NBER WORKING PAPER SERIES

THE IMPACT OF INCOME ON THE WEIGHT OF ELDERLY AMERICANS

John Cawley
John R. Moran
Kosali I. Simon

The Impact of Income on the Weight of Elderly Americans
John Cawley, John R. Moran, and Kosali I. Simon
NBER Working Paper No. 14104
June 2008
JEL No. H55,I1,I12,I38,J14,J26

ABSTRACT

This paper tests whether income affects the body weight and clinical weight classification of elderly Americans using a natural experiment that led otherwise identical retirees to receive significantly different Social Security payments based on their year of birth. We exploit this natural experiment by estimating models of instrumental variables using data from the National Health Interview Surveys. The model estimates rule out even moderate effects of income on weight and on the probability of being underweight or obese, especially for men.

John Cawley
124 MVR Hall
Department of Policy Analysis and Management
Cornell University
Ithaca, NY 14853
and NBER
jhc38@cornell.edu

Kosali I. Simon
137 MVR Hall
Department of Policy Analysis & Management
Cornell University
Ithaca, NY 14853-4401
and NBER
kis6@cornell.edu

John R. Moran
604 Ford Building
Department of Health Policy and Administration
Pennsylvania State University
University Park PA 16802
jrm12@psu.edu

Introduction

The goal of this paper is to estimate the causal impact of income on weight and clinical weight classification for elderly Americans. Even the correlation of income with weight has been the subject of disagreement. It is frequently stated that the poor are more likely to be obese[2] (e.g. Drewnowski and Specter 2004; Critser 2003), but research findings on the relationship between income and obesity have long been inconsistent. Sobal and Stunkard (1989) review studies on obesity and socioeconomic status (frequently measured by income) for developed countries and conclude that while results vary considerably, on the whole there appears to be a strong inverse relationship for women but an inconsistent relationship for men and children.[3] A recent careful analysis of data from the National Health and Nutrition Examination Surveys reveals a more complicated and nuanced picture: during much of the period 1971-2002 there was no statistically significant difference in rates of overweight (body mass index[4] or BMI greater than or equal to 25) between the poor (defined as income less than 130% of the poverty line) and nonpoor, but the poor do have a significantly higher prevalence of obesity (BMI>=30) (Joiffe 2007). In the most recent data (2003-04), the poor had a significantly *lower* prevalence of overweight, and a statistically indistinguishable prevalence of obesity, relative to the nonpoor (Ibid).

Lakdawalla and Philipson (2002) argue that the impact of income on weight may depend on initial weight and on the source of the income. Their model implies that additional income

---

[2] For example, Drewnowski and Specter (2004) write: "There is no question that the rates of obesity and type 2 diabetes in the United States follow a socioeconomic gradient, such that the burden of disease falls disproportionately on people with limited resources, racial-ethnic minorities, and the poor." (p. 6). Critser (2003) writes: "Poverty. Class. Income. Over and over, these emerged as the key determinants of obesity and weight-related disease." (p. 116).

[3] There is little research on the correlation between income and obesity among the elderly in particular, but Hedley and Ogden (2006) find that the patterns for adults aged 50 and older are similar to those for adults aged 20-49; i.e. for both age groups, the probability of obesity is uncorrelated with income for white males, but the probability of obesity falls with income for white females.

will lead to increased food consumption and therefore weight gain among underweight

individuals and will lead to decreased food consumption and therefore weight loss among

overweight individuals. They also hypothesize that weight may be affected differently by earned

income than by unearned income (also see Lakdawalla, Philipson, and Bhattacharya, 2005). If

work is sedentary, earned income may imply a bigger increase in weight than unearned income,

because the earned income is accompanied by a work-related reduction in physical activity.

Schroeter et al. (2008) use published income elasticities of demand for food to estimate

that a 10% rise in income leads to very large changes in weight: roughly 25 pounds for the

average male and 22 pounds for the average female. However, these estimates may be

implausibly high. For example, during the period 1900 – 2000, per capita personal income in the

U.S. rose 16.3%[5] but average weight gain was only 9 - 12 pounds (Freedman et al. 2002), despite

the fact that changes in many other variables than income may have contributed to a rise in

weight (e.g. Lakdawalla and Philipson 2002; Anderson, Butcher, and Levine 2003; Cutler,

Glaeser, and Shapiro 2003; Chou, Grossman, and Saffer 2004).

To our knowledge, two previous papers have sought to estimate the causal impact of

income on weight.[6] Quintana-Domeque (2005) used the method of instrumental variables to

estimate the impact of income on weight using as a natural experiment whether the household

received an inheritance, gift, or lottery winnings, but these windfalls explain so little variation in

income (that is, they are such weak instruments) that the estimates are very imprecise.

Schmeiser (2008) exploits variation across states in the generosity of the Earned Income Tax

Credit (ETIC) to estimate the impact of EITC income on the BMI of the relatively young

---

[4] Body mass index is equal to weight in kilograms divided by height in meters squared.
[5] Authors' calculations based on per capita personal income data from Bureau of Economic Analysis, U.S.
Department of Commerce, and the inflation calculator on the Bureau of Labor Statistics website.

(roughly 25-43 year old), low-income Americans. In all models, Schmeiser is unable to reject the null hypothesis of no effect of income on weight for (low-income) men. His results for (low-income) women indicate that an additional $1,000 per year is associated with a gain of between 0.14 and 0.31 BMI units or an average increase of between 0.84 to 1.80 pounds.

This paper and Schmeiser (2008) complement each other; we contribute to the literature by estimating the impact of income on weight for another vulnerable population: the elderly. Our method involves exploiting a natural experiment in the United States known as the Social Security Benefits Notch, which generated large exogenous differences in income across otherwise identical individuals. This natural experiment affected the elderly, for whom weight classification is an important indicator of health. To preview the results, our instrumental variables estimates yield no evidence that income affects weight or the probability of being underweight or obese among elderly Americans; even moderate effects can be ruled out.

In subsequent sections we discuss the significance of weight classification for the elderly (our population of interest), describe the natural experiment we exploit (the Social Security Benefits Notch), describe our data (the National Health Interview Surveys) and empirical methods, before turning to a discussion of the empirical results.

The Significance of Weight for the Health of the Elderly

The recent rise in the prevalence of obesity in the U.S. has been experienced by the elderly as well as by those of younger ages. The prevalence of obesity[7] (BMI>=30) among American men aged 60-74 quadrupled from 8.4 percent in 1960-62 to 35.8 percent in 1999-2000

---

[6] In contrast, several papers have estimated the causal impact of weight on wages; e.g. Cawley (2004), Morris (2006), Lundborg et al. (2007), Brunello and D'Hombres (2007), Norton and Han (2008), and Greve (forthcoming).
[7] The same BMI thresholds are used to define underweight and obesity in the elderly as in younger adults (Heiat et al., 2001).

(Flegal et al., 2002). Over the same period, the prevalence of obesity among American women aged 60-74 rose by 50 percent: from 26.2 percent to 39.6 percent (Ibid). More recently (1997-2002), the prevalence of obesity in the Medicare population increased by 5.6 percentage points, or by about 2.7 million beneficiaries (Doshi et al., 2007). One reason that it is important to understand whether income affects the weight of the elderly is because it would shed light on whether rising income was in part responsible for the recent rise in elderly obesity.

Obesity among the elderly is a public health and public policy concern because it has consistently been associated with increased risk of disability, limitations in activities of daily living, diabetes, other chronic conditions, and lower quality of life (Lakdawalla, Goldman, and Shang, 2005; Heiat, Vaccarino, and Krumholz, 2001; Elia, 2001; Himes, 2000). From age 70 onward, Medicare spends 35 percent more on obese individuals than on healthy-weight individuals (i.e. those with BMI between 18.5 and 25); this amounts to an additional $36,000 in Medicare costs over the obese person's remaining lifetime (Lakdawalla, Goldman, and Shang, 2005). Finkelstein et al. (2003) estimate that between 51.5 and 78.5 billion dollars (2002$) of Medicare spending per year is attributable to overweight and obesity.

The public health impact of elderly obesity is of growing concern for several reasons (Doshi et al., 2007). First, obesity among the elderly is projected to continue to rise (Arterburn, Crane, and Sullivan, 2004). Second, the percentage of the U.S. population over age 65 is also projected to rise, from 12.2 percent in 2005 to 15.8 percent in 2020, 19.4 percent in 2030, and further to 20.5 percent in 2040 (Board of Trustees, Federal Old-Age and Survivors Insurance, 2006). Third, health care expenditures are disproportionately devoted to the elderly. The average per capita total health care expenditure on Americans over age 65 was $11,089, which is four times the amount spent per capita on those under age 65: $3,352 (Keehan et al., 2004).

Overall, the 13 percent of the population over age 65 consumed 36 percent of all health care spending (Ibid). Moreover, the percentage of health care expenditures devoted to the elderly is expected to increase because the life expectancy of the elderly has been rising (National Center for Health Statistics, 2005). The combination of all of these factors – the elderly constituting a rising share of the population, increased life expectancy by the elderly, and increased obesity among the elderly - creates the potential for large increases in the health care costs attributable to elderly obesity.

At the lower end of the weight classification system, underweight status (sometimes referred to as "frailty"), defined as a BMI less than 18.5, has consistently been found to be correlated with increased risk of morbidity and mortality for the elderly (e.g. Corrada et al., 2006). While it may be true that "you can never be too rich", for the elderly it is possible to be "too thin." In fact, their mortality risk associated with being underweight may exceed the risk associated with being obese (Taylor and Ostbye, 2001). To an unknown extent, this may be due to unobserved illness causing weight loss prior to death (Adams et al., 2005). The correlation of underweight status with mortality risk among the elderly motivates us to examine the impact of Social Security income on underweight status as well as obese status.

Another important risk factor for morbidity and mortality among the elderly is body composition. As people age, they tend to lose muscle mass and gain fat mass (Zamboni et al., 2005; Elia, 2001). Body mass index (BMI) is a measure of overall body mass and does not distinguish fat from fat-free mass (Prentice and Jebb, 2001; U.S. DHHS, 2001). As a result, it cannot precisely indicate when the elderly have either morbid levels of fatness or dangerously low levels of muscle and bone mass (Himes, 2000). For this reason, there have been calls to replace BMI with a measure of fatness based on body composition (Smalley et al, 1990; Garn et

al, 1986; Burkhauser and Cawley, 2008). However, publicly-available social science datasets

lack these more accurate measures of fatness based on body composition. Utilizing the data that

are available, we study a nationally representative sample of elderly Americans that includes

information on weight and height, which allow us to calculate BMI.

