y^* = x\beta + \gamma_1 private + \gamma_2 Public + \lambda_1 l_{pvt} + \lambda_2 l_{pub} + \varepsilon$$

Where, x is a set of exogenous covariates and β, γ_1, and γ_2 are parameters associated with the exogenous covariates and insurance variables. The error term is partitioned into ε, an independently distributed random error, and latent factors l_{pvt} and l_{pub} which denote unobserved characteristics common to individual's choice of insurance and outcome of that individual. λ_1 and λ_2 are factor loadings or parameters associated with the latent factors that capture the degree of correlation between unobserved determinants of insurance choice and outcomes.

The transformation from y^* given in (15) to the observed random variable y is through an appropriate distribution function f such that:

(16) $$\Pr(y^* = y \mid x, Pvt, Pub, l_{pvt}, l_{pub}) = f(x\beta + \gamma_1 Pvt + \gamma_2 Pub + \lambda_1 l_{pvt} + \lambda_2 l_{pub})$$

In the case of the binary outcome, f is assumed to be the extreme value distribution function, that is, the outcome equation is a logit model. In the linear case f is the identity link.

Following the multinomial logit framework (McFadden, 1980, p. S15), the probability of choosing in private insurance, public insurance or remaining uninsured is formulated as:

(17) $$\begin{aligned}&\Pr(private = 1 \mid z, l_{pvt}) = g(z\alpha_{pvt} + \delta_1 l_{pvt})\\ &\Pr(public = 1 \mid z, l_{public}) = g(z\alpha_{pub} + \delta_1 l_{pub})\\ &\Pr(private = 0, public = 0 \mid z,) = 1 - \Pr(private = 1 \mid z, l_{pvt}) - \Pr(public = 1 \mid z, l_{public})\end{aligned}$$

where z denotes exogenous covariates in the insurance choice model. We denote covariates in this site-choice module by z and covariates in the outcome equation by x to highlight the fact that they contain the instrumental variables in the empirical analysis. We use the extreme value distribution for g so that the model for insurance coverage is a multinomial logit.

Because the latent factors l_{pvt} and l_{pub} enter both choice of insurance (17) and outcome (16) equations, they capture the unobserved factors that induce self-selection into insurance and are also correlated with unobservable factors related to outcomes. Under these assumptions, the joint distribution of selection and outcome variables, conditional on the common latent factors, is simply the product of the functions described in equations (16) and (17).

The problem in estimation arises because the common latent factors l_{pvt} and l_{pub} are unknown. We assume that these latent factors are normally distributed. Given this assumption the latent factors can be can be integrated out of the joint density. For example, the joint density of observing outcome y and $Pvt = 1$ equals:

$$\begin{aligned} &\Pr(y^* = y, private = 1 | x, z) = \\ &\int f(x\beta + \gamma_1 private + \gamma_2 public + \lambda_1 l_{pvt} + \lambda_2 l_{pub}) g(z\alpha_{pvt} + \delta_1 l_{pvt}) \phi(l_{pvt}) dl_{pvt} \end{aligned} \tag{18}$$

Cast in this form, the unknown parameters of the model may be estimated by maximum likelihood. The main computational problem is that the integral in equation (18) does not have, in general, a closed form solution. But this difficulty can be addressed using simulation-based estimation (Gourieroux and Monfort, 1996) to numerically integrate equation (18). Because of the complexity of our model, standard simulation methods are quite slow. Therefore, we adapt an acceleration technique that uses quasi-random draws based on Halton sequences (Bhat, 2001; Train, 2002).We maximize the simulated likelihood using a quasi-Newton algorithm.

4.2 Data and Instruments

Data

The primary data source for our analysis is the National Longitudinal Survey of Youth (NLSY). The NLSY includes a nationally representative sample of 12,686 people aged 14-22 years in 1979 who were surveyed annually until 1994, and biennially through 2004. Our study uses NLSY data from 1989-2004. We exclude the years prior to 1989 as well as 1991 because the survey did not collect information on health insurance status in those years. We further restrict the sample, excluding pregnant women. After these restrictions, 79; 876 person-year observations (40; 223 male and 39; 653 female) were eligible to be included in the study sample.

