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# Why the Poor Get Fat: Weight Gain and Economic Insecurity

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# Why the Poor Get Fat: Weight Gain and Economic Insecurity*

Trenton G. Smith, Christiana Stoddard, and Michael G. Barnes

## Abstract

Something about being poor makes people fat. Though there are many possible explanations for the income-body weight gradient, we investigate a promising but little-studied hypothesis: that changes in body weight can—at least in part—be explained as an optimal response to economic insecurity. We use data on working-age men from the 1979 National Longitudinal Survey of Youth (NLSY79) to identify the effects of various measures of economic insecurity on weight gain. We find in particular that over the 12-year period between 1988 and 2000, the average man gained about 21 pounds. A one percentage point (0.01) increase in the probability of becoming unemployed causes weight gain over this period to increase by about 0.6 pounds, and each realized 50% drop in annual income results in an increase of about 5 pounds. The mechanism also appears to work in reverse, with health insurance and intrafamily transfers protecting against weight gain.

**KEYWORDS:** obesity, unemployment, moral hazard, NLSY79

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*Worries go down better with soup than without.*
--Jewish proverb

## 1. INTRODUCTION

Everyone knows why people gain weight: They eat too much. Or exercise too little. Or lack self-control. Or live in a world of abundant, low-cost calories. Or maybe it just runs in the family.

That body weight is a function of a multitude of economic decisions—that is, decisions involving market transactions either directly (via the purchase of food, or labor-saving devices, or athletic club memberships) or indirectly (via the allocation of scarce leisure time to physical exertion or the preparation of nutritious meals)—is beyond dispute. But as an economic decision problem, weight gain is intriguing because economic explanations must compete with (or be reconciled with) explicitly *non*-economic explanations from other fields, from psychology and sociology to nutrition science and even molecular genetics. In this article we focus on a particular purported cause of weight gain—economic insecurity—which is both related to popular theories from psychology and consistent with theory and evidence from behavioral biology.

Economic insecurity—defined, roughly speaking, as the risk of catastrophic income loss faced by an individual or household—has not received much attention as an independent cause of obesity from economists or public health advocates.[1] But viewed from the perspective of behavioral biology, the motivation for a relationship between insecurity and body fat is obvious: the reason humans and other animals evolved the ability to store body fat is presumably because it was necessary to survive periodic food shortages. The evidence for this is surprisingly strong. It has been demonstrated again and again, for instance, that animals in natural environments face very real periodic starvation risk, and that such risk is a strong predictor of fattening behavior (e.g., Ekman and Lilliendahl 1993, Shively and Wallace 2001). It therefore seems reasonable to ask whether weight gain in humans might be—at least in part—the manifestation of an "optimal fattening" response to economic insecurity.

An obvious objection to this hypothesis is that in the modern world, the necessity of precautionary fattening is ameliorated (perhaps completely) by the

[1] A notable exception is to be found in a case study (Dietz 1995) of a young girl whose mother reported a monthly cycle of feast and famine (evidently induced by the manner in which food stamps and other social services payments were dispersed). The author conjectured that the girl's obesity might be a biologically induced response to periodic food shortage. This purported relationship between food stamp distribution dates and dietary intake has since been confirmed empirically (Wilde and Ranney 2000, Wilde and Andrews 2000).

existence of risk-free financial instruments. But while it could be argued that for many people a savings account is not a viable option (because, for example, deposits might be subject to confiscation by creditors, or social service agencies, or even family members), there is a more fundamental reason to expect body fat to be sensitive to economic circumstance: if our hypothesis is correct, the mechanisms by which economic insecurity generates weight gains are likely to be deeply rooted in psychological and neuroendocrine systems.[2] That is to say, if in human evolutionary history it happened to be advantageous in a particular situation to build up energy reserves (as body fat), this likely would have been accomplished via a subtle shift in the complex mix of hormones and other biochemical signals that govern hunger, satiety, and metabolic efficiency in humans.[3] Translating this into economic theory is straightforward: if economic insecurity causes weight gain—either as an optimal response or as an evolutionary vestige[4]—then it will do so by effectively inducing a shift in consumer preferences. This article can thus be viewed as a test of a theory of endogenous preferences.

In the pages that follow, we briefly review previous studies of obesity, report the results of new empirical tests of our "economic insecurity" hypothesis, and discuss some implications for consumer welfare and public policy.

## 2. BACKGROUND

Cross-sectional analyses of the demography of body weight in the developed world have repeatedly shown that obesity and overweight status disproportionately affect the poor (e.g., Chang and Lauderdale 2005).[5] There are a number of plausible explanations for this, with causation potentially running in either direction: Higher body weights may lead to lower wages, either directly (via effects on productivity)[6] or indirectly (via employment discrimination).[7] Weight and income may be negatively correlated due to unobserved personal characteristics such as self-discipline or impulsivity (Cutler *et al.* 2003). And

[2] See Tooby and Cosmides (2008) for a discussion of the role of emotional responses to environmental cues in human evolutionary history.
[3] See Smith (2009) for a review of the biomedical literature relating to energy homeostasis in humans.
[4] The potential for such an "evolutionary mismatch" generated by rapid technological change has been emphasized by Smith (2004), Dasgupta and Maskin (2005), and Smith and Tasnádi (2007).
[5] The few attempts in the literature at estimating the causal effect of income on body weight have been largely inconclusive, but suggest a relatively small effect—on the order of one pound of body weight per $1000 in annual income (Schmeiser 2009, Cawley *et al*. 2008).
[6] See, e.g., Gates *et al*. 2008.
[7] See, e.g., Cawley 2004.


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there might be pure income effects on economic decisions about health,[8] physical activity, and food consumption.[9]

But this coincidence of poverty with obesity is intriguing, in part, because—the aforementioned explanations notwithstanding—economic theory would seem to predict just the opposite. One thing about weight loss that everyone seems to agree on is that eating well and being physically active take time: it takes much less time to eat calorie-intensive fast food, for instance, than it does to consume freshly prepared meals, and it takes less time to travel by car than on foot. And if "being thin" is a time-intensive good, then we should expect those with the highest opportunity cost of time—i.e., those with high wages—to choose less of it.[10] Moreover, this "time cost" theory of obesity has been borne out empirically, as a number of studies by economists have provided indirect evidence that the time cost of weight gain has driven the increase in obesity observed in recent decades: Cutler *et al.* (2003), for instance, emphasize the role of food processing technologies in reducing the time cost of food preparation; Lakdawalla and Philipson (2002) argue that Americans have gained weight in part because the workplace has become more sedentary; and Chou *et al*. (2004) point to the increasing prevalence of fast food restaurants as a key determinant of the observed trend.

### 2.1. TWO INCOME EFFECTS

It is possible, of course, that the opportunity cost of time does cause body weight to rise with income, while another income-related phenomenon works in the opposite direction. This brings us to the distinction between income and income security. As noted above, the primary biological function of body fat is its role as a form of precautionary savings. This would seem to suggest that in an optimal fattening framework, body fat should increase with both the *level* of currently available resources and with the *variability* of expected future resources.[11] In other words, it might be that the poor tend to be fat not because they have low income, but because they are at greater risk of becoming destitute. This

[8] A number of authors report a strong positive relationship between income and various measures of good health (see, e.g., Marmot *et al*. 1991, Case *et al*. 2002, or Deaton 2002). Sapolsky (2005) argues that physiologic responses to economic distress could plausibly generate many of the observed income-related health disparities.

[9] Reed *et al*. (2005), for instance, find positive income elasticities across a number of food purchase categories. Drewnowski (2004) argues that low-income households choose foods of low nutritional value in part because such foods are the most cost-effective source of calories.

[10] The direction of this effect is of course theoretically ambiguous (because income effects may dominate substitution effects), but it is nevertheless commonly assumed that the net effect of price variation is negative in most settings, including the economic analysis of obesity.

[11] For a formal model of consumer behavior in which a "preference for body fat" arises endogenously in the presence of income uncertainty, see Barnes and Smith (2009).

distinction is an important one because it leads directly to two testable hypotheses: i) an exogenous increase (decrease) in the *probability* of catastrophic income loss should result in a proportional increase (decrease) in body weight; while ii) an exogenous decrease (increase) in income *level* should result in a proportional decrease (increase) in body weight.