Natural Experiment: The Social Security Benefits Notch

This section describes the Social Security Benefits Notch, a natural experiment used by

us (and others) to isolate exogenous variation in the incomes of the elderly. Prior to 1972, neither

lifetime earnings (upon which Social Security benefits are based) nor post-retirement benefit

payments were indexed for inflation. Instead, Congress periodically adjusted benefits, enacting

large increases in 1967, 1969, 1971 and 1972. In 1972, Congress amended the Social Security

Act to provide automatic indexation of credited earnings for workers who had not yet retired.

The 1972 Amendments created an unintentional windfall for workers from certain birth cohorts

because of an error that led the prior earnings of these workers to be doubly indexed for inflation.

The high rates of inflation that occurred shortly thereafter ensured that this error led to a rapid

increase in benefits for the affected cohorts. As they retired, successive birth cohorts received

benefits that represented progressively increasing replacement rates (i.e. percentages of their pre-

retirement income); see Figure 1A. In the absence of new legislation, double indexation would

have eventually resulted in retirees receiving Social Security benefits larger than their pre-

retirement income (Social Security Administration, 2006).

In 1977, Congress eliminated double indexation for future cohorts of retirees by

correcting the error in the benefits formula. However, cohorts born prior to 1917 retained

doubly-indexed (i.e. higher) benefits under a grandfather provision. As a result, there arose a

permanent difference in Social Security payments across birth cohorts that came to be known as

the Social Security Benefits Notch (see Figure 1B).[8] This difference in benefits was large,

unanticipated,[9] and beyond the control of any individual retiree, and, as a result, constitutes a

valid natural experiment for estimating income effects among the elderly. The Benefits Notch

has been used to estimate the effect of income on retirement behavior (Krueger and Pischke,

1992), mortality (Snyder and Evans, 2006), living arrangements (Engelhardt, Gruber and Perry,

2005), the demand for prescription drugs (Moran and Simon, 2006), and homeownership

(Engelhardt, forthcoming). In a subsequent section we demonstrate that the Benefits Notch

generated sufficient variation in Social Security income for the purposes of this study.

A fortuitous feature of the Benefits Notch (from a research perspective) is the permanent

nature of the income differentials created by double indexation, which persisted throughout

retirement for the cohorts we study. As a result, our estimates will reflect the cumulative impact

of all previous additional Social Security income received due to the Notch. Because our

outcome of interest is the stock of past consumption (weight), the permanence of the double-

indexation windfall is useful because it allows us to estimate the change in steady-state weight

due to a longstanding change in income; an isolated single-year windfall would be unlikely to

have any contemporaneous impact on the stock of weight, but it is conceivable that a permanent

---

[8] The Notch refers to the cohorts with the lowest benefit levels (those born between 1917 and 1921 – see Figure 1B). However, studies that use the associated variation in benefits as a natural experiment generally classify the cohorts with peak benefits (those born 1915-1917) as the treatment group, and those from adjacent cohorts with lower benefits as the control group (e.g. Engelhardt, Gruber and Perry, 2005).

[9] The windfall was unanticipated because the benefit difference became apparent only when the various cohorts began receiving Social Security checks. As Snyder and Evans (2006) note, "The Commission's account indicates that the difference in Social Security benefits was unanticipated: 'After comparing their benefit checks against the larger checks of their pre-"Notch" colleagues, neighbors, and friends with similar employment records, they began expressing their dissatisfaction to public officials – and the "Notch" issue was born.' (Commission on the Social Security "Notch" Issue, 1994)."

stream of additional income could. [10]

Data: National Health Interview Survey (NHIS)

The National Health Interview Survey (NHIS) is a nationally representative survey of the

civilian non institutionalized population of the United States. The survey interviews

approximately 43,000 households consisting of approximately 106,000 individuals every year

(although the number varies over time) and asks a variety of core questions as well as special

modules of questions. In every year after 1975, weight and height (needed to calculate BMI) are

included in the core dataset. The dollar amount of Social Security benefits was asked from 1990-

1996. However, Social Security income data for 1993 were never released in public use form.

The number of unique individuals surveyed by the NHIS from 1990-92 and 1994-96 is 642,411.

We limit our sample to respondents aged 55 or older in a household headed by a Social

Security beneficiary born between 1901 and 1930 who do not have missing data on variables

used in the analysis. We also exclude a small number of households that report no Social

Security income or very low amounts (less than $100/month in 1996 dollars). Across the years

1990-92 and 1994-96 our NHIS sample includes 46,153 households that are home to roughly

69,000 individuals.

Ideally we would construct our weight variables (BMI and indicator variables for clinical

weight classification) using measurements of weight and height. Instead, the NHIS contains

self-reports of weight and height. Self-reported weight is characterized by reporting error

(Rowland, 1989). In general, the direction of reporting bias is negatively correlated with actual

weight: underweight people tend to over-report their weight, and overweight people tend to

---

[10] Because we use income data from the early to mid-1990s, and our treatment group consists of households with a
primary Social Security beneficiary born between 1915 and 1917, the typical household in our treatment group has

under-report their weight. Such reporting error can result in severe misclassification of individuals into clinical weight classification (Nieto-Garcia, Bush and Keyl, 1990). We correct for reporting error in weight and height as in previous research (e.g. Cawley 2004; Cawley and Burkhauser, 2006).

The NHIS lacks detailed data on caloric intake and energy expenditure; as a result we are not able to determine the mechanism (altered diet or altered physical activity) by which income affects weight (if in fact it does affect weight). This paper focuses on measuring the total effect of income on weight, which reflects the combined effect of income on diet, physical activity, and other behaviors.

Table 1 provides descriptive statistics for our dependent variables and the endogenous regressor (Social Security income). The average BMI among males in our sample is 26.2 and among women it is 26.4. Two percent of men and four percent of women are clinically underweight (defined as a BMI less than 18.5). Those in the healthy weight category (BMI between 18.5 and 25) constitute 39 percent of the male sample and 40 percent of the female sample. Forty four percent of men and thirty four percent of women are clinically overweight but not obese (defined as a BMI greater than or equal to 25 but less than 30). Fifteen percent of men and twenty-two percent of women are clinically obese (defined as a BMI of 30 or higher). The average annual household Social Security income in 2006 dollars is slightly over $16,000 for men and roughly $13,900 for women.

Methods

---

been receiving (elevated) Social Security benefits for slightly more than a decade at the time we observe them.

To determine the causal impact of income on clinical weight classification and BMI, we construct instrumental variables (IV) estimates of the effect of income on body weight using the variation in Social Security income attributable to the Benefits Notch. The first- and second-stage equations take the forms shown below:

(1) $$I_{ht} = \gamma + \theta Notch_h + \phi \mathbf{X}_{iht} + u_{iht}$$

(2) $$Weight_{iht} = \alpha + \beta \hat{I}_{ht} + \delta \mathbf{X}_{iht} + \varepsilon_{iht}$$

where i denotes an individual, h denotes households and t denotes years. In the first stage (equation 1), I_{ht} is Social Security income (measured in thousands of dollars) for household h in year t. Income is measured at the household level because we assume that married or cohabitating individuals pool resources and make joint decisions about diet and activities that have an effect on weight. When estimating equations (1) and (2), data will be weighted using NHIS survey weights, and standard errors will be clustered by year of birth.

For binary dependent variables we estimate equation (2) using two-stage least squares (2SLS) because IV probit models failed to converge in most cases. (The IV probit marginal effects that could be estimated were similar to the 2SLS coefficients.) The linear probability model (LPM) has well-known limitations relative to probit and logit models, but the use of robust standard errors, which are automatically computed when using the cluster command in STATA, is an acceptable solution to the problem of heteroskedasticity, and overall the LPM is often a good approximation to the response probability for common values of the regressors (Wooldridge, 2002). Moreover, the consistency of parameter estimates obtained from the LPM

does not depend on the assumed distribution of the error term, as is the case with maximum

likelihood estimators such as probit and logit.[11]

Our instrument, labeled $Notch_h$ in equation (1), is an indicator variable that equals one for

households whose primary Social Security beneficiary was born during the years of 1915-1917

(this is the treatment group – those who benefited most from double indexation of Social

Security benefits), and zero for households whose primary Social Security beneficiary was born

in any other year between 1901 and 1930 (the control group)**.** Because the majority of married

women in these birth cohorts qualified for benefits based on their husband's earnings history

(Snyder and Evans, 2006), we follow previous work in designating the male member of two-

person households as the primary Social Security beneficiary; thus, for all households containing

a male, we use the male's year of birth to assign the household to either the treatment or control

group. Households with no males can be divided into two categories: never-married females and

widowed/divorced females. In the case of never-married females, we designate the female as the

primary beneficiary and use her year of birth to determine treatment-control status for the

household. In the case of widowed or divorced females, we designate the deceased or former

husband as the primary beneficiary and subtract three years from the female's year of birth to

impute a birth year for the deceased or former husband.[12]

There is some discretion in how one defines the group of birth cohorts "treated" by the

Social Security Benefits Notch. We define it as households with a primary Social Security

beneficiary born between 1915-1917, inclusive, because these are the households that benefited

---

[11] We also attempted to estimate quantile IV models to see if the impact of income on body weight varied at different points in the weight distribution, but these models also failed to converge.

[12] Engelhardt, Gruber and Perry (2005) note that three years is the median difference in spousal ages for widowed or divorced elderly.

the most from double indexation, and, as a result, provide the greatest variation in Social Security income relative to adjacent cohorts in our NHIS sample.

In choosing the range of birth cohorts to include in the control group we follow several previous studies that have used the Notch as a natural experiment (Krueger and Pischke, 1992; Engelhardt, Gruber and Perry, 2005) and define our control group as households with a primary Social Security beneficiary born 1901-1914 or 1918-1930. In our previous work on income and prescription drug use (Moran and Simon, 2006), our estimates were not sensitive to this choice.

In equations (1) and (2), $\mathbf{X}_{iht}$ is a vector of control variables at the individual or household level, specifically: race (white, black), Hispanic ethnicity, education (less than high school, high school graduate, some college, college graduate, more than college), marital status (married household, single male, divorced female, widowed female, never married female), urban residence, region of residence, and year (as linear and quadratic). In addition, we include a full set of indicator variables for age to control for the effect of aging on body weight described earlier. For married, widowed, and divorced women, we also control for the age of the primary Social Security recipient in the household using linear and quadratic functions of the primary beneficiary's age.