Instruments

We use the two sets of instruments for insurance choice. The first set of instruments captures the distribution of firm size in every state and year. These data are obtained from the Statistics of U.S. Businesses (SUSB) available online at http://www.sba.gov/advo/research/data.html. We use these data to construct 2 instruments at the state-year level: (1) percentage of workers employed in firms with 100 to 499 employees, (2) percentage of workers employed in firms with 500 or more employees. These instruments would be valid under 2 conditions. First, they should be strong predictor private insurance coverage. Second, they should affect weight choice only through their effect on insurance choice. In the next section, we show that the instruments are strong predictors of private insurance as large firms are more likely to cover employees. The second assumption cannot be directly tested, however, it seems unlikely that changes in firm size distribution within a state (our models have state fixed effects) would be related to weight choices, except through insurance coverage. However, one important caveat is that it is possible that obese workers might prefer to live in states with larger firms to enjoy the benefits of pooled health insurance at these firms. To the extent that this is true, our IV estimates will overestimate the effects of insurance on bodyweight and obesity.

The second instrument captures generosity of Medicaid coverage. There has been a significant expansion of Medicaid eligibility during this period and there is significant variation across states in the pace at which these expansions have occurred. Prior research documents a strong association between Medicaid expansions and public insurance coverage. We use data from several years of CPS to construct this instrument. First, we regress a binary variable for Medicaid coverage on detailed information on demographics, family composition, income, and state*time fixed effects. The state*time fixed effects measure the generosity of Medicaid coverage in each state and year after controlling for other important determinants of Medicaid coverage. We posit that these state*time fixed effects essentially capture differences in Medicaid eligibility rules or enforcement of these rules. We use these fixed effects to create a predicted probability of Medicaid coverage for a standardized population and use these predicted probabilities as an instrument for public insurance coverage. Again, our instrument is valid if variation in our measure of Medicaid eligibility within a state in not correlated with unobserved determinants of obesity within a state. For example, our IV estimates would be biased upwards if deteriorating economic conditions increased obesity rates and also prompted states to expand Medicaid eligibility.

Finally, we also explored using state marginal income tax rates as an instrument for insurance coverage. The rational why one might choose to use taxes as an instrument is that since employer sponsored health insurance premiums are exempt from state and federal payroll taxes, the subsidy for employer sponsored insurance is greater in states with higher marginal income taxes. Consequently, states with higher marginal income tax rates should have a higher proportion of persons having employer provided insurance. Unfortunately, this was not true empirically. We found no significant relationship between state marginal income tax rates and insurance coverage.

Other explanatory variables

We include several other explanatory variables including race, age, gender, income, afqt scores and year fixed effects. All these variables are plausibly exogenous and important predictors of weight and insurance choices. In addition, in our preferred specifications we include state fixed effects to control for all time invariant differences across states. This is important as our instruments are measured at the state level.

4.3 Results

Table 3 presents the results from the second stage of the 2SLS regressions. Appendix Table 2 presents the first stage results. The aim of these regressions is to estimate the causal effect of public and private insurance on BMI and obesity. The first model presents results from the regression model without state fixed effects. The results show that both private and public insurance have no statistically significant effect on BMI. The point estimates for both public and private insurance are positive but are estimated imprecisely. This is despite the strong predictive power of the instruments in the first stage (F-stat = 139]. The next model includes state fixed effects to capture time invariant differences across states. The point estimates from this model are implausibly large and very imprecisely estimated. The results indicate that public and private insurance coverage reduce BMI by 3.8 and 7.7 points respectively. However, despite these large point estimates these estimates are statistically insignificant. These are classical symptoms of the weak instruments problem. In this specification the instruments are weak predictors of insurance coverage [F-Stat 2.9]. The last models present results from models with obese status as the outcome variable. The results are consistent with the BMI model. Public and private insurance coverage have no statistically significant effect on obesity and the point estimates from the specification with state fixed effects are implausibly large.