### 2.2. A RATIONAL PSYCHOLOGY OF WEIGHT GAIN

In addition to offering a fresh explanation for the negative association between income and body weight, we believe that a putative causal relationship between economic insecurity and body weight is worthy of further study for two reasons. First of all, as noted above, it has the appeal of a normative theory when viewed from the perspective of behavioral biology, and the rich literature in the realm of animal fattening overlaps with parallel studies of human obesity in intriguing ways.[12] And while caution should always be exercised when applying a naturalistic model to human behavior, it is widely accepted that modern obesity is somehow related to the fact that much of human evolutionary history has been characterized by caloric scarcity.

But perhaps more importantly, our hypothesis about the relationship between economic stressors and weight gain is consistent with what is known about the psychology of exercise and diet. Nutritionists, for instance, often refer to "stress-induced eating" and "comfort foods" when exploring the personal reasons for excessive body weight (Greeno and Wing 1994, Dallman *et al*. 2003). And certain types of depression—notably seasonal disorders triggered by annual fluctuations in the length of the day—are associated with weight gain, in ways that mimic the behavior of animals faced with imminent starvation (Madden *et al*. 1996).[13]

There is also the ubiquitous "self-control problem" suffered by just about anyone who has attempted to lose weight. Self-control is typically modeled in economics as a time inconsistency problem, in which the decision-maker applies a declining rate of discount to future outcomes (e.g., Laibson 1997), and as a result perpetually makes choices that seem (in retrospect) to be regrettable and contrary to his long term well-being. This, of course, is exactly how one might describe the behavior of an individual who anticipates a negative income shock that never arrives: he would experience perpetual regret at his over-reaction to perceived

[12] To note but one area in which this is true, nearly every gene and molecular signal known to govern energy homeostasis and metabolism in mice has been shown to have a homologous counterpart in humans (Barsh *et al*. 2000).

[13] More generally, Das *et al*. (2009) review survey data on mental health and socioeconomic characteristics from five developing countries, and conclude that household-level "economic shocks" induced by illness or unemployment have a greater impact on mental health than poverty.


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risk.[14,15] In a sense, then, the empirical results we report below constitute a test of an endogenous theory of self-control.

An important clarification is in order at the outset. Our aim is to measure the extent to which economic insecurity causes weight gain. While our estimation strategy attempts to control for the problems of reverse causation, unobservable personal characteristics, and income effects discussed above, our analysis will not (due to limitations in the data we employ) allow us to distinguish between intermediate mechanisms via which weight gain might occur. It might be, for instance, that the economically insecure react to economic stressors (or lack thereof) by altering either the quantity or the quality of their diet. Or it might be that economic insecurity makes people depressed and therefore inactive. Or it might be that the psychology of economic insecurity simply induces a lower metabolic rate in those who experience it. Distinguishing between these alternatives is a question we leave for future research.

## 3. EMPIRICAL APPROACH

Our analysis employs individual-level data from the National Longitudinal Survey of Youth, 1979 Cohort (NLSY79). The NLSY79 is a longitudinal survey that follows individuals belonging to a single cohort (born 1957-1964) over time. The longitudinal nature of this survey allows us to examine the relationship between changes in body weight over a 12-year period (ending in 2000) and one's personal experience with economic insecurity. We expect that the primary determinants of weight change over this period will include both the respondent's current (year 2000) circumstance (marital status, income, education, etc.) and his subjective beliefs about the probability of catastrophic income loss. Thus the inclusion of historical information in our suite of explanatory variables is motivated not by an explicitly dynamic theory of weight gain,[16] but rather by a

[14] See Sozou (1998), Dasgupta and Maskin (2005), and Barnes and Smith (2009) for formal theories of self-control consistent with this discussion. Zhang and Rashad (2008) provide evidence of an empirical relationship between obesity and time inconsistency.

[15] A natural corollary to this observation is that if the risk is real, apparent time inconsistencies need not be indicative of a self-control *problem*. A surprisingly high proportion of U.S. households do appear to suffer more from risk than from lack of self-control: some 11.2% report being "food insecure," defined as being (at least) occasionally worried about having enough money to buy food (Nord *et al*. 2004). A number of authors have reported positive associations between food insecurity and overweight status in women (Olson 1999, Townsend *et al*. 2001, Basiotis and Lino 2002, Gibson 2003, Wilde and Peterman 2006).

[16] A dynamic specification might be called for, for instance, if many months or years were required to adjust one's weight to a new optimal level, or if the long-term health impacts of weight gain were an important determinant of body weight. Since we focus instead on the effects of prospective (and potentially imminent) income loss, dynamic effects—if empirically important—could affect the error structure in Equation (1). We believe it unlikely that dynamic effects are

desire to capture variation in perceived financial or economic insecurity. Our specifications are thus of the form

$$W_{2000,ij} = W_{1988,ij}\alpha + X_{2000,ij}\beta + S_{ij}\gamma + \eta_j + \sigma_{ij} \qquad (1)$$

where $W_{tij}$ is individual $i$'s weight[17] in year *t*, $X_{2000,ij}$ is a vector of individual $i$'s personal characteristics in the year 2000, and $S_{ij}$ is a proxy for individual $i$'s subjective beliefs about his personal economic security. $\eta_j$ represents a state or regional fixed effect, and $\sigma_{ij}$ is a disturbance term. Robust standard errors are adjusted for an arbitrary within-state correlation pattern because many of the instruments are measured at the state level.[18]

Our primary concern with this specification is the potential for bias induced by the related problems of reverse causation and unobserved personal characteristics (that could be correlated with both body weight and $S_{ij}$). We would like to use an individual's employment history, for instance, as a proxy for his beliefs about the probability of unexpected job loss. But if heavier people are more likely to become unemployed (after controlling for beliefs about risk), or if there are unobserved characteristics common to both weight and unemployment, then estimation of (1) by ordinary least squares (OLS) will generate upward-biased estimates of $\gamma$.

This problem is partly (but not completely) ameliorated by the fact that we include weight in 1988 as a control variable. This is equivalent to controlling directly for unobservable permanent and pre-1988 personal characteristics (including genetic endowment, childhood experience, and early employment and educational history) that might affect weight. But in considering the effect on body weight of life events that occurred after 1988, we still must take care to measure only those events that are arguably exogenous. In considering an individual report of job loss, for example, the loss may be due to (i) unobserved personal characteristics (e.g., personality traits—like self-discipline—associated with both poor performance on the job and weight), or (ii) weight-related employment discrimination on the part of the employer, or (iii) a downturn in the local economy. Because we are interested in whether (and to what extent) events

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important, however, because the barriers to rapid weight gain/loss appear to be more psychological than physiological (in other words, there is no physical reason the human central nervous system couldn't accommodate rapid changes in weight), and because the long-term health effects of excessive body weight are unlikely to have been important in the pre-industrial world in which humans evolved.

[17] We examine weight controlling for height and height squared rather than body mass index (BMI) both to allow for an easier interpretation of our results and because this is a more flexible specification than BMI. Using BMI instead of weight (controlling for height) produces similar results (available from the authors upon request).

[18] In practice, this was implemented using Stata's *cluster* command, with clustering by state.


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like job loss *cause* weight gain, we would like to exclude events of the first two types from our analysis.

For this reason, we employ an instrumental variables (IV) estimation strategy, in which our proxy for economic insecurity is first regressed on observed personal characteristics and exogenous state- or metropolitan statistical area (MSA)-level instruments. In the second stage, body weight is regressed on a vector of personal characteristics and the *predicted* values of our proxy for economic insecurity from the first stage. This is, of course, the statistical equivalent of using randomized controls in medical research.

To ensure that our instruments will not be correlated with unobserved personal characteristics, we use primarily state-level variables for this purpose, and whenever possible we have chosen policy variables set by state legislatures. Our instruments are as follows: To identify the effect of economic insecurity, we use the series of annual BLS unemployment rates in the geographic areas where the individual resided between 1988 and 2000.[19] For various measures of fluctuations in annual household income, we also construct state-level averages and median values directly from the NLSY79 data (pooling both men and women). For health insurance, we use a vector of indicators of state-level regulations of the individual and small-group markets for health insurance that have been shown to influence health insurance prices.[20]

In order to be valid instruments, these state-level variables must be (i) strongly related to the endogenous variables of interest, and (ii) validly excluded, in the sense that the state-level variables are uncorrelated with the error term in the second stage. We report tests of the strength of our instruments in Section 5, below.