In the second stage (equation 2), $Weight_{iht}$ is a measure of weight (either BMI, or an indicator variable for one of the following clinical weight classifications: obese, overweight, healthy weight, or underweight) for an elderly adult i in household h in year t. The variable $\hat{I}_{ht}$ is predicted Social Security income from the first stage regression (equation 1). When $\hat{I}_{ht}$ is included in the second stage regression (equation 2), only the variation in Social Security income attributable to the Social Security Benefits Notch will be used in estimating the effect of income on body weight. Our identifying assumption is that the variation in Social Security income

induced by the Notch is uncorrelated with the unobservable determinants of body weight, as reflected in the error term ε_{iht}. (In defense of this assumption, recall that all age-specific variation in weight is absorbed by the set of age fixed effects.) Conditional on this assumption, the second stage coefficient on predicted Social Security income, β, will measure the causal impact of income on body weight.

In addition to estimating the effect of income on BMI, we also examine whether Social Security income decreases the probability of obesity, and whether Social Security income decreases the probability of underweight. These hypotheses are based on the theoretical work of Lakdawalla, Philipson, and Bhattacharya (2005), who predict that the effect of income on weight depends on the initial level of weight: for underweight individuals, additional income will lead to increased food consumption and therefore weight gain, whereas for overweight individuals additional income will lead to decreased food consumption or more physical activity and therefore weight loss.

Our data do not allow us to estimate separate income effects for the underlying mechanisms that determine body weight (food consumption or physical activity); instead, we estimate the total causal effect of income on weight and weight classification, incorporating all income-induced changes in behavior that influence BMI. Put another way, given a valid instrument, IV estimates provide the same information as if elderly households were randomly assigned different income levels; i.e., we obtain an estimate of the causal effect of income on body weight, but can offer no information on the various channels through which that causal effect operated.

Empirical Results

We first describe the basic correlation between body weight and Social Security income in the NHIS among those born 1901-1930. Table 2 shows, for increments of $5,000 in Social Security income (in 2006 dollars), the average BMI and percent obese for women and men. Among women, average BMI tends to fall slightly as Social Security income rises; specifically, average BMI falls from 26.74 for those who receive $5,000 or less annually to 26.16 for those who receive $20,000 to $25,000 annually. For a woman who is five feet, two inches tall, that difference in mean BMI (of 0.58 units) is equivalent to a difference of 3.2 pounds. For men, average BMI and percent obese vary only slightly with income. The difference of 0.35 units between the highest and lowest average BMI across income categories for men is equivalent to a difference of 2.4 pounds for a five foot, ten-inch tall male.

There are similar patterns of obesity prevalence over income. The prevalence of obesity tends to fall with income for women, from 24.6 percent among those with $5,000 or less in annual Social Security income to 20.1 percent among those with $20,000 to $25,000 annual benefits, a difference of 4.5 percentage points. In contrast, among men the prevalence of obesity rises and then remains roughly constant with income; the difference between the prevalence of obesity in the highest and lowest income categories is just 1.2 percentage points.

We next present conditional differences in BMI and clinical weight classification over Social Security income, based on our regression results that do not instrument for income. Table 3, which presents results for females, shows in column 1 that an extra $1,000 of Social Security income is associated with 0.013 units lower BMI. For a woman who is five feet, two inches tall, this translates into less than one-tenth of a pound. Among men (Table 4, column 1), an extra $1,000 of Social Security income is associated with 0.013 units higher BMI (which is the same magnitude, but opposite sign, as women). For a man who is five feet, ten inches tall, this

translates into less than one-tenth of a pound.

However, the correlation between income and weight may be nonlinear, so we present correlations of clinical weight classification with Social Security income. Table 3, column 1, indicates that among females an extra $1,000 of Social Security income is associated with a 0.1 percentage point lower probability of underweight and a 0.1 percentage point lower probability of obesity, both of which are statistically significant at the 10 percent level or better. Conditional on our regressors, women with $1,000 higher Social Security incomes are 0.2 percentage points more likely to be healthy weight. The sign of each of these correlations is consistent with the predictions of Lakdawalla and Philipson (2002).

Among males (Table 4, column 1), an extra $1,000 of Social Security income is associated with a 0.1 percentage point lower probability of underweight but no statistically significant difference in the probability of overweight or obesity. The difference in men's probability of being healthy weight associated with an extra $1,000 is also not statistically significant.

As discussed earlier, these correlations are hard to interpret, because they potentially reflect many distinct effects: the effect of income on weight, the impact of weight on lifetime earnings (and subsequently, Social Security benefits), and unobserved characteristics that may affect both weight and earnings (and subsequently, Social Security benefits).

Before presenting IV results, we first test whether the Social Security Notch generated significant differences in Social Security income across birth cohorts in the NHIS. Using data from the NHIS from 1990-1992 and 1994-1996 (recall that Social Security income data were not released for NHIS 1993), we graph household Social Security income by birth year for all birth cohorts between 1901 and 1930 after conditioning on other explanatory variables. Figure 2

illustrates that NHIS respondents born 1915-1917 (our treatment group in the natural experiment, which is illustrated on the graph as the birth cohorts between the vertical dashed lines) enjoy higher annual Social Security benefits than those born in other years between 1901 and 1930 (our control group). On average, those born 1915-1917 receive 7% higher benefits in the case of the male sample and 5% more in the case of the female sample, which translates into roughly $1,130 (in 2006 dollars) more annually for the male sample, and this windfall is received every year the recipient remains alive.

Annual income differences of this magnitude have the potential to affect body weight because even small changes in daily caloric intake can result in large changes in body weight over time. If even a small fraction of the additional income is spent on additional calories, changes in weight may result. For example, Hill et al. (2003) calculate that the recent rise in obesity in the U.S. was caused by a daily calorie surplus of just 15 calories for the median person, with 90 percent of the population increasing their intake by 50 or fewer calories per day. Apovian (2004) calculates that consuming an additional 12-ounce can of non-diet soda per day will add 15 pounds to a person's weight in one year. Weight is the stock of past consumption, so even small changes in daily flow can have a large impact on the stock over time. For this reason, even if the extra $1,130 annual Social Security income affected daily caloric intake only slightly, it has the potential to cause large changes in body weight over time.

Test statistics indicate that the Notch is a suitably powerful instrument for income. For both men and women, the partial F statistics in the first stage of our 2SLS model are close to 30, which is several times higher than the minimum standard of 10 cited in Stock, Wright, and Yogo (2002). This confirms that the Social Security Benefits Notch generated enough variation in income to be useful as an instrument in IV estimation.

The identifying assumption behind our IV estimation strategy is that being born between 1915 and 1917 affected Social Security income, but did not directly affect body weight, conditional on the observables in our second-stage regression. We have already confirmed the first part of that assumption: those birth year cohorts enjoyed significantly higher Social Security income. The second part of the identifying assumption, that the instrument (notch status) is uncorrelated with the second-stage error term is, strictly speaking, untestable. However, we can look for suggestive evidence on this by examining whether the weight of the treatment group varied from that of the control group *prior to receipt of any Social Security income*. If we find that the treatment group looked different from our control group with respect to our outcome of interest (body mass index), that would cast doubt on our identifying assumption (Heckman and Hotz 1989).

Figure 3(4) plots average BMI, conditional on our second-stage regressors, by birth year for women (men) in the National Health Interview Survey of 1976. Only those who have not yet retired are included in the sample. For both women (Figure 3) and men (Figure 4) the average BMI of the treatment group cohorts (shown between the vertical dashed lines) very closely resemble that of the adjacent birth year cohorts in the control group. For women, average BMI is quite flat, whereas for men there are small variations over birth-year cohorts, but in neither graph is the average BMI of the treatment group noticeably different from that of the control group. Estimates from reduced form regressions confirm that there are no statistically significant differences in pre-retirement BMI for the notch cohort. While this evidence is suggestive rather than definitive, it is consistent with our identifying assumption that birth year had no effect on BMI other than through Social Security income, conditional on our observables.

Figures 5 and 6 present reduced-form graphs of the IV results for the 1990s data: they

18

plot average BMI by birth year, conditional on our second-stage regressors. The Figures suggest that our IV regressions will indicate little effect of income on BMI; for both females (Figure 5) and males (Figure 6), the average BMI of the treatment group is very similar to that of adjacent birth cohorts in the control group.

The results of our IV regressions are presented in column 2 of Tables 3 (females) and 4 (males). No IV coefficient on Social Security income is statistically significant, for any of the BMI, underweight, overweight, healthy weight, or obesity regressions, for either females or males. As is often the case, the IV coefficients and standard errors are larger in absolute magnitude than those from models in which the endogenous variable has not been instrumented.

The most useful way to interpret our results may be to discuss the effect sizes our estimates rule out. Column 2 of Tables 3 and 4 present 95 percent confidence intervals for our IV estimates (defined as within 1.96 standard errors of the IV point estimate). In each case, the 95 percent confidence interval includes both zero and the OLS estimate. Moreover, we are able to exclude even moderate-sized effects of income on weight in most cases, especially for men. In considering the effect sizes that can be excluded, one should keep in mind that they correspond to a *permanent* $1,000 increase in annual Social Security income (in 2006 dollars), which is, on average, an increase of 7.2 percent for the females, and 6.2 percent for the males, in our sample.

Among men (Table 4), our estimated confidence intervals allow us to reject the hypothesis that a permanent increase of $1,000 in annual Social Security income lowers BMI by more than 0.095 units, or raises BMI by more than 0.081 units. This implies that, for a man who is 5 feet 10 inches tall, the extra income will not lower or raise weight by even two-thirds of one pound. The confidence interval on the IV coefficient implies that the income elasticity of BMI

cannot be less than -0.058 or greater than 0.05 for men.

Similarly, our confidence intervals suggest that an extra $1,000 in annual Social Security income does not decrease the risk of underweight by more than one-third of a percentage point or raise the risk of underweight by more than a tenth of a percentage point among men; this implies that differences in Social Security payments have little impact on frailty among the male elderly. We can also rule out reductions in the risk of overweight of more than 1.6 percentage points, or increases in the risk of overweight of more than 0.4 percentage points. Likewise, a reduction in the risk of obesity of more than 0.4 percentage points or an increase in the risk of obesity of more than 0.8 percentage points can be excluded. Finally, we can reject the hypothesis that an extra $1,000 in Social Security income raises the probability that a man is healthy weight by more than 1.4 percentage points or lowers it by more than 0.6 percentage points.