Table 4 and Appendix Table 3 present the results from the results from the MLE models. These models are our preferred specification. As discussed earlier they have several advantages over the 2SLS models. The results from the first model show that both public and private insurance have a statistically significantly effect on BMI. The results indicate that private insurance increases BMI by 1.3 points and public insurance increases BMI by 2.1 points. Both these effects are quite large and are precisely estimated. For example the effects of private insurance on BMI are similar to moving from the highest AFQT quartile to the lowest AFQT quartiles or moving from less than 8 years of education to more that 12 years of education. The second model includes state fixed effects. The results are virtually unchanged. The last two models use obesity as an outcome model. The results from these regressions are consistent with the BMI models – both public and private insurance increase obesity.

5 Conclusion

Our results indicate that health insurance does indeed make you fat. While the evidence that more generous private insurance leads to increases in body weight is somewhat weak, primarily because the magnitude of the estimated effect is quite small, our estimates of the effect of having insurance, either public or private, are larger and more precise.

While other authors have come to a different conclusion using a similar approach (Markowitz and Rashad 2007), we demonstrate that the difference is likely due to the method of estimation. When we estimate the model using two-stage least squares, which does not account for the discrete nature of the endogenous indicator of health insurance, our estimates are similar in the sense that we find little evidence that body weight is elastic with respect to insurance coverage. Adopting an alternative maximum likelihood method of estimation, which handles explicitly the discrete endogenous variable, we reach a different conclusion. Body weight is responsive to health insurance coverage. The estimate is both relatively large in magnitude and precise, and does not vary across the different model specifications.

Our estimates suggest that, by insulating people from the costs of obesity-related medical care expenditures, insurance coverage creates moral hazard in behaviors related to body weight. These effects are larger in public insurance programs where premiums are not risk adjusted and smaller in private insurance markets where obese might pay for incremental medical care costs in the form of lower wages (Bhattacharya and Bundorf 2005). By contrast, our estimates also suggest that making insurance more generous has no effect on body weight. Taken together, these findings indicate that providing incentives for healthy behaviors, especially among those with public coverage, might improve social welfare.

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Appendix A: A Characterization of the Social Optimum

In this section, we derive necessary conditions characterizing the socially optimal level of weight loss for a society of j = 1…J individuals. Each has the following expected utility, taken from equation (1):

$$\textbf{(A-1)} \quad EU_j = \sum_{i=1}^{N} \pi_i \left(W_{0j} - \omega_j\right) U\left(C_{ij}\right) - \Phi\left(\omega_j\right)$$

We define total social welfare, $\square$, as the sum of expected utilities over all individuals in the society:

$$\textbf{(A-2)} \quad \square = \sum_{j=1}^{J} \gamma_j EU_j$$

In (A-2), γ_j represents the Pareto weight that individual j has in the social welfare function. In the social budget constraint, total income equals total expenditures on consumption plus total medical expenditures over all individuals. Both income and the distribution of medical expenditures depend upon bodyweight decisions:

$$\textbf{(A-3)} \quad \sum_{j=1}^{J} \left\{ I\left(W_{0j} - \omega_j\right) - \sum_{i=1}^{N} \pi_i \left(W_{0j} - \omega_j\right)\left(M_i + C_{ij}\right) \right\} = 0$$

Equation (A-3) builds in our assumption that expectations about the distribution of medical expenditures in the population correspond to the observed distribution of expenditures.

The social problem is to pick consumption and bodyweight for all individuals in every state of the world — $\left\{C_{ij},\ \omega_j\right\}\ \forall i, j$ — to maximize $\square$ subject to the social budget constraint. To this end, we construct the following Lagrangian function, where λ is the multiplier associated with the social budget constraint, (A-3):

$$\textbf{(A-4)} \quad \begin{aligned} L = {} & \sum_{j=1}^{J}\sum_{i=1}^{N} \gamma_j \pi_i \left(W_{0j} - \omega_j\right) U\left(C_{ij}\right) - \gamma_j \Phi\left(\omega_j\right) \\ & - \lambda \sum_{j=1}^{J} \left\{ I\left(W_{0j} - \omega_j\right) - \sum_{i=1}^{N} \pi_i \left(W_{0j} - \omega_j\right)\left(M_i + C_{ij}\right) \right\} \end{aligned}$$

There are two sets of first order conditions:

$$\textbf{(A-5)} \quad \frac{\partial L}{\partial C_{ij}} = \gamma_j U'\left(C_{ij}\right) + \lambda = 0 \quad \forall i, j \text{, and}$$