Are these state economic variables exogenous? The policy instruments for health insurance are, from a theoretical standpoint, most likely to be valid—it is unlikely that insurance regulations are set based upon individuals' body weights. The other instruments are state aggregates (averages or medians). These instruments are only valid if they largely capture state-level economic conditions and are not driven by average omitted characteristics. For example, suppose "laziness" is an omitted characteristic correlated with the likelihood that an individual experiences both an income drop and weight gain. If the state average for income drops is high because many people in that state are lazy, this approach will not resolve the identification problem. If the average number of income drops is more reflective of overall state economic conditions, then this instrument is more likely to be valid. We therefore urge more caution in interpreting these

[19] These are either the unemployment rate in the MSA or the unemployment rate associated with the rural parts of the state, depending on where the individual lived in each year.

[20] See Congdon *et al*. (2005) for evidence of the connection between state regulations and health insurance prices.

results than with the results for health insurance, for example, where the instrument is more clearly exogenous. In general, to the extent that the IV results are biased due to this source of endogeneity, we expect the direction of bias to be the same as in the OLS estimates.

Finally, are the state and MSA-level economic variables validly excluded? Again, this is most clearly the case for the insurance regulation variables: it is unlikely that public policies such as these would affect individual weight other than through their effects on health insurance status. However, previous research—most notably Ruhm (2000, 2005)—has examined the direct effect of regional economic variables on individual weight. This literature, however, does not posit a separate effect of regional economic conditions independent of individual economic status, but rather implies area unemployment rates matter because they affect individual unemployment and therefore the individual time and resource constraints that can affect body weight. We report tests of over-identifying restrictions (Hansen *J*-statistics) that examine the exogeneity of the area economic conditions in Section 5, below.

Because many of our equations are over-identified, we use the two-stage Generalized Method of Moments (GMM) estimator in the IV analyses, as described by White (1982) and Davidson and MacKinnon (1993, p. 599). The GMM estimator is defined as $\hat{\beta}_{GMM} = (X'ZWZ'X)^{-1}X'ZWZ'y$, where $Z$ is the matrix of instruments and $W$ is the weighting matrix. When the equation is exactly identified, $W$ is the identity matrix. If the equation is over-identified, the optimal weighting matrix (Hansen 1982) is the inverse of $S = E[Z'\Omega Z]$, where $\Omega$ is the covariance matrix of the structural disturbance process. In other words, $S$ is the covariance matrix of the moment conditions.

## 4. DATA

We focus on the years 1988-2000, when all participants are older than 23 and had mostly completed their formal education. The longitudinal nature of the survey allows for long-term measures of individual economic experience (like unemployment in the past, as well as employment status at the time the survey was administered), and it allows for an examination of individual weight changes rather than simply differences in weight levels across individuals. The NLSY79 survey also includes data on other behaviors like smoking.

We exclude women from our analysis for three reasons. First, labor supply decisions for men are more uniform than those of women, particularly as our sample is ages 23-42, prime childbearing years. Second, body weight in women may be partly related to fertility decisions, and these decisions are also likely to be related to economic variables. Third, the economic security of women in the NLSY79 cohort is more dependent on spousal income than it is for men, and


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spouse-level indicators of economic insecurity are not reported as comprehensively in NLSY79 as the individual-level indicators we utilize.[21] However, it is important to note that because the analysis is specific to men, caution should be used in extrapolating to the general population.

The analysis also uses a number of other state-level variables. These data include unemployment rates and state health insurance regulations. Sources for each of these variables are listed in Appendix I.

Our data include four different measures of income insecurity. The first is the individual's Bayesian posterior probability of unemployment. This probability was calculated from weekly data on employment status available in NLSY79, based on a five-year (1996-2000) career horizon with prior distributions generated from the full sample of NLSY79 men (see Appendix I for details).[22] We hypothesize that individuals who face higher probabilities of future unemployment (as measured by their past experience) will gain more weight.

The second measure of insecurity measures the number of (50% or greater) drops in real annual household income that an individual experienced from 1988 to 2000. Our expectation is that individuals with more large year-to-year drops in household income are likely to have higher perceived levels of economic insecurity and thus we expect them to experience higher weight gains. Note that this measure (along with the two to follow) is likely to be affected not only by an individual's employment history, but also by any changes in hours or wages, and changes in other components of household income, such as spousal employment.

The third set of measures of insecurity proxy for the rate of change and volatility implicit in the individual's history of reported real annual income. These measures are the slope and $R^2$ from linear regressions of family income on a time trend, with a separate regression for each individual. The slope coefficient of the regression (or "Rate of Change") gives the individual's typical annual increase in income from 1988 to 2000. This annual increase may measure anticipated and predictable changes in income. The $R^2$ (or "Goodness of Fit") is a measure of deviations from a linear trend, and therefore how much uncertainty an individual has faced. Individuals with low $R^2$ will have experienced an

[21] Though we do not report them here, we did replicate the results presented in Tables II and III below for females in the NLSY79 cohort. In general, the results for women are less consistent. The effect of the probability of unemployment is similar to that for men, though—as might be expected the standard errors are usually larger. Results for women without children are even more imprecisely estimated due to the smaller sample size (only 471 women in the sample have no children).

[22] The posteriors are based on a five year horizon because the median tenure with a given employer is about four years for the NLSY sample (mean tenure is about six years). A five-year window is therefore limited to a period over which the "hazard rate" associated with employment status can be presumed to remain relatively constant.

income stream that is either highly volatile or highly non-linear, and thus would be likely to consider current (year 2000) and future income to be more at-risk.

The fourth measure of income insecurity is a proxy for the probability that the individual's 2000 household income will fall below the Department of Health and Human Services poverty threshold.[23] This measure is again constructed from individual regressions of real family income on a time trend. This statistic takes into account both the "rate of change" and "goodness of fit" factors discussed above, but allows us to examine a more specific hypothesis about income insecurity: that downside risk (and in particular, downside risk below a threshold value) affects body weight differently than upside risk. We expect that respondents facing a higher probability of poverty will gain more weight.[24]

We also have two measures of "safety nets" that could serve the purpose of decreasing the risk of (or, alternatively, mitigating the effects of) catastrophic income loss. The first is inheritance payments due to the death of a friend or family member in 2000. This measure is arguably exogenous, because a friend or relative's death is presumably an exogenous event. We also examine health insurance status as an indicator of greater economic security, with state regulations that affect health insurance prices as the identifying instruments. We expect these variables to have a negative effect on weight.

The means and standard deviations of all variables are reported in Tables I-A and I-B.[25] On average, men in our sample weighed 176.6 pounds in 1988, and 197.5 pounds in 2000 (for an average 12-year gain of 21 pounds). Table I-A indicates that average (posterior) probability of unemployment in 2000 was 3.1%. Individuals in our sample experienced on average 2.01 drops of 10% or more in reported real annual income between 1988 and 2000, and the average $R^2$ from individual-specific regressions of income on time was about 0.36, with a mean probability of falling into poverty of 3%. On average, individuals received about $2,200 in inheritance payments (non-recipients coded as zero). 83% of individuals in our sample were covered by health insurance at the time of the 2000 survey.

[23] This is a simplified version of the federal poverty line. This threshold is used by a number of government agencies in determining eligibility for services, including food stamps, WIC, and other food assistance programs.

[24] Roughly 10 percent of individuals in our sample experienced at least one year in which family income was topcoded (i.e., income was high enough that its specific value is omitted from NLSY79 in order to preserve respondent confidentiality). We drop these individuals from these specifications because we cannot accurately measure their income volatility.

[25] The tables report unweighted means to be consistent with the regression results.


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# 5. RESULTS

## 5.1. ORDINARY LEAST SQUARES ESTIMATES

Ordinary least squares estimates are presented in Table II. As noted above, these estimates will be biased if unobserved individual characteristics affect both body weight and the variable of interest. Table II includes six specifications, which differ only in the variable(s) included as proxies for economic insecurity. Note that in most specifications, the coefficient on weight in 1988 cannot be statistically distinguished from 1; as a result, the coefficients on the other variables of interest can be interpreted as indicating the effect of the variable on weight *gain* over the 1988 to 2000 period.[26]

Table II provides only mixed confirmation of our theoretical prediction of positive marginal effects of both income and insecurity on weight gain. The coefficient on income is negative (though not statistically significant) in all specifications, contrary to our prediction. Of the four measures of "insecurity" that we examine, only one ("goodness of fit") does not have the expected sign, though none are statistically significant. Of the two measures of "security," both have the expected sign, though the coefficient on health insurance is not statistically significant.[27] The extent to which these estimates are biased by unobservable individual characteristics and/or reverse causation can be ascertained by comparison to the IV results presented in Table III; these will be discussed in more detail below.

