RISK PERCEPTIONS AND LIFESTYLE CHOICES: EMPIRICAL AND THEORETICAL FINDINGS FOR SMOKING AND OBESITY

By

MICHAEL GREGORY BARNES

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To the Faculty of Washington State University:

The members of the Committee appointed to examine the dissertation of MICHAEL GREGORY BARNES find it satisfactory and recommend that it be accepted.

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Chair

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Abstract

by Michael Gregory Barnes, Ph.D.
Washington State University
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Chair: Trenton G. Smith

Risk is everywhere, but because individual risk *perceptions* are inherently difficult to measure researchers often ignore them and resort to deterministic models. There is emerging evidence however that risk perception plays a fundamental role in influencing (perhaps subconsciously) lifestyle choices. In this dissertation I show that *financial* risk influences both smoking and obesity, two lifestyle choices that have previously been treated almost exclusively as deterministic phenomena.

In my first paper I analyze the relationship between perceptions of economic insecurity and smoking behavior. An empirical model, designed to test theory motivated by findings in economics, psychology, and neuroscience, examines the effects of economic insecurity, defined as the probability of catastrophic income loss, on smoking. It is proposed that smoking is used as a form of "self-medication" in times of insecurity, in effect, decreasing an individual's "perceived" risk of income loss. Proxies for various measures of economic insecurity are derived from longitudinal data on income and employment history. Findings suggest that economic insecurity causes individuals to be more likely to smoke.

Perceptions of economic insecurity and weight are also positively correlated.

In my second paper I develop a two-period, two-state model, in which I endogenize preferences for body fat and observe optimal fattening under economic uncertainty. As motivated by behavioral ecology, weight gain is seen as a type of precautionary savings, in which humans gain weight when they perceive food insecurity. Comparative static results suggests that fattening is a form of self-insurance—individual's gain weight with increases in perceived economic uncertainty and lose weight with increases in perceived economic security.

My final paper is a theoretical and empirical investigation of the effect of household composition (i.e., number of workers and non-workers in the home) on weight. It is hypothesized that household composition affects weight through three mechanisms already established in the economics literature as determinants of obesity: risk, income, and time costs. Evidence in this paper suggests that increasing the number of workers and non-workers in the home decreases weight through the proposed mechanisms of reduced risk and the decreased time costs of eating healthy.

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Dedication

This dissertation is dedicated to my family, past, current, and future.

CHAPTER ONE

INTRODUCTION

The majority of economic theories on smoking and obesity are deterministic in nature and focus primarily on price and income effects (Ruhm 2000, Cutler *et al*. 2003, Cawley 2004, Zagorsky 2004, Ruhm 2005, Schroeter *et al.* 2008, etc.). It is almost certainly true, of course, that prices (of food, or cigarettes, or time) matter but there is no *ex-ante* reason to expect that when it comes to body fat, the consumer "price/income response" will prove a more important source of variation in modern human populations than what might be called the "risk response" for smoking and obesity. In this dissertation I show that financial risk (uncertainty) is an important determinant of smoking and obesity, two choices previously treated as deterministic phenomena. In this chapter I give a brief introduction to my three essays, which are then presented in their entirety in the following three chapters.

Chapter Two, *Tobacco Use as Response to Economic Insecurity: Evidence from the National Longitudinal Survey of Youth*, explores the role of economic insecurity on smoking behavior. Neuroscience suggests that cigarette consumption can be viewed as a form of "self-medication" in response to economic insecurity, in which individuals consume tobacco in order to (perhaps subconsciously) alter their subjective beliefs about catastrophic income loss (Smith 2009). An important implication of this view is that individuals who experience a greater degree of economic insecurity should be more likely to smoke. Instrumental variable estimation techniques on longitudinal data indicate that increasing economic insecurity causes an individual to be more likely to smoke.