The range of possible effect sizes is greater for women than men, but are still fairly modest in the case of BMI and the probability of underweight. Among women (Table 3, column 2), an extra $1,000 in annual Social Security income will not lower BMI by more than 0.229 units or raise BMI by more than 0.249 units; for a woman who is 5 feet 2 inches tall, the extra income will not lower weight by more than 1.25 pounds or raise it by more than 1.36 pounds. The confidence interval on the IV coefficient implies that the income elasticity of BMI cannot be less than -0.120 or greater than 0.131 for women. The largest income elasticities we can exclude for men are half the size of those we can exclude for women.

For women, an extra $1,000 in Social Security income is unlikely to lower the risk of underweight by more than 0.6 percentage points or raise the risk of underweight by more than 1.4 percentage points; as for elderly men, differences in Social Security payments have little effect on frailty among elderly women. For women's risk of overweight and obesity, substantial

20

effects remain within the confidence interval. Our estimates imply that an extra $1,000 per year does not lower the risk of overweight by more than 1 percentage point or raise it by more than 4.2 percentage points or decrease the risk of obesity by more than 3.2 percentage points or raise the risk of obesity by more than 1.2 percentage points. Finally, our estimates indicate that an extra $1,000 in annual Social Security income would not raise the probability that a woman is healthy weight by more than 2.4 percentage points or lower it by more than 4.6 percentage points.

Limitations

Our analysis has several limitations. First, because our outcome of interest is weight, which is the stock of past consumption, lagged income as well as contemporaneous income is relevant. Unfortunately, the NHIS does not include lifetime income streams.[13] However, because members of the treatment group have received elevated Social Security payments for as long as they have received Social Security benefits, our estimates of the effect of income on weight reflect not just the contemporaneous effect of a one-year increase in income, but also the impact of all prior windfall payments due to the Notch. Thus, our estimates to a certain extent reflect lagged income and therefore are overestimates of the impact of contemporaneous income on weight, which makes our inability to reject the null hypothesis of no effect even more interesting and informative.

Second, because our estimates are based on differences in Social Security payments received after retirement, they may not generalize to other sources of income. Lakdawalla and Philipson (2002) and Lakdawalla, Philipson, and Bhattacharya (2005) hypothesize that weight

---

[13] Even if this information were available, we wouldn't have any way of isolating exogenous differences in lifetime earnings.

may be affected differently by unearned income than by earned income. For example, if work is sedentary, changes in earned income may imply a bigger increase in weight than unearned income because the change in earned income is accompanied by a work-related reduction in physical activity. In general, our estimates will not capture this latter effect.

Another limitation is that the NHIS data lack measures of diet and physical activity, which precludes us from investigating the specific channels through which income affects weight. Instead, we estimate the combined effect of all behavioral changes induced by our natural experiment. Future research could examine whether income affects either or both of those behaviors.

The generalizability of our results may also be restricted to variations in Social Security income similar in magnitude to those generated by the Benefits Notch, which in our sample amounted to a permanent difference of roughly $1,100 per year in 2006 dollars. For the average household in our sample, this corresponds to an income difference of about 7.44 percent per year, which is similar in magnitude to the 5 percent benefits cut proposed by the "Boskin Commission" in the mid 1990s (see Snyder and Evans 2006, for details) and the 10 percent benefit reduction that would arise by the year 2015 if a recent proposal to switch from wage to price indexing were enacted (see Biggs, Brown, and Springstead 2005, for details). Moreover, given that the income differences induced by the Benefits Notch have been shown to exert a significant influence on other important outcomes, e.g. elderly living arrangements (Engelhardt, Gruber and Perry, 2005) and prescription drug use (Moran and Simon, 2006), our ability to rule out even moderately-sized effects on body weight are informative .

Finally, the extent to which our results generalize to younger populations is unclear. Still, answering this question for the elderly is an important end in and of itself because weight

status is correlated with morbidity, functioning, and mortality among the elderly, and because the elderly are among the most vulnerable in society, with a third of those aged 65 and over receiving all or almost all of their retirement income from Social Security (Social Security Administration, 2006).[14] At a minimum, we provide results for this one population of interest.

These issues notwithstanding, the variation in Social Security income created by the Benefits Notch provides a rare opportunity to utilize exogenous variation in income for the purpose of estimating the effect of income on BMI and clinical weight classification among a population of significant policy interest.

Discussion

Our instrumental variables estimates yield no evidence that income affects weight or the probability of being underweight, healthy weight, overweight, or obese among elderly Americans; we are unable to reject the null hypothesis of no effect in our IV models. The strongest conclusions one can draw from our analysis concern the effect sizes that our IV estimates allow us to rule out.

An increase in Social Security income of $1,000 a year represents an average increase of 7.2 percent for sample women and 6.2 percent for sample men. Our IV results indicate that an increase in income of this size, received every year for the rest of one's life, will not increase or decrease weight by even a pound among men, or 1.5 pounds among women. The medical literature has detected improvements in health for weight loss of 5 to 10 percent among the obese (Arbeeny, 2004; Fujioka, 2002), but there is no published evidence that losing a pound or two will improve health. In other words, any plausible weight loss associated with a 6-7 percent

---

[14] Almost two thirds of those aged 65 and over receive at least half of their retirement income from Social Security (Social Security Administration, 2006).

change in Social Security income for the rest of one's life is not expected to have any detectable impact on health.

Among the elderly, being underweight (frail) is an outcome of great interest because it is associated with significant risks for morbidity and mortality (Corrada et al., 2006). We fail to detect any impact of income on the probability of being underweight. Moreover, we can reject the hypothesis that an extra $1,000 of Social Security income received annually would decrease the risk of underweight by more than 0.6 of a percentage point for either men or women.

Obesity is another risk factor for morbidity among the elderly (Heiat et al., 2001), and we find no impact of income on obesity, either. Our estimates indicate that an extra $1,000 of Social Security income annually would not decrease the risk of obesity by more than half of a percentage point for men. For women, a more substantial effect on obesity remains in the confidence interval. Our estimates for women imply that the extra income would not lower the probability of obesity by more than 3.2 percentage points. To put this in context, 22 percent of our female sample is obese.

The results of this paper have important implications for public policy. First, it rules out any unintended effect on weight from a change in Social Security benefits. This is relevant because the growing actuarial imbalance in the Social Security program may lead to cuts in benefits similar in size to those created by the Notch, so it is useful to know that such cuts are unlikely to have adverse effects on weight. The results of this paper also imply that altering the level of Social Security benefits is unlikely to be an effective policy lever to reduce the considerable external costs of obesity imposed through Medicare. Finally, the results provide no evidence that rising income was partly responsible for the recent rise in elderly obesity.

Works Cited

Adams, KF, Schatzkin A, Harris TB, et al. 2005. "Overweight, obesity, and mortality in a large prospective cohort of persons 50 to 71 years old." *New England Journal of Medicine*, 355(8): 763-78.

Apovian, Caroline M. 2004. "Sugar-Sweetened Soft Drinks, Obesity, and Type 2 Diabetes." *JAMA*, 292(8): 978-979.

Arbeeny, Cynthia M. 2004. "Addressing the Unmet Medical Need for Safe and Effective Weight Loss Therapies." *Obesity Research*, 12(8): 1191-1196.

Arterburn, David E., Paul K. Crane, and Sean D. Sullivan. 2004. "The Coming Epidemic of Obesity in Elderly Americans." *Journal of the American Geriatric Society*, 52: 1907-1912.

Biggs, Andrew, Jeffrey Brown and Glenn Springstead. 2005. "Alternative Methods of Price Indexing Social Security: Implications for Benefits and System Financing." NBER Working Paper # 11406.

Board of Trustees, Federal Old-Age and Survivors Insurance and Federal Disability Insurance Trust Funds. 2006. "The 2006 Annual Report of the Board of Trustees of the Federal Old-Age and Survivors Insurance and Federal Disability Insurance Trust Funds. (Social Security Administration: Washington, DC).

Bound, John, Charles Brown, and Nancy Mathiowetz. 2002. "Measurement Error in Survey Data." in *Handbook of Econometrics*, Volume 5, ed. James Heckman and Ed Leamer. (New York: Springer-Verlag).

Brunello, Giorgio and Beatrice D'Hombres. 2007. "Does Body Weight Affect Wages? Evidence From Europe." *Economics and Human Biology*, 5: 1-19.

Burkhauser, Richard V., and John Cawley. 2008. "Beyond BMI: The Value of More Accurate Measures of Fatness and Obesity in Social Science Research." *Journal of Health Economics*, 27(2): 519-529.

Bray, G.A., C. Bouchard. and W.P.T. James, (Eds). 1998. *Handbook of Obesity*. (New York: Marcel Dekker).

Cawley, John. 2004. "The Impact of Obesity on Wages." *Journal of Human Resources*, 39(2): 451-474.

Cawley, John, and Richard V. Burkhauser. 2006. "Beyond BMI: The Value of More Accurate Measures of Fatness and Obesity in Social Science Research." NBER Working Paper #12291.

Chang, Virginia W. and Diane S. Lauderdale. 2005. "Income Disparities in Body Mass Index and Obesity in the United States, 1971-2002." *Archives of Internal Medicine*, 165: 2122-2128.

Commission on the Social Security "Notch" Issue. 1994. Final Report on the Social Security "Notch" Issue (Washington, DC: Social Security History Archives). Available online at http://www.socialsecurity.gov/history/notchbase.html, last access date September 2006.

Corrada, MM, Kawas CH, Mozaffar F, et al. 2006. "Association of body mass index and weight change with all-cause mortality in the elderly." *American Journal of Epidemiology*, 163(10: 938-49.

Critser, Greg. 2003. *Fat Land: How Americans Became the Fattest People in the World*. (New York: Houghton Mifflin).

Cypel, Yasmin S, Patricia M Guenther, and Grace J Petot. 1997. "Validity of portion-size measurement aids: A review." *Journal of the American Dietetic Association*, 97(3): 289-292.

Doshi, Jalpa A., Daniel Polsky, and Virginia W. Chang. 2007. "Prevalence and Trends in Obesity Among Aged and Disabled U.S. Medicare Beneficiaries, 1997-2002." *Health Affairs*, 26(4): 1111-1117.

Drewnowski, Adam and SE Specter. 2004. "Poverty and Obesity: the Role of Energy Density and Energy Costs." *American Journal of Clinical Nutrition*, 79: 6-16.

Elia, Marinos. 2001. "Obesity in the Elderly." Obesity Research, 9(4S): 244S-248S.

Engelhardt, Gary (2008) "Social Security and Elderly Homeownership," *Journal of Urban Economics* 63, 280-305.

Engelhardt, Gary, Jonathan Gruber, and Cynthia Perry. 2005. "Social Security and Elderly Living Arrangements: Evidence from the Social Security Notch." *Journal of Human Resources*, 40: 354-372.