Before moving on to the IV results, it is worth noting that coefficients on other variables in Table II are consistent with the economic insecurity hypothesis. Being black or Hispanic is associated with weight gains; smoking appears to induce weight loss; as does higher education. The results on race and ethnicity are consistent with possible genetic differences, group differences in other unobserved characteristics, and also with the possibility that blacks and Hispanics are subject to employment discrimination (and hence are faced, on average, with higher levels of economic insecurity than white non-Hispanic men). The negative effect of smoking on weight gain is interesting because it has been noted that the nicotine in cigarettes appears to target the same systems in the human brain that

[26] Because many surveys do not include data on long-term changes in body weight, we replicated all specifications with 1988 weight omitted. The estimated coefficients in these regressions (which we do not report) are very similar to those reported in Tables II and III below, but the standard errors are larger.

[27] Interestingly, the relationship between *income* and insecurity is more straightforward in our data, at least as measured by raw correlations: for all six measures of economic (in)security we employ, the correlation coefficients (which vary in magnitude from .05 to .36) have the signs that would be expected if low income were associated with economic insecurity.

are stimulated by indicators of economic security, and that smoking might be properly thought of as a "self-medicating" response to economic insecurity.[28] That smoking would cause weight loss is consistent with this hypothesis.

Note also that the coefficient on age is negative: in effect, this implies (because we control for weight in 1988) that while older individuals[29] are heavier in our sample, their rate of weight gain is slower.

### 5.2. INSTRUMENTAL VARIABLES ESTIMATES

Table III shows the effect of our various measures of economic insecurity on weight gains between 1988 and 2000.[30] In these specifications, the effects of economic insecurity are larger than in the OLS results and in all, insecurity appears to promote weight gain. The first four columns in Table III report results for specifications with alternative measures of economic insecurity: according to our IV estimates, (1) a 1% increase in the probability of becoming unemployed causes an increase in body weight of over half a pound, (2) for each additional year in which real income drops by at least 50%, body weight increases by 5 pounds, (3) a decrease in $R^2$ (a measure of income stability) by 0.1 units corresponds to an increase in body weight of 2.4 pounds, and (4) each percentage point increase in the probability of falling into poverty results in an additional third of a pound of weight gained.

Columns 5 and 6 consider "safety nets" that could ameliorate the effect of economic insecurity. In column 5, we examine the effect of the size of payments received (via inheritance)[31] due to the death of a friend or family member in 2000, and find small (just over 4 pounds per $100,000 received) but statistically significant negative effects on weight gain.[32]

Interpreting the effect of health insurance on weight gain requires special consideration. Because health insurance is often purchased on the individual market or is contingent upon employment, it is subject to the well-known *adverse selection* problem: because healthier individuals are less likely to need health

[28] Evidence for this tobacco-insecurity hypothesis is outlined in Pomerleau (1997) and Smith (2009).

[29] The cohort of men in our sample ranged from 23 to 32 years of age in 1988.

[30] First-stage regression results for these specifications are presented in Appendix II. In general, we find that our state- or MSA-level instruments are highly significant and have the expected signs in the first stage regressions, with exceptions noted below.

[31] Inheritance is treated as an exogenous variable in all specifications.

[32] Death of a close friend or relative may lead to mental health changes that affect weight. To control for this, we re-estimated the results including an indicator variable equal to 1 for anyone who received any inheritance at all, as well as the variable indicating the value of the inheritance. If the death is what matters most, we would expect the dummy variable to pick up this effect. However, the coefficient is negligible and the value of the inheritance conditional on there being a death is what drives the weight differences.


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insurance, they are less likely (at a given price) to purchase it. On the other hand, health insurance can also induce a *moral hazard* problem: given the presence of insurance, individuals might invest less time or money in health-promoting preventive measures (such as active weight loss) that might decrease the demand for medical services in the future (Rothschild and Stiglitz 1976). Our IV estimation strategy should eliminate the adverse selection problem. Our estimate of the effect of health insurance on weight gain can thus be interpreted as the net effect of two opposing forces: weight *loss* due to improved financial security, offset by weight *gain* induced by moral hazard. As the final column in Table III indicates, the security effect dominates, by about 3.5 pounds. Adverse selection also seems to be important and affects our estimates in the expected direction, as evidenced by the 5.6-pound difference between our OLS and IV estimates.

The instrumental variables coefficient estimates are somewhat larger than the OLS estimates, which raises the concern that the instruments may not be valid. Table IV reports statistical tests of the validity of our instruments. The columns of this table correspond to the specifications of Table III. The first set of statistics test the over-identifying restrictions, and therefore the exogeneity of the instruments. The tables report the Hansen *J*-statistic, described in Hansen (1982). The null hypothesis is that the model is correctly specified and that the over-identifying restrictions are valid. In every case, the test fails to reject this null, with *p*-values ranging from about .2 to almost .9. This leads to greater confidence in our IV estimates because it appears that the instruments are more likely to be exogenous.

The second test statistic reported is for a test of instrument relevance—whether or not the instruments and the endogenous variables of interest are sufficiently correlated. We report the F statistics for the joint significance of the instruments in the first stage regressions. For all specifications, the *p*-values are small, usually about zero. However, in a few cases, the *F* statistic is smaller than 10, the usual cutoff for indicating weak instruments. The *F*-statistics for the number of drops of real income and for the probability of poverty are particularly low by this measure, suggesting caution in interpreting these IV results.

These results are robust to a number of alternative specifications. We have estimated results including fixed effects for the industry of occupation in an individual's current or most recent occupation (if unemployed). This makes very little difference to our results. We also examined specifications using the number of weeks unemployed over the past five years (in lieu of the non-linear transformation of these data via Bayes' formula), again with similar results. Using longer windows of time for unemployment experience attenuates the results, as might be expected if unemployment experience in the distant past is less predictive of future spells of unemployment. Using the number of 10 percent

drops in family income as opposed to 50 percent drops also leads to similar but somewhat attenuated results.[33]

## 6. IMPLICATIONS FOR CONSUMER WELFARE

The implications of weight gain for consumer welfare are not uncontroversial. If consumers freely choose how much to eat and how much to exercise, then (assuming complete markets) conventional welfare analysis would conclude that government intervention aimed at improving health through weight loss could not make people better off. Such analysis would suggest, moreover, that if the rise in obesity observed in recent decades has been driven by a concurrent rise in the opportunity cost of time, then obesity can actually be viewed as an *optimal* outcome by the metric of economic efficiency (Chou, *et al*. 2004, Cutler *et al*. 2003). In other words, the fact that we are collectively fatter might be taken as a sign that we are collectively better off.[34]

Of course, if self-control problems are an important determinant of weight gain, it is no longer clear that efficiencies in the markets for food or labor translate into welfare gains.[35] But our findings suggest an entirely different perspective: if apparently time-inconsistent choices about diet and exercise are in fact natural responses to risk, then body weights will be "excessive" only to the extent that risk is somehow "excessive." And while a revamping of America's social safety net may be a novel solution to the modern obesity epidemic, many threats to economic security (job stability, availability of health care, etc.) are arguably determined largely by factors beyond the control of the individual consumer. It might be appropriate, then, to recast this debate over the putative impact of obesity on consumer welfare as a discussion of the welfare effects of economic insecurity. Indeed, if the proportion of the modern obesity epidemic attributable to economic insecurity could be reliably estimated,[36] the cost of the associated

[33] These results are all available from the authors upon request.

[34] One commonly cited "market failure" associated with obesity is the above-mentioned moral hazard problem (e.g., Bhattacharya and Sood 2005, Rashad and Markowitz 2007). To the extent that health insurance is inducing weight gain, public expenditures to promote weight loss might be justified on efficiency grounds. Our results suggest, however, that the net effect of health insurance on weight is negative.

[35] Cutler *et al*. (2003), for instance, argue that if self-control problems are strong enough, they could more than offset efficiency gains made elsewhere. They also note, however, that—measured in the currency of time cost—the 20-minute decrease in the amount of time required for daily food preparation realized in the last few decades more than offsets the 15 minutes of daily exercise that would be required to offset the gains in weight observed over the same time period.