In Chapter Three, *Income and Health at Risk: Optimal Fattening in the Presence of Economic Insecurity*, I introduce economic uncertainty and endogenize preferences for body fat in a theoretical model for weight gain. Evidence from behavioral ecology suggests that weight gain can be thought of as a type of precautionary fattening pursued in times of uncertainty. In essence, weight gain is a form of self-insurance—a transfer of savings from one period to the next. In this chapter I demonstrate that the notion of body fat as an optimal response to food insecurity can be incorporated into an economic theory of obesity. In doing so, I am able to capture many of the salient features of the modern obesity epidemic and shed light on two anomalies found in current human populations. Comparative statics on the first order conditions from the theoretical models indicate that individuals gain weight with increases in economic insecurity, and lose weight with increases in economic security.

The final chapter, *Friends (with Money) Don't Let Friends Get Fat—a Theoretical and Empirical Analysis of Household Workers and Weight Gain*, focuses on the effect of changes in household composition on changes in weight. Risk, time costs, and income effects are recognized as three causes of obesity in modern society (Ruhm 2000, Cutler *et al*. 2003, Ruhm 2005, Smith *et al*. 2007). It is suggested that these three effects are the mechanisms through which household composition (*i.e.*, the number of workers and non-workers in the home) affects weight. Although several have analyzed the relationship between social networks and obesity (see for example Costa-Font and Gil 2004 and Christakis an Fowler 2007), this paper is the first to analyze the effect of the social network within the home on weight. Theoretical and empirical evidence from this paper suggest that increasing the number of workers in the home decreases individual weight through the purported risk effect.

References

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

Christakis, N. J. Fowler (2007): "The Spread of Obesity in a Large Social Network over 32 Years," *The New England Journal of Medicine*, 357; 4, 370-379.

Costa-Font, J. and J. Gil (2004): "Social Interactions and the Contemporaneous Determinants of Individual's Weight," *Applied Economics*, 36, 2253-2263.

Cutler, D. E. Glaeser, and J. Shapiro (2003): "Why Have Americans Become More Obese?" *Journal of Economic Perspectives*, 17 (3), 93-118.

Ruhm, C. J. (2000): "Are Recessions Good For Your Health?" *The Quarterly Journal of Economics*, May, 617-650.

Ruhm, C. J. (2005): "Healthy living in hard times," *Journal of Health Economics*, 24, 341-363.

Schroeter, C., J. Lusk, W. Tyner (2008): "Determining the Impact of Food Price and Income Change on Body Weight," *Journal of Health Economics*, 27 (1), 45-68.

Smith, T. G. (2009): "Reconciling Psychology with Economics: Obesity, Behavioral Biology, and Rational Overeating," forthcoming in *Journal of Bioeconomics*.

Smith, T. G., C. Stoddard, M. Barnes (2007): "Why the Poor Get Fat: Weight Gain and Economic Insecurity," Working Paper, *Washington State University Working Paper 2007-16*.

Zagorsky, J. (2004): "The Wealth Effects of Smoking," *Tobacco Control*, 13, 370-374.

CHAPTER TWO

TOBACCO USE AS RESPONSE TO ECONOMIC INSECURITY: EVIDENCE FROM THE NATIONAL LONGITUDINAL SURVEY OF YOUTH

Introduction

It has long been noted that poverty and tobacco use seem to go together (Beyer *et* al. 2001, Mulatu and Schooler 2002 and M. Siahpush 2003). Many potential mechanisms have been proposed to explain this relationship including pure income effects, time preferences, and stress. In this paper, we test a novel hypothesis inspired by findings in neuroscience: that a particular type of stress—*economic insecurity*, roughly defined as the probability of catastrophic income loss—impacts smoking decisions.

A theory in neuroscience known as the serotonin hypothesis links feelings of distress and depression to low levels of serotonin (see for example Cotman and McGaugh 1980). Furthermore, it is hypothesized that economic insecurity can induce a neuroendocrine state characterized by low levels of serotonin while high levels of serotonin characterize an individual of economic security. It has been suggested that nicotine selectively stimulates serotinergic neurons in the brain in a manner that appears to reflect an *increased* sense of economic security (for a review see Smith 2009). Accordingly, tobacco use might, in effect, be viewed as a form of "self-medication" in response to economic insecurity, in which individuals consume tobacco in order to (perhaps subconsciously) alter their subjective beliefs about catastrophic income loss.[1] An important implication of this view is that individuals who experience a greater degree of economic insecurity should be more

[1] Smoking can also be considered as a form of "self-deception" because smokers chemically or physiologically alter their perceived risk of insecurity.

likely to smoke. This is the central hypothesis we aim to test in the pages that follow.