(A-6)
$$\frac{\partial L}{\partial \omega_j} = -\sum_{i=1}^{N} \pi_i'\left(W_{0j}-\omega_j\right)\gamma_j U\left(C_{ij}\right) - \gamma_j \Phi'\left(\omega_j\right) + \lambda\left(I'\left(W_{0j}-\omega_j\right) + \sum_{i=1}^{N} \pi_i'\left(W_{0j}-\omega_j\right)\left(M_i + C_{ij}\right)\right) = 0 \quad \forall j$$

An immediate implication of (A-5) is that at the social optimum, each individual *j* in the society must set his (or her) consumption level to the same value, say C_j^*, across all the N different health states:

(A-7) $C_{ij} = C_j^* \ \forall i, j$

Applying (A-7) to (A-6) yields the following:

(A-8)
$$-\left(\gamma_j U\left(C_j^*\right) + \lambda C_j^*\right)\sum_{i=1}^{N} \pi_i'\left(W_{0j}-\omega_j\right) - \gamma_j \Phi'\left(\omega_j\right) + \lambda\left(I'\left(W_{0j}-\omega_j\right) + \sum_{i=1}^{N} M_i \pi_i'\left(W_{0j}-\omega_j\right)\right) = 0 \quad \forall j$$

By definition, $\sum_{i=1}^{N} \pi_i\left(W_{0j}-\omega_j\right) = 1$, so we have $\sum_{i=1}^{N} \pi_i'\left(W_{0j}-\omega_j\right) = 0$. Furthermore, differentiating equation (7), which defines the risk-adjusted premium, $P\left(W_{0j}-\omega_j\right)$, yields the fact that:

(A-9) $P'\left(W_{0j}-\omega_j\right) = -\sum_{i=1}^{N} \pi_i'\left(W_{0j}-\omega_j\right) M_i \quad \forall j$.

These equations and (A-5) permit a further simplification of equation (A-8):

(A-10) $-\Phi'\left(\omega_j\right) - U'\left(C_j^*\right)\left(I'\left(W_{0j}-\omega_j\right) - P'\left(W_{0j}-\omega_j\right)\right) = 0 \quad \forall j$

Hence, the social optimum requires each individual to equate the marginal (utility) costs of weight loss with the marginal (utility) benefits from the weight loss—an increase in income and a reduction in expected medical costs.

One feasible allocation that meets (A-10) would set consumption for each individual equal to income, less the risk-adjusted premium given weight:

(A-11) $C_j^* = I\left(W_{0j}-\omega_j\right) - P\left(W_{0j}-\omega_j\right) \ \forall j$

It is easy to show that this allocation would be optimal for some distribution of initial bodyweight, $\{W_{0j}\}$, and some set of Pareto weights, $\{\gamma_j\}$. In this allocation, there are no transfers between individuals with different initial bodyweights. Other optimal and feasible allocations are possible, but these would involve fixed transfers between individuals that do not depend upon final bodyweight (though they might depend upon initial bodyweight). Optimal transfers would clearly vary with $\{\gamma_j\}$, though all optimal allocations would need to obey condition (A-10).