Finkelstein, Eric A., Ian C. Fiebelkorn, and Guijing Wang. 2003. "National Medical Spending Attributable to Overweight and Obesity: How Much, and Who's Paying?" *Health Affairs* web exclusive, W3-219.

Flegal, K.M., M.D. Carroll, C.L. Ogden and C.L. Johnson. 2002. "Prevalence and Trends in Obesity Among U.S. Adults, 1999-2000*." Journal of the American Medical Association*, 288(14): 1723-1727.

Freedman, David S., Laura Kettel Khan, Mary K. Serdula, Deborah A. Galuska, and William H. Dietz. 2002. "Trends and Correlates of Class 3 Obesity in the United States From 1990 Through 2000." *JAMA*, 288: 1758-1761.

Fuchs,V. 1982. *Economics Aspects of Health*. (Chicago IL: University of Chicago Press).

Fujioka, Ken. 2002. "Management of Obesity as a Chronic Disease: Nonpharmacologic, Pharmacologic, and Surgical Options." *Obesity Research*, 10(Suppl 2): 116S-123S.

Garn, S.M., W.R. Leonard, V.M. Hawthorne. 1986. "Three Limitations of the Body Mass Index." *American Journal of Clinical Nutrition*, 44: 996-97.

Grabowski, David C. and John E. Ellis. 2001. "High Body Mass Index Does Not Predict Mortality in Older People: Analysis for the Longitudinal Study of Aging." *Journal of the American Geriatric Society*, 49: 968-979.

Greve, Jane. 2008. "Obesity and Labor Market Outcomes: New Danish Evidence." Unpublished manuscript, University of Aahus.

Heckman, James and Joseph Hotz. 1989. "Choosing Among Nonexperimental Methods for Estimating the Impact of Social Programs: The Case of Manpower Training." *Journal of the American Statistical Association*, 84: 862-880.

Hedley, A.A., C.L. Ogden, C.L., Johnson, M.D. Carroll, L.R. Curtin and K.M. Flegal. 2004. "Prevalence of Overweight and Obesity Among U.S. Children, Adolescents, and Adults, 1999-2002." *Journal of the American Medical Association*, 291(23): 2847-2850.

Hedley, Allison A. and Cynthia L. Ogden. 2006. "More For the Money? Differences in the Prevalence of Adult Obesity in the U.S. by Income Level – 1999-2002." Paper presented at the 2006 Population Association of America (PAA) Meetings.

Heiat, Asefeh, Viola Vaccarino, and Harlan M. Krumholz. 2001. "An Evidence-Based Assessment of Federal Guidelines for Overweight and Obesity as They Apply to Elderly Persons." *Archives of Internal Medicine*, 161: 1194-1203.

Hill, James, Holly R. Wyatt, George W. Reed, and John C. Peters. 2003. "Obesity and the Environment: Where Do We Go From Here?" *Science*, 299(7): 853-855.

Himes, Christine L. 2000. "Obesity, Disease, and Functional Limitation in Later Life." *Demography*, 37(1): 73-82.

Institute of Medicine. 2005. Preventing Childhood Obesity: Health in the Balance. National Academies Press: Washington, D.C.

Joliffe, Dean. 2007. "The Income Gradient and Distribution-Sensitive Measures of Overweight in the U.S." National Poverty Center Working Paper Series #07-27.

Keehan, Sean P., Helen C. Lazenby, Mark A. Zezza, and Aaron C. Catlin. 2004. "Age Estimates in the National Health Accounts." *Health Care Financing Review* Web Exclusive, 1(1): 1-16. December.

Kollmann, Geofrey. 2003. "Social Security Notch Issue: A Summary." Congressional Research Servie Report for Congress, Order Code 95-188 EPW.

Krueger, Alan and Jorn-Steffen Pischke. 1992. "The Effect of Social Security on Labor Supply: A Cohort Analysis of the Notch Generation," *Journal of Labor Economics*, 10 (4): 412-437.

Lakdawalla, Darius, and Tomas Philipson. 2002. "The Growth of Obesity and Technological Change: A Theoretical and Empirical Examination." NBER Working Paper #8946.

Lakdawalla, Darius, Tomas Philipson, and Jay Bhattacharya. 2005. "Welfare-Enhancing Technological Change and the Growth of Obesity." *American Economic Review*, 95(2): 253-257.

Lakdawalla, Darius N., Dana P. Goldman, and Baoping Shang. 2005. "The Health and Cost Consequences of Obesity Among the Future Elderly." *Health Affairs*, 24: R30-R42.

Lee, L.F. and J.H. Sepanski. 1995. "Estimation of Linear and Nonlinear Errors in Variables Models Using Validation Data." *Journal of the American Statistical Association*, 90(429):130–40.

Lundborg, Petter, Kristian Bolin, Soren Hojgard, and Bjorn Lindgren. 2007. "Obesity and Occupational Attainment Among the 50+ of Europe." In: Kristian Bolin and John Cawley (eds.), *The Economics of Obesity, Advances in Health Economics and Health Services Research*, 17, pp. 219-252.

Miles, Toni P., and Christine L. Himes. 1995. "Biological and Social Determinants of Body Size Across the Life Span—A Model for the Integration of Population Genetics and Demography." *Population Research and Policy Review* 14: 327-346.

Mizuno, Tooru, I-Wei Shu, Hideo Makimura, and Charles Mobbs. 2004. "Obesity Over the Life Course." *SAGE KE*, June 16.

Moran, John and Kosali Simon. 2006. "Income and the Use of Prescription Drugs by the Elderly: Evidence from the Notch Cohorts." *Journal of Human Resources*, 41: 411-432.

Morris, Stephen. 2006. "Body Mass Index and Occupational Attainment." *Journal of Health Economics*, 25: 347-364.

National Center for Health Statistics. 2005. Health: United States, 2005: with Chartbook on Trends in the Health of Americans. NCHS: Hyattsville, MD.

National Institutes of Health. 1998. *Clinical Guidelines on the Identification, Evaluation, and Treatment of Overweight and Obesity in Adults*. NIH Publication 98-4083. (NIH: Washington, D.C.).

Nieto-Garcia F.J., T.L. Bush, P.M. Keyl.1990."Body mass definitions of obesity: sensitivity and specificity using self-reported weight and height." *Epidemiology*. 1990, Mar;1(2):146-52.

Norton, Edward C., and Euna Han. 2008. "Genetic Information, Obesity, and Labor Market Outcomes," *Health Economics*, forthcoming.

Ogden, Cynthia, Margaret D. Carroll, Lester R. Curtin, Margaret A. McDowell, Carolyn J. Tabak, and Katherine M. Flegal. 2006. "Prevalence of Overweight and Obesity in the United States, 1999-2004." *JAMA*, 295(13): 1549-1555.

Pi-Sunyer, F.X. 2002. "Medical Complications of Obesity in Adults. In C.G. Fairburn & K.D. Brownell, *Eating Disorders and Obesity: A Comprehensive Handbook*, 2nd Edition. New York: Guilford Press.

Plankey, M.W., J. Stevens, K.M Flegal and P.F. Rust. 1997. "Prediction Equations do not Eliminate Systematic Error in Self-Reported Body Mass Index." *Obesity Research*, 5: 308-314.

Prentice Andrew M. and Susan A. Jebb. 2001. "Beyond Body Mass Index." *Obesity Reviews*, 2(3): 141-147.

Quintana-Domeque, Climent. 2005. "The Income Gradient in Body Mass Index." Poster presentation, IHEA 5th World Congress.

Reynolds, Sandra L. and Christine L. Himes. "Cohort Differences in Adult Obesity in the U.S." 1982-1996." *Journal of Aging and Health*. Forthcoming.

Rowland, M. L. 1989. "Reporting Bias in Height and Weight Data." *Statistical Bulletin*, 70(2), 2-11.

Schroeter, Christiane, Jayson Lusk, and Wallace Tyner. 2008. "Determining the Impact of Food Price and Income Changes on Body Weight." *Journal of Health Economics*, 27: 45-68.

Schmeiser, Maximilian D. 2008. "Expanding Wallets and Waistlines: The Impact of Family Income on the BMI of Women and Men Eligible for the Earned Income Tax Credit." Unpublished manuscript, Department of Consumer Science, University of Wisconsin at Madison.

Schwartz, Robert S. 1998. "Obesity in the Elderly." In: *Handbook of Obesity*, edited by George A. Bray, Claude Bouchard, and W.P.T. James. (New York: Marcel Dekker).

Smalley, K.J., A.N. Knerr, Z.V. Kendrick, J.A. Colliver, and O.E. Owen. 1990. "Reassessment of Body Mass Indices." *American Journal of Clinical Nutrition*, 52: 405-08.

Sndyer, Stephen E., and William Evans. 2006. "The Impact of Income on Mortality: Evidence from the Social Security Notch." *Review of Economics and Statistics*, 88: 482-495.

Sobal J.and A. Stunkard. 1989. "Socioeconomic Status and Obesity: Review of the Literature." *Psychological Bulletin*, 105: 260-275.

Social Security Administration. 2006. "Social Security History." World wide web content, http://www.ssa.gov/history/notchfile1.html Accessed December 21, 2006.

Social Security Administration. 2006. "Performance and Accountability Report for Fiscal Year 2006." Available online at: http://www.ssa.gov/finance/2006/Overview.pdf.

Stevens, June, Jianwen Cai, Elise R. Pamuk, et al. 1998. "The Effect of Age on the Association Between Body-Mass Index and Mortality." *New England Journal of Medicine*, 338(1): 1-7.

Stock, James H., Jonathan H. Wright, and Motohiro Yogo. 2002. "A Survey of Weak Instruments and Weak Identification in Generalized Method of Moments." *Journal of Business and Economic Statistics*, 20(4): 518-529.