Background

Findings in psychology, neuroscience, medicine, and economics contribute to the development of our hypothesis. In this section we present evidence from these fields as they pertain to the relationship between socioeconomic status (SES) and smoking, stress and smoking, and the use of nicotine as self-medication.

Although it is commonly accepted that low-SES and smoking are highly correlated (Ashton and Stepney 1982, Ross and Wu 1995, Mulatu and Schooler 2002, Kirsch 1999), it has yet to be established whether (i) something about having low SES causes individuals to take up smoking (Gilbert 1995, Levine *et al.* 1997, Hersch 2000), (ii) expenditures on tobacco cause or exacerbate low SES, i.e., smokers are poor because they smoke (Zagorsky 2004), or (iii) unobservable individual characteristics (e.g., a personal disregard for long-term consequences) cause both smoking and low SES; in other words, an individual would choose—as revealed by his time-preferences—to smoke, regardless of his socioeconomic environment (Fuchs 1980). These findings suggest that an apparent link between smoking and low-SES exists, but the direction of causation between the two remains unclear. It is also unclear whether one, all, or none of the relationships presented above model the low-SES smoking association correctly.

Alternatively, Ruhm (2000 & 2005) demonstrates that increases in income are correlated with smoking. He finds that increases in the state median household income correspond to increases in smoking behavior. This relationship may exist because Ruhm uses state-level measures which are likely more exogenous to the smoking decision than individual-level measures, which the previously mentioned studies have used. Ruhm's use of regression analysis does not imply that high-SES (or high levels of income) are correlated with smoking, but that marginal increases in state median income are correlated with individual smoking behavior. Consequently, these results do not contradict those that support a relationship between low-SES and smoking, instead they imply that a more complicated relationship likely exists, and that a number of factors affect this relationship. Furthermore, because previous literature has failed to control for unobservable personal characteristics and other causes of endogeneity (that likely play a prominent role in cigarette smoking and other individual choices) these findings likely do not reflect the unbiased effects associated with smoking.

Studies in economics, psychology, and medicine suggest that a strong positive correlation exists between stress and smoking. Evidence demonstrates that both financial and non-financial stress are associated with cigarette consumption. Siahpush *et al*. (2005) find the probability of experiencing any form of financial stress to be 1.5 times higher in smoking households than in non-smoking homes. They also find that the correlation between smoking and financial stress does not vary significantly across income levels implying that the smoking-stress association may be independent of SES. In a seminal paper, Becker and Murphy (1988) present an economic theory of addictive consumption. They suggest that "tension-raising events affect the demand for addictive goods", and propose that temporary events or shocks can 'hook' an individual to addictive goods. This theory is supported by various findings in psychology. Specifically, Ashton and Stepney (1982) present a number of studies detailing the relationship between smoking behavior and stressful- or anxiety-causing events. Among them are the findings of Schachter *et al*. (1977) and Mangan and Golding (1978) whose experiments demonstrate that stressful- and tension-raising events induce smoking.[2] In addition to distress (Lawton 1962), anxiety and depression may also cause both smoking initiation and heavy smoking (e.g. Tyas and Pederson 1998 and Baker *et al*. 2004). These studies offer ample evidence that stress and smoking are highly correlated.

Emerging evidence from neuroscience offers insight to why the smoking-stress relationship may exist. Neuroscience suggests that the relationship between stress and smoking may be modulated by serotonergic systems in the brain. In a review of neuroscience literature, Smith (2009) explains that as nicotine enters the bloodstream it binds to receptors in the brain that enhance the release of serotonin and other neurotransmitters. The fact that smoking is highly prevalent across most anxiety disorders (Morissette et al. 2007) implies that nicotine consumption likely plays an important role in regulating desirable chemical responses in those that suffer anxiety and stress. Nicotine then, may presumably be taken as self-medication to regulate insecurity and stress (Tompkins 1968), varying the levels of nicotine intake depending on the circumstance (Ashton *et al.* 1979), and ultimately achieving an 'optimal' dose for a given activity (Ashton and Watson 1970). In fact, smokers report feeling less stressed after smoking (Morissette et al. 2007)—such is the case with any symptom after taking medication. Baker *et al.* (2004) propose that individuals may develop a dependence on nicotine based on the anxiety relief the biological effects of nicotine offer. Gilbert (1997) reports that smoking has been described as a tranquilizer that relaxes the body and helps the smoker feel calm (Spielberger 1986 and McNeill *et al*. 1987). By enhancing reactions that reduce and terminate stressors