Figure 1: Model Timeline

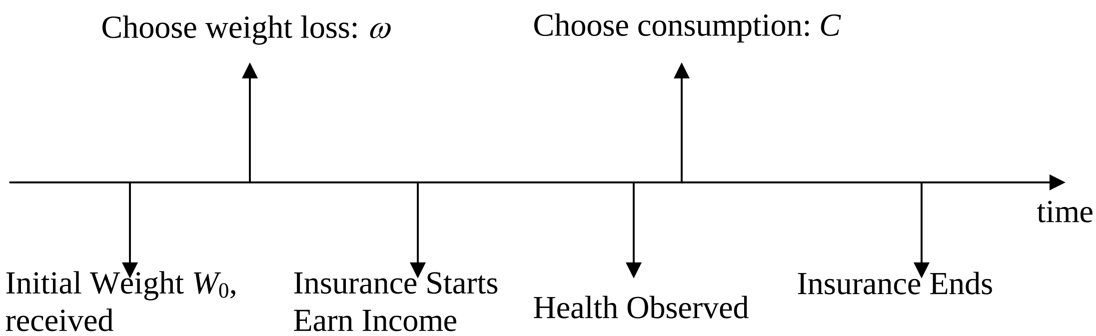

Table 1: Study Population Characteristics by Plan Assignment

	All	Free	25%	50%	95%	Individual
N	2,461	824	492	167	442	536
BMI at Entry	24.79	24.80	24.70	24.89	24.73	24.89
	(4.53)	(4.45)	(4.81)	(4.02)	(4.41)	(4.63)
BMI at Exit	25.31	25.39	25.03	25.43	25.31	25.40
	(4.78)	(4.64)	(4.76)	(4.63)	(5.16)	(4.76)
BMI Change	0.52	0.59	0.33	0.55	0.58	0.51
	(2.45)	(2.46)	(2.16)	(2.42)	(2.75)	(2.44)
BMI Change Per Year	0.15	0.16	0.10	0.15	0.17	0.15
	(0.74)	(0.74)	(0.62)	(0.66)	(0.86)	(0.74)
Obese at Entry	0.12	0.12	0.12	0.13	0.11	0.13
Obese at Exit	0.14	0.14	0.13	0.16	0.12	0.15
Became Obese	0.04	0.04	0.03	0.06	0.04	0.05

Note: Used chi-square test for categorical variables and t-test of mean relative to free for continuous variables. No differences are statistically significant.

Table 2: The Effect of Insurance Coverage on Body Weight and Obesity - Randomized Health Plan Assignment

	BMI Change Per Year			Became Obese		
	(1)	(2)	(3)	(1)	(2)	(3)
25% Coinsurance Rate	-0.109	-0.175	-0.179	-0.005	-0.012	-0.016
	[1.48]	[2.20]*	[2.25]*	[0.23]	[0.57]	[0.71]
50% Coinsurance Rate	-0.062	-0.139	-0.132	0.025	0.016	0.007
	[0.64]	[1.36]	[1.26]	[0.92]	[0.56]	[0.24]
95% Coinsurance Rate	-0.032	-0.111	-0.114	0	-0.01	-0.015
	[0.40]	[1.28]	[1.31]	[0.00]	[0.41]	[0.61]
Individual Deductible	-0.037	-0.071	-0.079	0.01	0.007	0.004
	[0.72]	[1.33]	[1.45]	[0.68]	[0.46]	[0.25]
Maximum $ Expenditure	0	0	0	0	0	0
	[0.70]	[1.65]	[1.93]	[0.35]	[0.18]	[0.73]
Constant	0.161	0.442	0.39	0.051	0.168	0.197
	[6.32]**	[1.92]	[1.66]	[2.88]**	[2.59]**	[2.95]**
Includes Individual Controls		X	X		X	X
Includes Site Effects and Participation Incentive			X			X
Observations	2441	2441	2441	2441	2441	2441
R-squared	0	0.01	0.01	0	0.01	0.01