[36] While our analysis provides estimates of the magnitude of the impact of selected measures of insecurity on weight gain, the limited size of our sample precludes us from simultaneously estimating, for example, the relative impacts of food price and availability. Moreover, our data is longitudinal and thus cannot speak to demographic changes in the population.


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weight gain could provide a lower bound on the social cost of risk in the marketplace.[37]

## 7. CONCLUSION

In the natural world, body fat serves as an insurance plan, and animals at greater risk of starvation are more likely to gain weight. This phenomenon has received little attention in the study of human obesity, and (perhaps as a result) epidemiological studies have often conflated the effects of income, time costs, and economic insecurity, and have not always accounted for potential reverse causation or unobserved individual characteristics.

Our results provide evidence that economic insecurity is an important cause of weight gain. Each of four measures of economic insecurity (probability of unemployment, number of income drops, volatility of income, and probability of being in poverty) generate weight gains, with magnitudes that are considerable relative to the overall increase in weight observed over a 12 year period. While the mean respondent gained 21 pounds over our 12-year window, for instance, a decrease of one standard deviation in our various measures of economic insecurity corresponds to a decrease in weight gain of between 0.3 and 7 pounds. We also find that intrafamily transfers (as measured by a reported inheritance) and health insurance are protective against weight gain: an increase of one standard deviation in support provided by financial safety nets leads to decreases in weight gain of around one pound.

As noted at the outset, this study does not attempt to address the proximate mechanisms (presumably some combination of the quality or quantity of food consumed, physical activity, and metabolic rate) by which economic insecurity leads to weight gain. These proximate mechanisms have been the primary focus of most epidemiological research on obesity, and a major implication of our findings is that without a better understanding of the ultimate *causes* of each mechanism (presumably some combination of information sets and material constraints), the potential for misinterpretation in obesity research is great.

There is also the question of the cause of the recent increase in the incidence of obesity in the U.S. and around the world. Unfortunately, the measures of economic insecurity available to us in this study are not easily recovered from historical data, making it difficult for us to estimate how much of the observed secular trend might be attributable to changes in economic insecurity. Nevertheless, for at least one of our variables we can perform a "back of the

[37] Such costs would arguably include not just the cost of lost productivity and medical treatment for obesity-related illness (which in 2001 reportedly added up to $117 billion in the U.S. [U.S. Department of Health and Human Services 2001]), but also associated consumer expenditures on food.

envelope" calculation to obtain a measure of the potential contribution of changes in insecurity to the overall trend. Between 1979 and 2001, the prevalence of health insurance among U.S. workers decreased by about eight percentage points (Gilmer and Kronick 2005). During roughly the same period, the average body weight of men aged 30-39 (i.e., working age men young enough to be unaffected by changes in retirement security) increased by 13.6 pounds (Ogden *et al*. 2004). Using our (admittedly imprecise) estimate of the effect of health insurance on body weight, the observed decrease in health coverage translates into a population average weight gain of 0.3 pounds. In other words, our results imply that changes in health insurance markets alone could account for nearly 3% (with a 95% upper confidence bound of 10%) of the observed trend in body weight. It is also worth noting that some commentators have argued that—over the same thirty years or so in which obesity has risen so dramatically—there has been a concurrent increase in the degree to which individual households in the U.S. are exposed to other types of financial risk.[38]

The relationship between economic insecurity and weight gain bears all the hallmarks of an evolutionary adaptation: it has strong parallels in studies of animal behavior; it is evidently governed by behavioral algorithms written into our DNA; and it is associated with behaviors commonly perceived as "emotional" rather than "rational," as these terms are understood in common usage. Moreover, a "fattening response" to the presence of economic insecurity would appear to be more appropriate in a pre-industrial world—in which the food supply was far less reliable—than it is today. But the question of whether such behavior remains "optimal" in the modern world is perhaps beside the point. The fact that economic insecurity appears to be an important cause of weight gain in the U.S. today suggests the need for additional research that will improve our understanding of both the various ways in which the income of American families is at risk, and the particular ways in which such risk is translated into weight gain.

[38] See, for example, Neumark (2000) on the rate of involuntary job loss and Hacker (2004, 2006) for discussions of the change from defined-benefit pensions to individual 401(k) accounts. Auld and Powell (2006) also note that Canada—a country with an arguably stronger social safety net—has an obesity rate that is 7 percentage points lower than the U.S. rate, with at most 1/3 of the difference attributable to demographic differences.


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# 8. TABLES

Table I-A: Means and Standard Deviations of Individual Characteristics
NLSY Men

| **Characteristic** | Mean | Standard Deviation |
|---|---|---|
| Family income (in $1000) in 2000 | 57.291 | 53.361 |
| Posterior probability of unemployment, 2000 | 0.031 | 0.077 |
| Number of 50% Drops in Real Family Income, 1988-2000 | .554 | .821 |
| Annual income: Rate of Change (slope), 1988-2000 | 1.135 | 2.552 |
| Annual income: Goodness of Fit $(R^2)$, 1988-2000 | 0 .358 | 0 .289 |
| Probability of Falling Below the Poverty Level, 2000 | 0.033 | 0.101 |
| Total value of inheritance (in $1000) | 2.208 | 21.584 |
| Covered by Health Insurance, 2000 | 0.834 | 0.372 |
| Currently smoke, 2000 | 0.31 | 0.462 |
| Weight (in lbs) in 2000 | 197.457 | 39.104 |
| Weight (in lbs) in 1988 | 176.56 | 32.117 |
| Height (in inches) | 69.663 | 2.591 |
| Height (in inches) squared | 4859.646 | 359.358 |
| Age in 2000 | 38.855 | 2.264 |
| Black | 0.275 | 0.446 |
| Hispanic | 0.184 | 0.387 |
| White | 0.542 | 0.498 |
| Married in 2000 | 0.606 | 0.489 |
| Never Married by 2000 | 0.205 | 0.404 |
| Divorced or separated by 2000 | 0.185 | 0.388 |
| Widowed by 2000 | 0.004 | 0.065 |
| BA | 0.220 | 0.415 |
| Some college | 0.214 | 0.411 |
| High school graduate | 0.445 | 0.497 |
| High school dropout | 0.119 | 0.324 |
| Live within a metropolitan area in 2000 | 0.728 | 0.445 |

Sources: See Appendix I.

Table I-B: Means and Standard Deviations of State and MSA Characteristics
NLSY79, various years

| Characteristic | Mean | Standard Deviation |
|---|---|---|
| Unemployment rate in local labor market, 1988 | 6.325 | 2.597 |
| Unemployment rate in local labor market, 1989 | 5.532 | 2.078 |
| Unemployment rate in local labor market, 1990 | 5.670 | 1.965 |
| Unemployment rate in local labor market, 1991 | 7.382 | 2.740 |
| Unemployment rate in local labor market, 1992 | 8.013 | 2.5 |
| Unemployment rate in local labor market, 1993 | 7.548 | 2.62 |
| Unemployment rate in local labor market, 1994 | 7.129 | 2.692 |
| Unemployment rate in local labor market, 1996 | 6.846 | 3.103 |
| Unemployment rate in local labor market, 1998 | 5.106 | 2.813 |
| Unemployment rate in local labor market, 2000 | 4.474 | 2.536 |
| Mean State Probability of Falling Below the Poverty Level, 2000 | 0.045 | 0 .015 |
| Median State Probability of Falling Below the Poverty Level, 2000 | 0.001 | 0 .002 |
| Mean State Annual Income: Goodness of Fit ( $R^2$ ), 1988-2000 | 0.356 | 0.03 |
| Median State Annual Income: Goodness of Fit ( $R^2$ ), 1988-2000 | 0.302 | 0.05 |
| Mean State Annual Income: Rate of Change (slope), 1988-2000 | 1.109 | 0.274 |
| Median State Annual Income: Rate of Change (slope), 1988-2000 | 0.895 | 0.283 |
| Mean State Number of 50% Drops in Real Family Income, 1988-2000 | 0.581 | 0.102 |
| Median State Number of 50% Drops in Real Family Income, 1988-2000 | 0.069 | 0.247 |
| State Health Insurance Regulation: Plan Liability, 2000 | 0.249 | 0.433 |
| State Small Group Health Insurance Regulation: No. of Mandates, 2000 | 31.026 | 9.217 |
| State Small Group Health Insurance Regulation: NAIC Rating Bands, 2000 | 0.609 | 0.487 |
| State Small Group Health Insurance Regulation: Tight Rating Bands, 2000 | 0.23 | 0.421 |
| State Small Group Health Insurance Regulation: Community Rating, 2000 | 0.357 | 0.479 |
| State Individual Health Insurance Regulation: Any Market Reform, 2000 | 0.238 | 0.426 |
| State Individual Health Insurance Regulation: Guaranteed Issue, 2000 | 0.173 | 0.379 |