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[2] In an experiment Schachter *et al*. (1977) administer electric shocks to individuals and find that more shocks of greater intensity correspond to higher levels of smoking. Mangan and Golding (1978) find that subjects in

(Dunn 1973) individuals may become dependent on even small doses of nicotine. These examples suggest that nicotine consumption plays a significant role in helping individuals cope with stress and insecurity through self-medication. It is proposed that the self-medication process raises low levels of serotonin, characteristic of an insecure individual, to mimic the serotonin levels of a secure individual, ultimately increasing an individual's perception of security.

This paper is innovative because, as motivated by neuroscience, it goes beyond the somewhat vague concept of SES as a measure of financial stress. In particular, it is hypothesized that economic insecurity, *regardless* the level of SES, increases the probability of smoking. Jacob Hacker (2004) argues that economic insecurity is a bigger problem in America than is the disparity between socioeconomic classes, saying: "It's not where you are on the ladder that counts but how far you fall when you slip and what's there to catch you". In this paper we seek to establish a causal relationship between economic security and smoking behavior by addressing issues relating to endogeneity that have previously been ignored, and suggest self-medication as the mechanism behind this relationship. We hypothesize that indicators of economic insecurity cause smoking, while factors that increase economic security and lessen financial stress decrease the likelihood an individual will smoke—these variables serve as "safety nets".

Data

The data used to test these hypotheses come from the *National Longitudinal Survey of Youth, 1979 Cohort* (NLSY79). This labor market survey follows 12,686 individuals born between 1957 and 1964. Although the primary year of concern is 1998, the model

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a room with white noise interrupted with loud bursts of noise smoke more than subjects in a room with no noise.

specification covers a time period of sixteen years from 1983 to 1998. 1983 is chosen as the initial year of interest because in 1983 all the respondents are at least eighteen years old. This age is significant because it is the age when many begin taking upon themselves a certain level of economic independence and begin to face varying levels of individual economic security, it is also the legal smoking age in most states. The nature of the dataset allows a comprehensive study of one's personal experience with economic insecurity over the period, the beliefs they form from these experiences, and the effect of those beliefs on smoking behavior at the end of the period (1998).[3] Women are excluded from the analysis because the women in our sample are ages 18-40, peak child bearing years, and may consequently be less likely to smoke for reasons other than that of economic security.

Several demographic and individual-level variables that are expected to play a role in determining smoking behavior are included in our empirical analysis, they are: family income, age, race, weight, height in 1985, a dummy variable indicating whether the individual smoked before 1983, a dummy variable indicating whether the respondent lives in a metropolitan area, marital status, years of schooling, and the years of schooling their mother completed. Unless otherwise specified each measure is from 1998. Smoking behavior pre-1983 is included to control for individual smoking behavior prior to the period on interest. Controlling for pre-1983 smoking serves several purposes: 1) it controls for permanent unobservable personal characteristics that don't change over the time period as well as pre-1983 insecurity that could affect smoking in 1998, 2) it controls for smoking addictions that were created prior to 1983 and may influence 1998 smoking, and 3) it results

[3] Because past experiences play a strong role in forming future expectations (Feather 1982; 63) we proxy for perceived income risk using past and current measures of employment and income. In fact, "expectations and realizations of job-loss match up closely" in most cases (Dominitz and Manski 1997). Accordingly,

in the security variables measuring only the effect of insecurity that has occurred during the period of interest on smoking. Over 90% of the men that smoke in 1998 began smoking prior to 1983, so it is reasonable to assume that this variable successfully captures smoking behavior prior to 1998. The remaining variables are included in the regression to control for various individual and demographic measures. The means and standard deviations for all the variables used in the regression analysis are reported in Tables 1a-1d.