Absolute value of t statistics in brackets

* significant at 5%; ** significant at 1%

Table 3: Effect of Public and Private Insurance on BMI and Obesity: 2SLS Results

	BMI-No State FE		BMI-State FE		Obese-No State FE		Obese-State FE	
	coefficient	**std error**	**coefficient**	**std error**	**coefficient**	**std error**	**coefficient**	**std error**
Public Ins.	0.7002	1.2298	-3.8172	10.7426	-0.0840	0.0931	-0.1239	0.7831
Private Ins.	0.9065	0.7741	-7.7786	4.8906	0.0168	0.0570	-0.4573	0.3595
Year == 1990	0.2208	0.0765	0.2926	0.1095	0.0119	0.0056	0.0151	0.0077
Year == 1992	0.5856	0.0889	0.5303	0.1086	0.0330	0.0066	0.0300	0.0077
Year == 1993	0.7054	0.1047	0.4364	0.3817	0.0415	0.0078	0.0188	0.0272
Year == 1994	0.7935	0.1091	0.6006	0.3900	0.0485	0.0082	0.0298	0.0279
Year == 1996	0.9836	0.1129	0.8122	0.2803	0.0525	0.0085	0.0378	0.0200
Year == 1998	1.2102	0.1216	1.2379	0.2245	0.0708	0.0092	0.0687	0.0162
Year == 2000	1.6074	0.1339	1.7121	0.1918	0.0999	0.0102	0.1041	0.0139
Year == 2002	1.7830	0.1506	1.6174	0.2067	0.1029	0.0114	0.0919	0.0148
Year == 2004	1.8644	0.1740	1.5763	0.2957	0.1091	0.0132	0.0889	0.0212
Age	0.3858	0.0652	0.4975	0.1064	0.0230	0.0049	0.0284	0.0077
Age Square	-0.0039	0.0009	-0.0051	0.0013	-0.0002	0.0001	-0.0003	0.0001
Nonwhite	1.3416	0.0657	1.0474	0.4127	0.0789	0.0050	0.0556	0.0295
Male	0.8224	0.0857	0.4774	0.6630	-0.0151	0.0065	-0.0214	0.0484
Educ 0 to 8 yrs	1.1532	0.2615	-1.1703	1.2250	0.0732	0.0188	-0.0633	0.0890
Educ 8 to 12 yrs	0.4730	0.0959	-0.4040	0.5038	0.0322	0.0072	-0.0222	0.0363
Income ($000s)	-0.0007	0.0002	0.0013	0.0012	-0.0001	0.0000	0.0001	0.0001
AFQT Quartile 1	1.0038	0.2004	-0.8140	1.1223	0.0666	0.0149	-0.0549	0.0801
AFQT Quartile 2	0.6752	0.1019	-0.1584	0.4249	0.0397	0.0075	-0.0106	0.0309
AFQT Quartile 3	0.3557	0.0658	0.0390	0.1703	0.0215	0.0050	0.0023	0.0124
Constant	14.8588	1.2164	20.5830	3.4176	-0.4152	0.0910	-0.0761	0.2477

Table 4: Effect of Public and Private Insurance on BMI and Obesity: MLE Results

	BMI-No State FE		**BMI-State FE**		**Obese-No State FE**		**Obese-State FE**	
	coefficient	**std error**	**coefficient**	**std error**	**coefficient**	**std error**	**coefficient**	**std error**
Private Ins.	1.269	0.093	1.309	0.094	0.847	0.245	0.987	0.311
Public Ins.	2.092	0.151	2.190	0.154	0.667	0.205	0.873	0.264
Year == 1990	0.214	0.076	0.217	0.076	0.125	0.053	0.130	0.056
Year == 1992	0.586	0.089	0.583	0.089	0.318	0.060	0.332	0.066
Year == 1993	0.667	0.092	0.655	0.092	0.366	0.064	0.376	0.072
Year == 1994	0.751	0.098	0.744	0.098	0.406	0.067	0.420	0.076
Year == 1996	0.957	0.108	0.956	0.108	0.443	0.075	0.462	0.086
Year == 1998	1.187	0.120	1.187	0.120	0.544	0.082	0.565	0.095
Year == 2000	1.593	0.133	1.594	0.133	0.718	0.095	0.752	0.116
Year == 2002	1.777	0.149	1.783	0.149	0.762	0.107	0.803	0.132
Year == 2004	1.849	0.170	1.851	0.170	0.806	0.118	0.848	0.144
Age	0.378	0.064	0.376	0.064	0.190	0.036	0.196	0.039
Age Square	-0.004	0.001	-0.004	0.001	-0.002	0.000	-0.002	0.001
Nonwhite	1.308	0.050	1.325	0.052	0.482	0.044	0.531	0.065
Male	0.906	0.041	0.918	0.041	0.028	0.038	0.048	0.044
Educ 0 to 8 yrs	1.199	0.156	1.166	0.155	0.598	0.106	0.638	0.131
Educ 8 to 12 yrs	0.470	0.049	0.505	0.049	0.244	0.040	0.286	0.053
Income ($000s)	-0.001	0.000	-0.001	0.000	-0.004	0.002	-0.004	0.002
AFQT Quartile 1	0.965	0.077	0.877	0.078	0.476	0.067	0.454	0.079
AFQT Quartile 2	0.694	0.065	0.650	0.066	0.327	0.047	0.316	0.054
AFQT Quartile 3	0.366	0.057	0.345	0.058	0.180	0.036	0.170	0.039
Constant	14.671	1.089	14.494	1.093	-7.108	0.830	-7.508	1.052