Sources: See Appendix I


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Table II: Effect of Economic Insecurity on Body Weight in Men, 2000
(State Fixed Effects)

| Variables | (1) | (2) | (3) | (4) | (5) | (6) |
|---|---|---|---|---|---|---|
| Family income (in $1000) | -0.00936 (0.0075) | -0.0166 (0.022) | -0.0407 (0.027) | -0.00828 (0.0078) | -0.00953 (0.0076) | -0.0107 (0.0074) |
| Posterior Probability of Unemployment | 11.47 (8.49) | -- | -- | -- | 11.49 (8.50) | 13.68 (8.93) |
| Number of 50% Drops in Real Family Income, 1988-2000 | -- | 0.980 (0.69) | -- | -- | -- | -- |
| Annual income: Rate of Change (slope), 1988-2000 | -- | -- | 0.000261 (0.00029) | -- | -- | -- |
| Annual income: Goodness of Fit ($R^2$), 1988-2000 | -- | -- | 1.115 (1.55) | -- | -- | -- |
| Probability of Poverty | -- | -- | -- | 9.182 (8.37) | -- | -- |
| Inheritance Received (in $1000) | -- | -- | -- | -- | -0.0398*** (0.012) | -0.0398*** (0.012) |
| Health Insurance | -- | -- | -- | -- | -- | 2.121* (1.23) |
| Currently Smoke | -4.85*** (1.11) | -4.89*** (1.15) | -4.83*** (1.12) | -4.79*** (1.09) | -4.89*** (1.11) | -4.80*** (1.11) |
| Weight in 1988 (in pounds) | 0.966*** (0.021) | 0.962*** (0.022) | 0.963*** (0.022) | 0.966*** (0.021) | 0.966*** (0.021) | 0.964*** (0.021) |
| Height (in inches) | 5.036 (5.79) | 5.054 (6.01) | 5.018 (6.07) | 4.947 (5.75) | 5.238 (5.76) | 5.307 (5.70) |
| Height (in inches) squared | -0.0292 (0.042) | -0.0287 (0.043) | -0.0284 (0.044) | -0.0286 (0.041) | -0.0307 (0.042) | -0.0311 (0.041) |
| Age | -0.750*** (0.16) | -0.72*** (0.19) | -0.71*** (0.20) | -0.73*** (0.16) | -0.754*** (0.16) | -0.763*** (0.16) |
| Black | 7.818*** (1.32) | 8.105*** (1.30) | 8.173*** (1.35) | 7.949*** (1.28) | 7.726*** (1.30) | 7.773*** (1.29) |
| Hispanic | 2.125 (1.33) | 2.154 (1.38) | 2.096 (1.40) | 2.196 (1.32) | 2.014 (1.32) | 2.104 (1.32) |
| Married | 1.949 (1.33) | 2.991** (1.40) | 2.731* (1.36) | 2.187 (1.35) | 1.972 (1.33) | 1.587 (1.39) |
| Divorced or Separated | -1.412 (1.47) | -0.841 (1.48) | -0.865 (1.52) | -1.427 (1.48) | -1.364 (1.47) | -1.493 (1.49) |
| Widow | -4.255 (11.5) | -4.785 (11.0) | -4.079 (11.3) | -4.315 (11.4) | -4.321 (11.4) | -4.048 (11.3) |
| BA Degree | -2.219 (1.86) | -0.939 (2.11) | -1.012 (2.12) | -2.217 (1.84) | -2.048 (1.86) | -2.509 (1.96) |
| Some College | -1.043 (1.75) | -1.125 (1.79) | -1.160 (1.85) | -1.024 (1.77) | -0.994 (1.75) | -1.417 (1.79) |
| High School Graduate | 0.738 (1.68) | 1.060 (1.68) | 1.012 (1.73) | 0.772 (1.68) | 0.722 (1.68) | 0.439 (1.74) |
| Live Within a Metropolitan Area | 2.544* (1.27) | 2.966** (1.29) | 2.988** (1.27) | 2.583** (1.28) | 2.527** (1.26) | 2.470* (1.26) |
| $N$ | -4.85*** | -4.89*** | -4.83*** | -4.79*** | -4.89*** | -4.80*** |
| $R^2$ | 0.683 | 0.682 | 0.677 | 0.677 | 0.683 | 0.684 |

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table III: Effect of Economic Insecurity on Body Weight in Men, 2000
(Instrumental Variables)

| Variables | (1) | (2) | (3) | (4) | (5) | (6) |
|---|---|---|---|---|---|---|
| Family income | -0.00171 | -0.0366 | -0.102*** | 0.00240 | -0.00198 | -0.00298 |
| (in $1000) | (0.0088) | (0.032) | (0.037) | (0.013) | (0.0088) | (0.0065) |
| Posterior Probability | 61.75** | -- | -- | -- | 111.8*** | 68.76*** |
| of Unemployment | (31.2) | | | | (23.6) | (22.2) |
| Number of 50% Drops in Real | -- | 5.445* | -- | -- | -- | -- |
| Family Income, 1988-2000 | | (3.15) | | | | |
| Annual income: Rate of Change | -- | -- | 0.00261*** | -- | -- | -- |
| (slope), 1988-2000 | | | (0.00071) | | | |
| Annual income: Goodness of Fit | -- | -- | -24.27*** | -- | -- | -- |
| $(R^2)$, 1988-2000 | | | (7.17) | | | |
| Probability of Poverty | -- | -- | -- | 2.997 | -- | -- |
| | | | | (34.7) | | |
| Inheritance Received | -- | -- | -- | -- | -0.0443*** | -0.0448*** |
| (in $1000) | | | | | (0.0084) | (0.0073) |
| Health Insurance | -- | -- | -- | -- | -- | -3.518 |
| | | | | | | (6.41) |
| Currently Smoke | -4.531*** | -3.827*** | -3.715*** | -4.974*** | -4.645*** | -4.979*** |
| | (1.06) | (1.09) | (0.75) | (1.08) | (1.06) | (0.64) |
| Weight in 1988 (in pounds) | 0.970*** | 0.963*** | 0.968*** | 0.985*** | 0.969*** | 0.975*** |
| | (0.018) | (0.018) | (0.013) | (0.017) | (0.018) | (0.012) |
| Height (in inches) | 6.270 | 1.654 | -1.948 | 2.070 | 6.481* | 7.469** |
| | (3.84) | (4.70) | (3.99) | (3.70) | (3.87) | (3.20) |
| Height (in inches) squared | -0.0373 | -0.00431 | 0.0215 | -0.00806 | -0.0387 | -0.0457** |
| | (0.028) | (0.034) | (0.029) | (0.027) | (0.028) | (0.023) |
| Age | -0.760*** | -0.707*** | -0.647*** | -0.680*** | -0.758*** | -0.762*** |
| | (0.14) | (0.15) | (0.11) | (0.11) | (0.14) | (0.12) |
| Black | 6.559*** | 7.695*** | 7.823*** | 7.182*** | 6.473*** | 6.063*** |
| | (1.36) | (1.16) | (0.78) | (1.04) | (1.35) | (1.21) |
| Hispanic | 2.716*** | 2.484** | 2.753*** | 2.545** | 2.630** | 2.858*** |
| | (1.03) | (1.22) | (0.81) | (1.03) | (1.03) | (0.98) |
| Married | 3.089* | 3.062* | 3.112*** | 3.460* | 3.150** | 2.075 |
| | (1.59) | (1.69) | (1.14) | (1.79) | (1.59) | (1.35) |
| Divorced or Separated | -0.338 | -0.974 | -0.248 | -1.139 | -0.250 | -1.159 |
| | (1.57) | (1.64) | (1.23) | (1.10) | (1.56) | (0.94) |
| Widow | 1.742 | 0.519 | 1.331 | -1.313 | 2.421 | 0.570 |
| | (8.38) | (8.84) | (8.19) | (8.61) | (8.49) | (8.21) |
| BA Degree | -1.441 | -1.412 | 1.396 | -1.522 | -1.236 | -0.493 |
| | (1.72) | (1.78) | (1.36) | (1.34) | (1.72) | (2.17) |
| Some College | 0.180 | -1.333 | 1.830 | 0.537 | 0.247 | 1.133 |
| | (1.68) | (1.88) | (1.60) | (1.54) | (1.67) | (1.91) |
| High School Graduate | 0.774 | -0.501 | 1.779 | 0.750 | 0.786 | 1.544 |
| | (1.50) | (1.71) | (1.27) | (1.21) | (1.49) | (1.79) |
| Live Within a | 2.833*** | 2.759*** | 2.648*** | 2.546*** | 2.866*** | 2.534*** |
| Metropolitan Area | (1.01) | (1.03) | (0.74) | (0.94) | (0.99) | (0.93) |
| $N$ | 2561 | 2561 | 2281 | 2281 | 2561 | 2548 |
| $R^2$ | 0.670 | 0.672 | 0.640 | 0.672 | 0.670 | 0.671 |