Swinburn, B.A., I. Caterson, J.C. Seidell, W.H. Dietz and W.P.T. James. 2002. "The Scientific Basis For Diet, Nutrition, and the Prevention of Excess Weight Gain and Obesity."
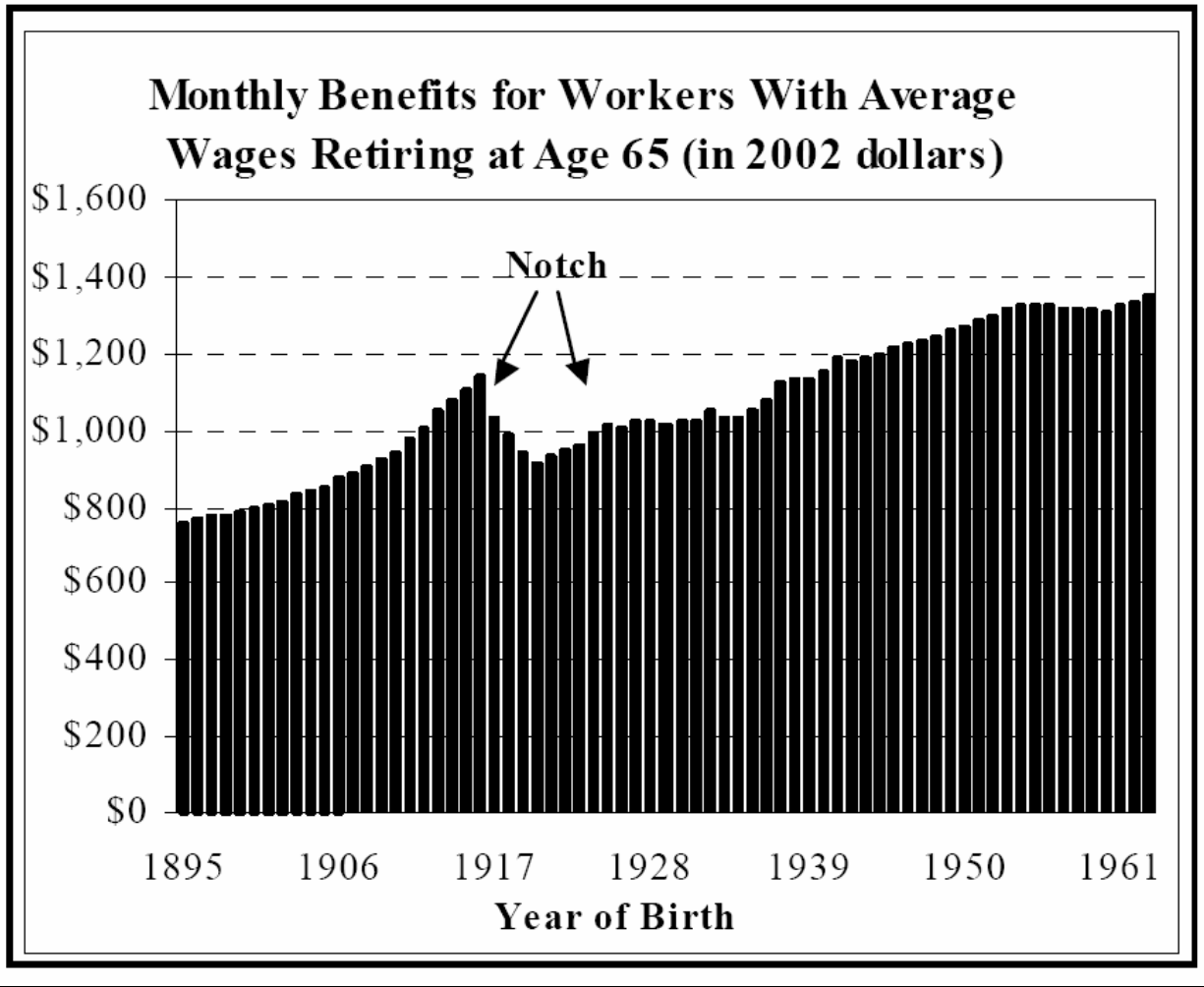
Background paper for Joint WHO/FAO Expert Consultation on Diet, Nutrition, and the Prevention of Chronic Disease.

Taylor, Donald H., Jr. and Truls Ostbye. 2001. "The Effect of Middle- and Old-Age Body Mass Index on Short-Term Mortality in Older People." *Journal of the American Geriatric Society*, 49:1319-1326.

U. S. Census Bureau. 2005. "Historical Income Tables – Households." http://www.census.gov/hhes/www/income/histinc/inchhtoc.html

U.S. Department of Health and Human Services. 2001. *The Surgeon General's Call to Action to Prevent and Decrease Overweight and Obesity*. Washington D.C.: U. S. Government Printing Office.

Vaughan, V., and R. Vuskavage. 1976. "Investigating Discrepancies between Social Security Administration and Current Population Survey Benefit Data for 1972." In: *Proceedings of the Social Statistics Section, American Statistical Association*. Alexandria, VA 824-829.

Wooldridge, Jeffrey M. 2002. *Econometric Analysis of Cross Section and Panel Data*. (Cambridge, MA: MIT Press).

World Health Organization (WHO). 2003. *Diet, Nutrition, and the Prevention of Chronic Diseases*. Report of a joint WHO/FAO Expert Consultation.

Zamboni, M., G. Mazzali, E. Zoico, T.B. Harris, J.B. Meigs, V. DiFrancesco, F. Fantin, L. Bissoli, and O. Bosello. 2005. "Health Consequences of Obesity in the Elderly: A Review of Four Unresolved Questions." *International Journal of Obesity*, 29: 1011-1029.

**Figure 1A: Replacement Rates by Birth Cohort**

Benefits as % of Earnings
for Age 65 Retirees
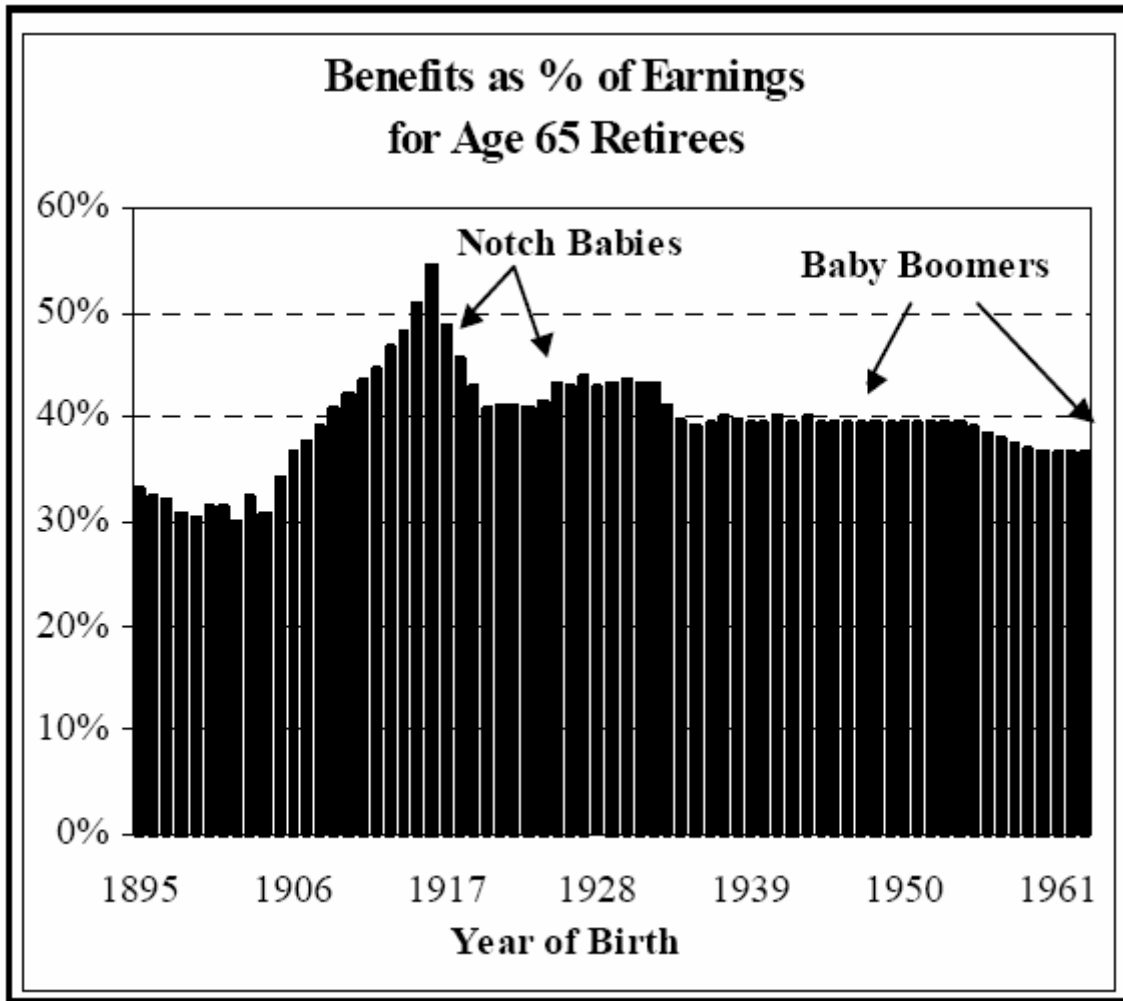
Notes: Reprinted from Kollman (2003).

Figure 1B: The Social Security Benefit Notch

Monthly Benefits for Workers With Average Wages Retiring at Age 65 (in 2002 dollars)

Notes: Reprinted from Kollman (2003).