Appendix Table 1: RAND Enrollees Demographic and Health Status Covariates are Balanced at Start of Experiment

	All	Free	25%		50%		95%		Individual
N	2,461	824	492		167		442		536
Age (Years)	37.36	37.85	36.91		38.35		37.35		36.70
	(11.18)	(11.51)	(10.69)		(11.16)		(11.14)		(11.14)
Education (Years of School Completed)	12.34	12.15	12.48		12.47		12.41		12.39
	(3.03)	(3.20)	(2.91)		(3.07)		(2.87)		(3.00)
Family Income (Year Preceding Enrollment)	11524	11135	11879	*	12993	**	11654		11229
	(5772)	(5734)	(5785)		(5825)		(5791)		(5710)
Participation Incentive Offered at Enrollment	461.17	175.32	702.81	**	811.14	**	733.22	**	345.40
	(370)	(238)	(281)		(324)		(348)		(211)
Race - White	0.88	0.87	0.87		0.92		0.86		0.88
Race - Black	0.11	0.12	0.11		0.07		0.13		0.11
Race - Other	0.01	0.01	0.02		0.01		0.01		0.01
Married	0.80	0.81	0.81		0.83		0.77		0.79
Female	0.54	0.54	0.53		0.56		0.57		0.53
Self Reported Health Status - Excellent	0.45	0.45	0.45		0.49		0.46		0.45
Self Reported Health Status - Good	0.43	0.42	0.43		0.40		0.43		0.45
Self Reported Health Status - Fair	0.09	0.10	0.10		0.10		0.09		0.07
Self Reported Health Status - Poor	0.02	0.03	0.01		0.02		0.02		0.02
Self Reported Health Status - Missing	0.01	0.01	0.01		-		0.01		0.00

Appendix Table 2: First Stage Results for 2SLS models

	Public-No State FE		**Public-State FE**		**Private-No State FE**		**Private-State FE**	
	coefficient	**std error**	**coefficient**	**std error**	**coefficient**	**std error**	**coefficient**	**std error**
% in firms 0 to 499	0.5466	0.0981	0.2126	0.2822	2.3617	0.1736	0.8901	0.4992
% in firms 500+	-0.0248	0.0315	0.1117	0.1035	0.7434	0.0558	0.3727	0.1831
Pr. Medicaid Enrollment	0.2074	0.0125	0.0650	0.0233	-0.2722	0.0221	-0.1143	0.0412
Year == 1990	0.0030	0.0038	0.0034	0.0038	0.0057	0.0067	0.0058	0.0066
Year == 1992	-0.0127	0.0044	-0.0037	0.0046	0.0080	0.0077	-0.0008	0.0082
Year == 1993	0.0240	0.0045	0.0345	0.0048	-0.0395	0.0079	-0.0454	0.0085
Year == 1994	0.0190	0.0048	0.0334	0.0054	-0.0276	0.0084	-0.0358	0.0095
Year == 1996	-0.0027	0.0053	0.0168	0.0063	-0.0108	0.0094	-0.0242	0.0111
Year == 1998	-0.0045	0.0057	0.0081	0.0066	-0.0024	0.0100	-0.0045	0.0116
Year == 2000	-0.0117	0.0061	-0.0019	0.0075	-0.0020	0.0109	0.0026	0.0133
Year == 2002	-0.0144	0.0067	-0.0004	0.0079	-0.0252	0.0118	-0.0259	0.0139
Year == 2004	-0.0124	0.0075	0.0083	0.0091	-0.0401	0.0133	-0.0431	0.0161
Age	0.0024	0.0028	0.0026	0.0028	0.0115	0.0050	0.0115	0.0050
Age Square	0.0000	0.0000	0.0000	0.0000	-0.0001	0.0001	-0.0001	0.0001
Nonwhite	0.0384	0.0021	0.0452	0.0022	-0.0489	0.0037	-0.0604	0.0038
Male	-0.0581	0.0018	-0.0591	0.0018	-0.0099	0.0031	-0.0093	0.0031
Educ 0 to 8 yrs	0.0444	0.0058	0.0486	0.0058	-0.2875	0.0103	-0.2891	0.0103
Educ 8 to 12 yrs	0.0314	0.0021	0.0330	0.0021	-0.1177	0.0037	-0.1217	0.0037
Income ($000s)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
AFQT Quartile 1	0.0991	0.0032	0.1016	0.0032	-0.2578	0.0057	-0.2532	0.0057
AFQT Quartile 2	0.0166	0.0028	0.0166	0.0028	-0.1049	0.0049	-0.1000	0.0050
AFQT Quartile 3	0.0039	0.0026	0.0040	0.0026	-0.0393	0.0046	-0.0363	0.0046
Constant	-0.2159	0.0550	-0.2087	0.0954	0.1500	0.0973	0.4747	0.1688
F-statistic	**139.14**		**2.91**		**120.51**		**4.52**	