The second through sixth and eighth variables listed in Table III are treated as endogenous. Instruments in all specifications include the unemployment rate in respondent's local labor market for each survey year. In addition, state-level mean and median values of the number of 50% income drops; of the "goodness of fit" and "rate of change" variables; and of the probability of poverty-level income are included as an instruments in the specifications (2), (3), and (4), respectively. Seven state-level health insurance policy variables (see Appendix I) are included as instruments in the sixth specification. See Appendix I for sources.
Robust standard errors (adjusted for within-state clustering) in parentheses.
* significant at 10%, ** significant at 5%, *** significant at 1%


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Table IV: Tests of Validity of Instruments
(Columns Index Specifications as Reported in Table III)

| | (1) | (2) | (3) | (4) | (5) | (6) |
|---|---|---|---|---|---|---|
| **Tests of Over-Identification (Instrument Exogeneity)** | | | | | | |
| Null: Over-identifying restrictions are valid (implies instruments are exogenous) (Note that "Fail to Reject the Null" implies *valid* instruments) | | | | | | |
| Hansen J statistic (over-identification test of all instruments) | 4.56 | 9.40 | 25.56 | 15.66 | 4.53 | 10.57 |
| $\chi^2$ distribution *p*-value | .87 | .59 | .27 | .15 | .87 | .78 |
| **Tests of Instrument Relevance** | | | | | | |
| *F* statistic for relevance of instruments in 1st stage | 10.36 | 1.63 | $R^2$ : 4.58 Slope: 13.12 | 3.47 | 10.36 | Health: 8.32 Posterior: 9.71 |
| *p*-value | .00 | .12 | .00 | .00 | .00 | .00 |

## 9. APPENDIX I: CONSTRUCTED AND NON-NLSY VARIABLES

Posterior Probability of Unemployment. NLSY79 includes weekly data on employment status (working, unemployed, out of labor force, etc.) for each subject. Our aim is to derive from this information a measure of each respondent's subjective beliefs about the probability of experiencing involuntary job loss at the time of the 2000 survey (when final body weight is measured in our sample). We posit that the underlying risk (i.e., the hazard rate) is fixed but unknown (to the worker) at the beginning of the worker's current career, and that each worker adjusts his beliefs in a Bayesian manner as time goes on. We calculate the posterior probability as follows:

Consider the fixed (but unknown) probability $\pi$ of a worker becoming unemployed over a period of $n+1$ weeks. He knows at the outset that there are $k$ possible values of $\pi$, denoted $\pi_i$ for $i = 1,2,...,k$ and prior probabilities $P(\pi = \pi_i)$. After $n$ weeks he observes that he has been unemployed for a total of $x \leq n$ weeks. The probability that he will be unemployed in week $n+1$ is then given by

$$\sum_{i=1}^{k} \pi_i P(\pi = \pi_i \mid x) \tag{2}$$

where

$$P(\pi = \pi_i \mid x) = \frac{P(x \mid \pi = \pi_i) P(\pi = \pi_i)}{\sum_{j=1}^{k} P(x \mid \pi = \pi_j) P(\pi = \pi_j)} \tag{3}$$

and (since for any given value $\pi_i$, $x$ is the realization of a binomially distributed random variable)

$$P(x \mid \pi = \pi_i) = \frac{n!}{x!(n-x)!}(\pi_i)^x (1-\pi_i)^{n-x} \qquad (4)$$

To implement (2), we generated values for $\pi_i$ (job-loss hazard) and $P(\pi = \pi_i)$ (prior probability of a given hazard level) from the sample of 5507 male NLSY79 respondents for whom comprehensive weekly employment data is available during our sample window. In particular, observations on the total number of weeks of unemployment experienced were sorted into 100 bins (i.e., of approximately 55 observations each); $\pi_i$ was then calculated as the mean hazard (number of weeks unemployed divided by total number of weeks) for individuals in the *i*th bin, with prior probability $P(\pi = \pi_i)$ given by the number of observations in bin *i* divided by the total number of observations.

Health Insurance Policies. Seven state-level measures of health insurance-related regulation were obtained from the December 1999 *State Legislative Health Care and Insurance Issues* published by BlueCross BlueShield Association. *Plan Liability* indicates whether a state has laws in place that hold health plans and their employees liable for damages for harm to enrollees; *No. of Mandates* is a count of the number of specific plan mandates (benefits, providers, or persons covered) written into state law; *NAIC Rating Bands*, *Tight Rating Bands*, and *Community Rating* are various measures of the extent to which plans can use experience, health status, and/or duration of coverage in setting small group rates; *Any Market Reform* is a composite of these three variables, applied to the market for individual plans; and *Guaranteed Issue* states require health plans to offer coverage to all individuals regardless of their health status or claims experience.

Number of 50% Drops in Real Family Income, 1988-2000. Family annual income in each survey year is reported in NLSY79. This variable is a count of the number of times family income (adjusted for inflation) was at least 50% less than the most recently reported previous income.

Probability of Being Below the Poverty Line. This variable is formed by finding the probability that individual *i*'s predicted family income in 1998 is below the poverty level. Poverty levels were obtained from the Department of Health and Human Services *HHS Poverty Guidelines*. These guidelines are a simplified version of the federal poverty line, and are used to determine eligibility for a number of programs, including food stamps, WIC, and other food assistance programs. They depend on the number of family members living in the home and family income. They are uniform for the continental US, but are higher for Alaska and Hawaii. In order to find the probability of being below the poverty level, we regress real annual family income on a year trend for each individual. Given the coefficients for the slope and intercept for a linear time trend in family


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income, and the usual assumption of Gaussian error structures, we obtain a *t*-distributed estimate of household income in the year 2000. We then solve for *t* and (using the *ttail* command in Stata) compute the probability of having income below the poverty level.

Self Reported Weight and Height Corrections. Self-reported weight and height were corrected for reporting bias using the method described in Cawley (2000). Matched data on reported and actual heights and weights from the NHANES III survey were used for this purpose. Separate OLS regressions were performed for each sex and race/ethnic group.

To estimate the actual weight in pounds of an individual, actual weight of the subset of NHANES III respondents between the ages of 26 and 45 was regressed on reported weight (in lbs.), reported weight squared, and the respondent's age in years. Estimated coefficients were then used to correct for the bias. Coefficients for reporting error in height were computed by regressing actual height on reported height (in inches) and reported height in inches squared.

Unemployment Rates. The NLSY reports unemployment rates for the local labor market. These are either the unemployment rate in the metropolitan statistical area (MSA) or the unemployment rate associated with the rural parts of the state, depending on where the individual lived in each year.