Figure 2:
Annual Social Security Income by Birth Year

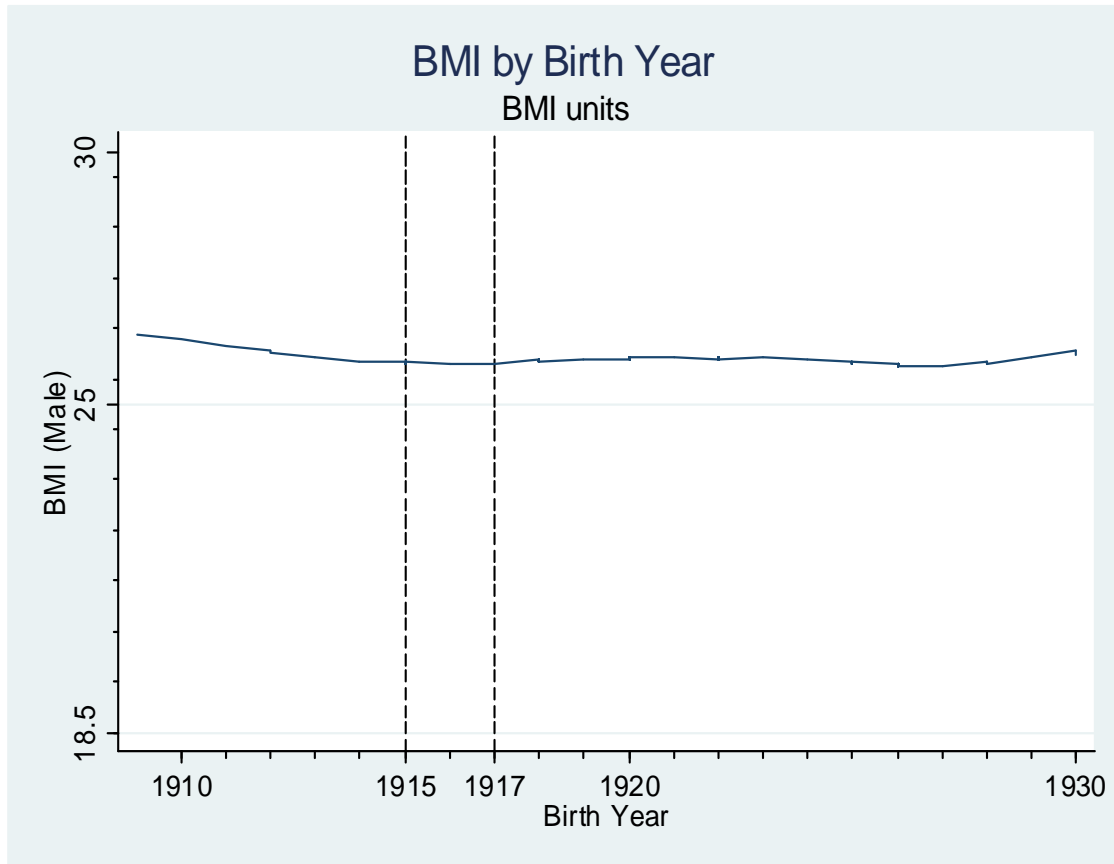Household Social Security Income by Birth Year
Thousands of 2006 dollars
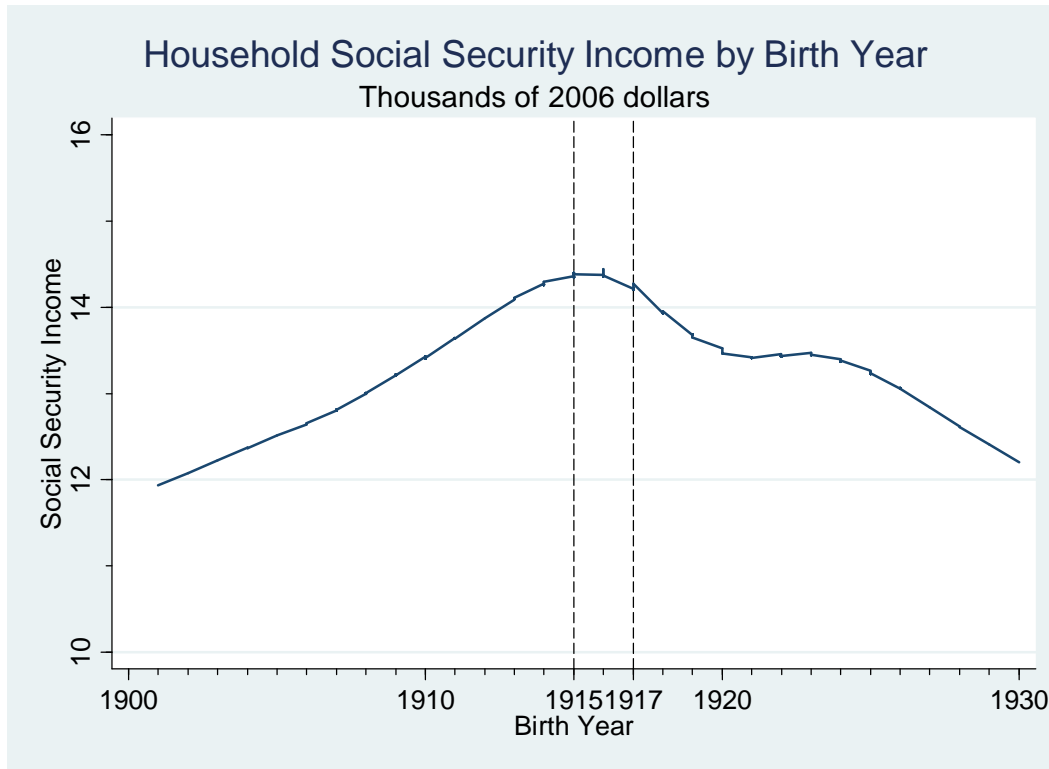
Notes: Data: NHIS 1990-92 and 1994-96. Income is conditioned on all basic regressors (i.e. except birth year and age fixed effects) in our model to produce a smoothed series. In this paper, cohorts born 1915-1917 (i.e. those between the vertical dashed lines), which received peak benefits, serve as the treatment group and those born 1901-1914 and 1918-1930, which received lesser benefits, serve as the control group. Income is in 2006 dollars.

Figure 3:
Pre-test: Pre-Retirement BMI by Birth Year, Females
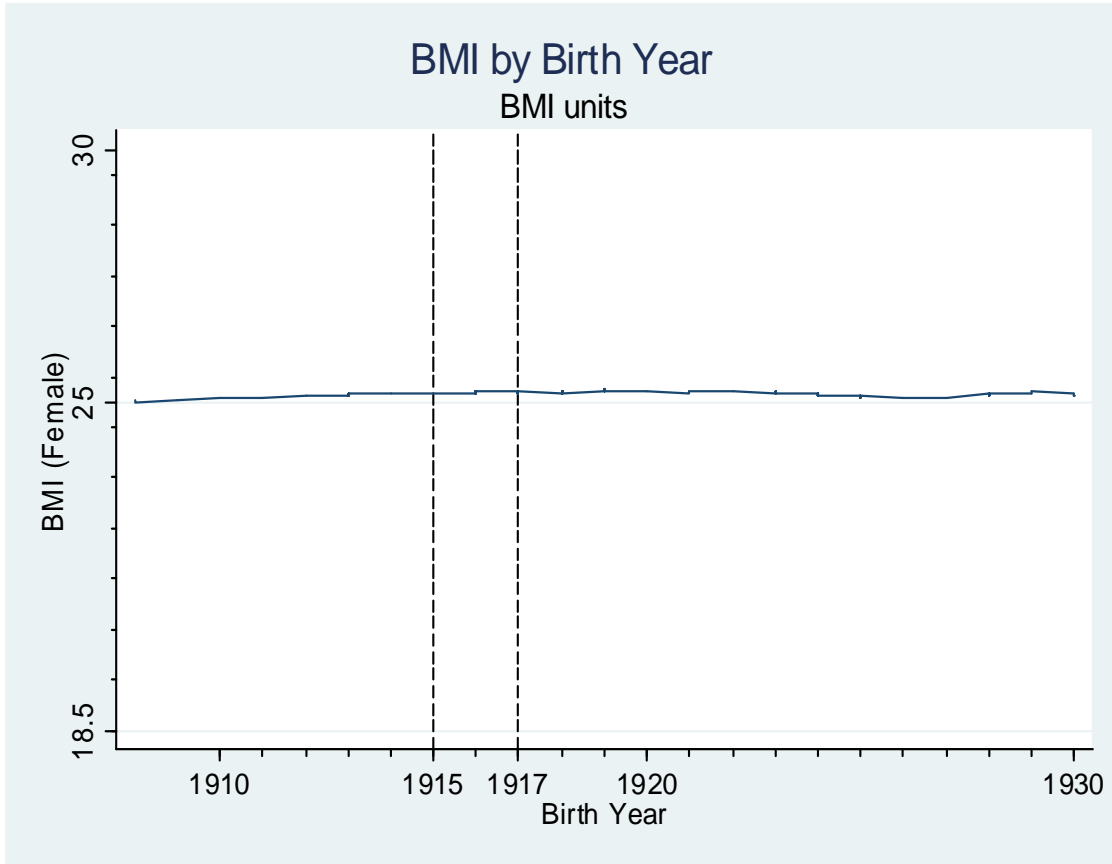
Note: Data: NHIS 1976. Non-retired individuals under the age of 65 are used in this calculation. BMI is conditioned on all basic regressors (i.e. except birth year and age fixed effects) in our model to produce a smoothed series. In this paper, cohorts born 1915-1917 (i.e. those between the vertical dashed lines), which received peak benefits, serve as the treatment group and those born 1901-1914 and 1918-1930, which received lesser benefits, serve as the control group.

Figure 4:
**Pre-test: Pre-Retirement BMI by Birth Year, Males**

Note: Data: NHIS 1976. Non-retired individuals under the age of 65 are used in this calculation. BMI is conditioned on all basic regressors (i.e. except birth year and age fixed effects) in our model to produce a smoothed series. In this paper, cohorts born 1915-1917 (i.e. those between the vertical dashed lines), which received peak benefits, serve as the treatment group and those born 1901-1914 and 1918-1930, which received lesser benefits, serve as the control group.