Appendix Table 3: First Stage Results for MLE models

	Public-No State FE		**Public-State FE**		**Private-No State FE**		**Private-State FE**	
	coefficient	**std error**	**coefficient**	**std error**	**coefficient**	**std error**	**coefficient**	**std error**
% in firms 0 to 499	30.8556	2.4072	4.3208	7.6902	19.1894	1.3751	7.3312	3.9023
% in firms 500+	4.3796	0.7933	1.6022	2.7916	5.2915	0.3981	2.9991	1.4132
Pr. Medicaid Enrollment	4.4842	0.3433	2.6147	0.6278	-0.9681	0.1700	-0.5031	0.3142
Year == 1990	0.3162	0.1116	0.3262	0.1127	0.0007	0.0489	0.0050	0.0492
Year == 1992	-0.0120	0.1262	0.1355	0.1351	-0.1021	0.0582	-0.1165	0.0621
Year == 1993	0.4193	0.1160	0.6246	0.1271	-0.2763	0.0581	-0.2648	0.0642
Year == 1994	0.3185	0.1244	0.6093	0.1416	-0.2482	0.0632	-0.2332	0.0726
Year == 1996	-0.0108	0.1413	0.3621	0.1672	-0.3029	0.0729	-0.3035	0.0868
Year == 1998	0.0382	0.1503	0.3687	0.1769	-0.3046	0.0795	-0.2501	0.0929
Year == 2000	-0.0818	0.1633	0.2923	0.2035	-0.4447	0.0911	-0.3552	0.1108
Year == 2002	-0.2835	0.1747	0.1370	0.2090	-0.7410	0.1012	-0.6743	0.1184
Year == 2004	-0.3777	0.1922	0.2090	0.2387	-0.9700	0.1175	-0.8876	0.1392
Age	0.0110	0.0744	0.0206	0.0756	0.0283	0.0390	0.0292	0.0393
Age Square	0.0005	0.0010	0.0003	0.0011	-0.0001	0.0006	-0.0001	0.0006
Nonwhite	0.6359	0.0498	0.7414	0.0523	-0.1566	0.0274	-0.2274	0.0287
Male	-1.2173	0.0510	-1.2798	0.0518	-0.8610	0.0600	-0.8638	0.0606
Educ 0 to 8 yrs	-0.4444	0.1125	-0.3718	0.1149	-1.3949	0.0734	-1.4182	0.0736
Educ 8 to 12 yrs	0.0239	0.0614	0.0572	0.0630	-0.6009	0.0330	-0.6471	0.0330
Income ($000s)	-0.0001	0.0000	-0.0001	0.0000	0.0001	0.0000	0.0001	0.0000
AFQT Quartile 1	1.2465	0.1160	1.3352	0.1183	-1.0656	0.0556	-1.0274	0.0574
AFQT Quartile 2	0.8320	0.1115	0.8737	0.1136	-0.6747	0.0432	-0.6411	0.0441
AFQT Quartile 3	0.6693	0.1125	0.6819	0.1140	-0.3459	0.0416	-0.3292	0.0420
Constant	-11.4118	1.4551	-6.5811	2.5957	-3.4054	0.7344	-0.8305	1.3061