## 10. APPENDIX II: FIRST-STAGE REGRESSION RESULTS

| | Posterior | Number of drops | $R^2$ | Slope | Probability of being in poverty | Health Insurance |
|---|---|---|---|---|---|---|
| Value of inheritance | | | | | | .0001 |
| | | | | | | (.0001) |
| Weight (in lbs.) in | .0000 | -.0003 | -.0003 | -2.8455 | .0000 | .0005** |
| 1988 | (.0001) | (.0004) | (.0002) | (2.0522) | (.0001) | (.0002) |
| Height (in inches) | -.0216 | -.0610 | -.0529 | 163.2412 | .0038 | -.0222 |
| in 1985 | (.0184) | (.2085) | (.0883) | (552.0883) | (.0219) | (.1003) |
| Height$^2$ (in inches) | .0002 | .0005 | .0004 | -1.1872 | .0000 | .0001 |
| in 1985 | (.0001) | (.0015) | (.0006) | (3.9734) | (.0002) | (.0007) |
| Age in 2000 | .0002 | -.0154** | -.0034 | -59.028*** | -.0013* | .0000 |
| | (.0007) | (.0060) | (.0022) | (17.6943) | (.0007) | (.0034) |
| Black | .0240*** | .1094** | .0170 | 274.3960** | .0167*** | -.0229 |
| | (.0042) | (.0470) | (.0186) | (125.0876) | (.0059) | (.0145) |
| Hispanic | .0022 | -.0428 | .0311 | .9248 | -.0040 | -.0287 |
| | (.0046) | (.0379) | (.0194) | (173.3396) | (.0065) | (.0181) |
| Married | -.0172*** | -.443*** | -.0200 | -284.7702* | -.0369*** | .1750*** |
| | (.0044) | (.0356) | (.0187) | (156.1686) | (.0074) | (.0244) |
| Divorced or | -.0144** | -.1094** | -.0455** | -596.01*** | -.0266*** | .0462* |
| Separated | (.0058) | (.0514) | (.0159) | (151.5655) | (.0079) | (.0263) |

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First Stage Results, Continued

| | Posterior | Number of drops | $R^2$ | Slope | Probability of being in poverty | Health Insurance |
|---|---|---|---|---|---|---|
| Widow | -.0273*** | -.2766* | -.0453 | -1395.7*** | .0383 | -.0978 |
| | (.0096) | (.1551) | (.0976) | (266.4862) | (.0551) | (.1353) |
| BA Degree | -.0183*** | -.208*** | .0306 | -330.8862* | -.0160* | .2366*** |
| | (.0053) | (.0645) | (.0231) | (190.6597) | (.0095) | (.0292) |
| Some College | -.0138* | -.176*** | .0135 | -697.79*** | -.0226** | .2116*** |
| | (.0069) | (.0607) | (.0200) | (145.5652) | (.0103) | (.0286) |
| High School | -.0113* | -.1669** | -.0094 | -526.19*** | -.0207** | .1563*** |
| Graduate | (.0056) | (.0687) | (.0177) | (109.6119) | (.0099) | (.0261) |
| Live Within a | .0058** | .0359 | -.0202 | -81.3255 | .0035 | .0123 |
| Metropolitan area | (.0027) | (.0304) | (.0125) | (104.1951) | (.0055) | (.0184) |
| Currently Smoke | .0155*** | .1326*** | -.007*** | 113.7494 | .0106* | -.0433** |
| | (.0039) | (.0407) | (.0126) | (83.2511) | (.0054) | (.0186) |
| Family Income | -.0001*** | -.003*** | .0030 | 50.2885** | -.0007*** | .0006*** |
| | (.0000) | (.0002) | (.0003) | (1.7713) | (.0001) | (.0001) |
| Mean number of drops>50% in state | | .5730** | | | | |
| | | (.2533) | | | | |
| Median number of drops>50% in state | | .0330 | | | | |
| | | (.0970) | | | | |
| State median $R^2$ | | | .0584 | 2870.443 | | |
| | | | (.3005) | (2710.426) | | |
| State mean $R^2$ | | | 1.1269** | -5540.937 | | |
| | | | (.4975) | (3999.249) | | |
| Widow | -.0273*** | -.2766* | -.0453 | -1395.7*** | .0383 | -.0978 |
| | (.0096) | (.1551) | (.0976) | (266.4862) | (.0551) | (.1353) |
| State median slope | | | -.0001** | -.1701 | | |
| | | | (.0001) | (.3801) | | |
| State mean slope | | | .0000 | .5928* | | |
| | | | (.0000) | (.3441) | | |
| State median probability of being in poverty | | | | | .1829 | |
| | | | | | (.8905) | |
| State mean probability of being in poverty | | | | | .7016*** | |
| | | | | | (.1757) | |
| Unemployment rate in local labor market, 1988 | .0009 | -.0032 | -.0018 | 71.8531* | .0006 | -.017*** |
| | (.0009) | (.0114) | (.0045) | (36.9149) | (.0016) | (.0045) |
| Unemployment rate in local labor market, 1989 | -.0025** | -.0089 | .0048 | 23.2004 | -.0015 | .0119** |
| | (.0010) | (.0183) | (.0067) | (53.2857) | (.0023) | (.0094) |
| Unemployment rate in local labor market, 1990 | .0014 | .0116 | -.0053 | -15.8618 | -.0024* | .0143 |
| | (.0026) | (.0158) | (.0058) | (62.7640) | (.0015) | (.0072) |
| Unemployment rate in local labor market, 1991 | .0002 | .0004 | .0003 | 8.1630 | .0000 | -.0003 |
| | (.0002) | (.0016) | (.0005) | (4.8515) | (.0002) | (.0005) |
| Unemployment rate in local labor market, 1992 | -.0022** | .0006 | .0034 | 3.5791 | .0002 | -.0001 |
| | (.0012) | (.0203) | (.0057) | (46.3977) | (.0023) | (.0045) |
| Unemployment rate in local labor market, 1993 | -.0015 | -.0030 | -.0055 | -107.10*** | .0015 | .0137** |
| | (.0014) | (.0154) | (.0053) | (39.7963) | (.0020) | (.0061) |
| Unemployment rate in local labor market, 1994 | .0002 | -.0004 | .0000 | -26.0448 | -.0016 | -.0137* |
| | (.0013) | (.0196) | (.0062) | (35.4554) | (.0019) | (.0072) |
| Unemployment rate in local labor market, 1996 | .0021*** | .0066 | .0014 | 18.5373 | .0007 | .0023 |
| | (.0005) | (.0125) | (.0036) | (23.3600) | (.0012) | (.0038) |
| Unemployment rate in local labor market, 1998 | .0009 | .0209 | .0065 | 19.9976 | .0030 | -.0060 |
| | (.0015) | (.0145) | (.0055) | (36.8245) | (.0021) | (.0057) |

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First Stage Results, Continued

| | Posterior | Number of drops | $R^2$ | Slope | Probability of being in poverty | Health Insurance |
|---|---|---|---|---|---|---|
| Unemployment rate in local labor market, 2000 | .0023** (.0011) | -.0099 (.0130) | -.0055 (.0053) | -3.2186 (37.0718) | -.0013 (.0019) | -.0049 (.0059) |
| Health Insurance Regulation: No. of Mandates | | | | | | .0008 (.0009) |
| Health Insurance Regulation: NAIC Ratings Bond | | | | | | -.057*** (.0144) |
| Health Insurance Regulation: Tight Rating Bands | | | | | | -.0361* (.0204) |
| Health Insurance Regulation: Community Rating | | | | | | -.056*** (.0138) |
| Health Insurance Regulation: Any Market Reform | | | | | | -.0020 (.0185) |
| Health Insurance Regulation: Guaranteed Issue | | | | | | .0396** (.0190) |
| Health Insurance Regulation: Plan Liability | | | | | | -.0439** (.0194) |
| Percent in state below poverty line, 1988 | | | .0000 (.0036) | 21.8952 (30.5339) | | |
| Percent in state below poverty line, 1989 | | | .0024 (.0053) | 82.6858* (46.2904) | | |
| Percent in state below poverty line, 1990 | | | .0078 (.0069) | -66.9430 (65.1375) | | |
| Percent in state below poverty line, 1991 | | | -.0071 (.0064) | -57.932 (56.1036) | | |
| Percent in state below poverty line, 1992 | | | -.0020 (.0062) | 15.5030 (56.8843) | | |
| Percent in state below poverty line, 1993 | | | -.0013 (.0042) | -1.2119 (31.4442) | | |
| Percent in state below poverty line, 1994 | | | -.0022 (.0037) | 24.6284 (34.0643) | | |
| Percent in state below poverty line, 1996 | | | -.0028 (.0043) | -30.5601 (31.9775) | | |
| Percent in state below poverty line, 1998 | | | .0055 (.0043) | 25.4756 (34.8470) | | |
| Percent in state below poverty line, 2000 | | | -.0034 (.0040) | -14.1217 (37.5178) | | |

Robust standard errors in parentheses: *** p<0.01, ** p<0.05, * p<0.1

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