Figure 5:
Female BMI by Birth Year
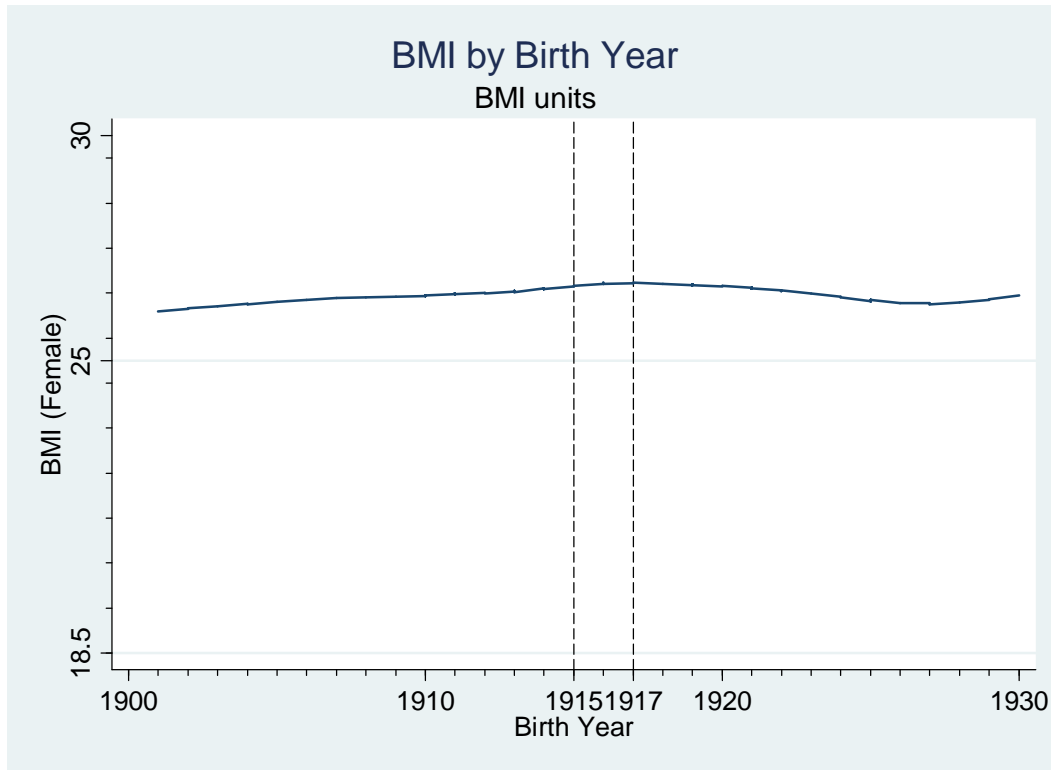
Note: Data: NHIS 1990-92 and 1994-96. BMI is conditioned on all basic regressors (i.e. except birth year and age fixed effects) in our model to produce a smoothed series. In this paper, cohorts born 1915-1917 (i.e. those between the vertical dashed lines), which received peak benefits, serve as the treatment group and those born 1901-1914 and 1918-1930, which received lesser benefits, serve as the control group.
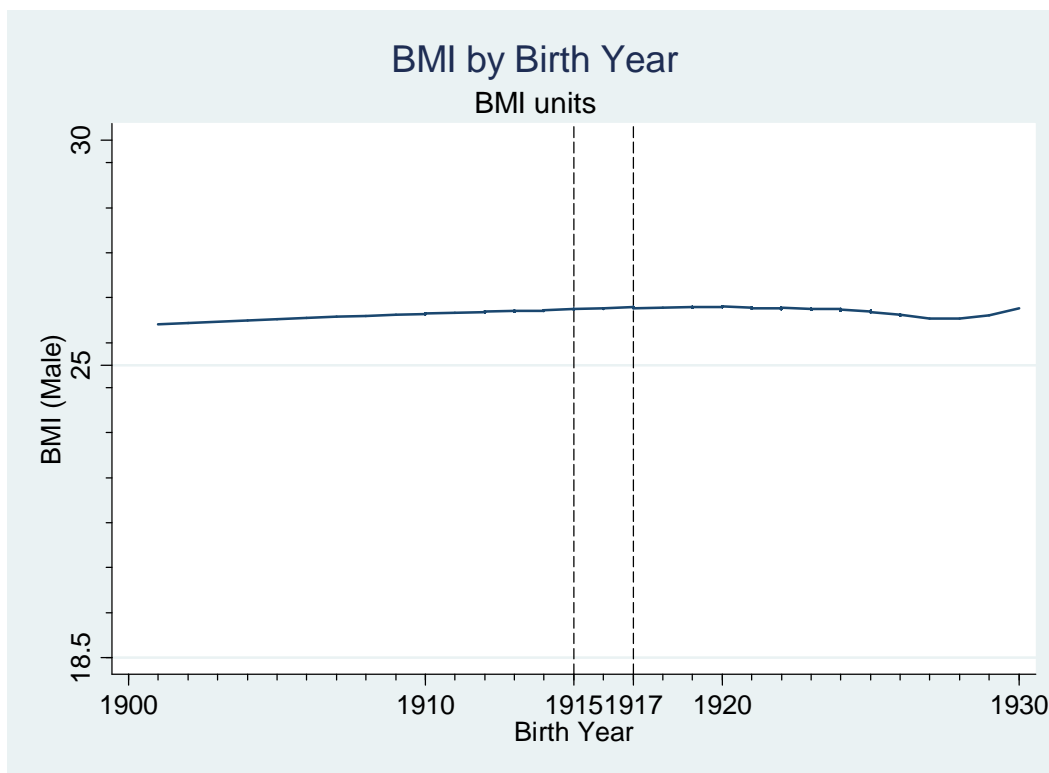
Figure 6:
Male BMI by Birth Year

BMI by Birth Year
BMI units

Note: Data: NHIS 1990-92 and 1994-96. BMI is conditioned on all basic regressors (i.e. except birth year and age fixed effects) in our model to produce a smoothed series. In this paper, cohorts born 1915-1917 (i.e. those between the vertical dashed lines), which received peak benefits, serve as the treatment group and those born 1901-1914 and 1918-1930, which received lesser benefits, serve as the control group.

Table 1:
Descriptive Statistics of Selected Variables
Mean and (Standard Deviation)

Variable	Males (N=28,503)	Females (N=42,011)
Household Social Security income, in 2006 dollars	16023.98 (6580.14)	13896.53 (6445.19)
Indicator for treatment (i.e. primary Social Security beneficiary was born 1915-1917).	0.12 (0.32)	0.13 (0.34)
Body Mass Index (BMI), corrected for reporting error	26.19 (4.04)	26.39 (5.43)
Underweight	0.02 (0.13)	0.04 (0.20)
Healthy weight	0.39 (0.49)	0.40 (0.49)
Overweight	0.44 (0.50)	0.34 (0.47)
Obese	0.15 (0.36)	0.22 (0.42)
Years since 1989 until survey year	3.96 (2.15)	4.00 (2.16)
Resident of region 1	0.22 (0.41)	0.22 (0.42)
Resident of region 2	0.26 (0.44)	0.26 (0.44)
Resident of region 3	0.34 (0.47)	0.35 (0.48)
Resident of region 4	0.18 (0.39)	0.17 (0.38)
Lives in a metropolitan area	0.61 (0.49)	0.61 (0.49)
Age of the primary Social Security beneficiary	72.72 (6.34)	74.88 (6.98)
Primary Social Security beneficiary is Hispanic	0.03 (0.18)	0.03 (0.17)
Primary Social Security beneficiary is White	0.92 (0.27)	0.92 (0.28)
Primary Social Security beneficiary is Black	0.07 (0.26)	0.08 (0.27)

Table 1 (continued):
Descriptive Statistics of Selected Variables
Mean and (Standard Deviation)

Variable	Males (N=28,503)	Females (N=42,011)
Primary Social Security beneficiary education is less than HS	0.39 (0.49)	0.39 (0.49)
Primary Social Security beneficiary education is HS	0.32 (0.46)	0.34 (0.48)
Primary Social Security beneficiary education is some college	0.13 (0.33)	0.13 (0.34)
Primary Social Security beneficiary education is college	0.09 (0.28)	0.07 (0.26)
Primary Social Security beneficiary education is more than college	0.08 (0.27)	0.06 (0.24)
Household is headed by a single male	0.21 (0.41)	n/a
Household is headed by a never married female	n/a	0.03 (0.17)
Household is headed by female widow	n/a	0.39 (0.49)
Household is headed by female divorcee	n/a	0.05 (0.22)
Primary Social Security beneficiary's birth year	1919.75 (6.48)	1917.64 (7.09)

Notes: Weighted data on respondents to NHIS 1990-92 and 1994-96 born 1901-1930. "Primary Social Security beneficiary" refers to the person in the household whose birth year determines whether the person in question is affected by the Notch. For example, in the case of a woman living with her married male partner, it is his birth year that counts.

Table 2
Average BMI and Percent Obese
By Category of Social Security Income

Household Social Security Income	Females		Males	
	Average BMI	Percent Obese	Average BMI	Percent Obese
$0-$5,000	26.74	24.6%	25.98	14.4%
$5,000-$10,000	26.75	25.2%	26.04	15.7%
$10,000-$15,000	26.39	22.8%	26.25	15.8%
$15,000-$20,000	26.22	20.5%	26.23	15.4%
$20,000-$25,000	26.16	20.1%	26.33	15.6%

Data: Respondents to NHIS 1990-92 and 1994-96 born 1901-1930. Sample weights are used. Income is in 2006 $.

Table 3:
Income and Weight Among Females (N=42,011)

Dependent Variable	1 OLS or LPM Coefficient on Social Security Income (in 1000s)	2 2SLS Coefficient on Social Security Income (in 1000s) and 95% C.I.
Body Mass Index	-0.013*** (0.005)	0.010 (0.122) [-0.229, 0.249]
Indicator for Underweight	-0.001** (0.0002)	0.004 (0.005) [-0.006, 0.014]
Indicator for Healthy Weight	0.002*** (0.0005)	-0.011 (0.018) [-0.046, 0.024]
Indicator for Overweight	0.0002 (0.0004)	0.016 (0.013) [-0.01, 0.042]
Indicator for Obese	-0.001*** (0.0004)	-0.010 (0.011) [-0.032, 0.012]

Notes:
1) Data: Females in households headed by a Social Security beneficiary born in 1901-1930 surveyed by the National Health Interview Survey, 1990-92 and 1994-96.
2) Coefficient indicates the correlation with, or effect on, weight of $1,000 (in 2006 $) in additional annual Social Security income.
3) Standard errors are in parentheses, and the 95% confidence interval for the coefficient is in brackets.
4) Each cell of the table corresponds to a separate regression.
5) Other regressors include: year (as linear and quadratic), age of primary Social Security recipient in household (as linear and quadratic), and indicator variables for age, race, Hispanic, education category, marital status, urban residence, and region of residence.
6) * indicates statistical significance at the 10% level; ** indicates significance at the 5% level; and *** indicates significance at the 1% level.

Table 4:
Income and Weight Among Males (N=28,503)

Dependent Variable	1 OLS or LPM Coefficient on Social Security Income (in 1000s)	2 2SLS Coefficient on Social Security Income (in 1000s) and 95% C.I.
Body Mass Index	0.013*** (0.003)	-0.007 (0.045) [-0.095, 0.081]
Indicator for Underweight	-0.001*** (0.0001)	-0.001 (0.001) [-0.003, 0.001]
Indicator for Healthy Weight	-0.001 (0.001)	0.004 (0.005) [-0.006, 0.014]
Indicator for Overweight	0.0007 (0.006)	-0.006 (0.005) [-0.016, 0.004]
Indicator for Obese	0.0004 (0.0004)	0.002 (0.003) [-0.004, 0.008]

Notes:
1) Data: Males born 1901-1930 surveyed by the National Health Interview Survey, 1990-92 and 1994-96.
2) Coefficient indicates the correlation with, or effect on, weight of $1,000 (in 2006 $) additional annual Social Security income.
3) Standard errors are in parentheses, and the 95% confidence interval for the coefficient is in brackets.
4) Each cell of the table corresponds to a separate regression.
5) Other regressors include: year (as linear and quadratic), and indicator variables for age, race, Hispanic, education category, marital status, urban residence, and region of residence.
6) * indicates statistical significance at the 10% level; ** indicates significance at the 5% level; and *** indicates significance at the 1% level.