Several state and regional variables are included in our analysis. They include, state cigarette prices (in cents), clean indoor-air laws,[4] state median home income, local unemployment rates from 1983-1998, state regulations for health insurance, a regional country dummy variable, and other state averages generated from the NLSY79 data including the number of drops in real income and the probability that a family's income falls below the poverty threshold.

We construct several measures of economic insecurity.[5] These measures are meant to capture the financial shocks an individual experiences over the time period and the resulting effect of those shocks on current smoking. The first proxy for economic insecurity is an individual's perceived probability of unemployment. This measure is formed by using a Bayesian updating process on unemployment history and is effectively called the Bayesian posterior probability of unemployment. The posterior probability is calculated using weekly data on employment status available in NLSY79 based on a five-year history (1994-1998) with prior distributions being generated from the full sample

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perceptions change through time, based on individual experiences. It has been suggested that an uncertain economic future is likely to cause a shift to a higher discount rate (Becker and Mulligan 1997).

[4] A point system ranking states clean-indoor air laws similar to one discussed by Frank Chaloupka (1996) is implemented. Higher points indicate greater restrictions in a state.

of NLSY79 men (see Data Appendix for details).[6] This variable represents an individual's perceived economic security based on their employment history. The average posterior probability of unemployment is 0.029 (2.9 percent), with the average being 0.051 for smokers and 0.023 for nonsmokers.

The second proxy for economic insecurity measures the probability that an individual's family income falls beneath the specified poverty threshold. This variable is formed through a series of steps briefly described here (see Data Appendix for details). First, each individual's annual family income is regressed on a time trend separately for the 16-year period. Then, using prediction interval techniques, the resulting predicted family income in 1998 is used to calculate the probability of falling below the poverty threshold based on family size. Predicted family income is used because it is presumably a good measure of an individual's perceived family income based on their income history. In essence, by including predicted family income and deviations from expected income this variable reflects income volatility faced by the individual due to employment history, possible changes in hourly wages, and changes in household composition that might result from exogenous shocks to the local economy, but are not captured by our other measures of insecurity. The average probability of being below the poverty level for smokers is 0.053, while the average for non-smokers is 0.032.

The final proxy for economic insecurity, an alternative measure for the volatility of income, is the number of drops in annual real income greater than 10 percent over the 16-year period. A drop indicates that income in year *k* is at least 10 percent less than

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[5] A complete description of the variables that are created or obtained from a source other than NLSY79 is found in a data appendix.

income in year *k-1*. This measure captures significant adverse income changes and is likely a good indicator of financial insecurity faced over the time period. Individuals with more drops in real income are assumed to face greater perceived levels of economic insecurity, and accordingly will likely face greater probabilities of smoking.

One measure of economic security is included in our analysis. The proxy we include for economic security is a dummy variable indicating whether an individual has a health plan in 1998. About 83% of the individuals in our sample have some form of health insurance.[7] Because health insurance decreases financial loss associated with costly medical expenditures, it serves as a safety net and is hypothesized to have a negative effect on smoking.

Empirical Model

To test the hypothesis that economic insecurity causes smoking behavior we use the following linear model:

$$S_{1998,i} = ES_i\alpha + X_{j,i}\delta + \varepsilon_i$$

where $S_{1998,i}$ is a binary variable indicating whether an individual smokes daily in 1998, ES_i is a proxy for individual *i*'s perceived economic security, $X_{j,i}$ is a vector of demographic, individual, state, and regional variables for individual *i* in year *j*, and ε_i is the disturbance term. Robust standard errors are adjusted for within-state correlation because the instruments used are state-level measures.

Two approaches are used to estimate this model. The first approach used is the linear probability model. The linear probability model is chosen over a logit (or probit)

[6] The sample median tenure with a given employer in the NLSY sample is four years, with the mean being six. Therefore, the hazard rate associated with employment over the five-year window is presumed to remain fairly constant.

approach for several reasons. First, like logit (and probit), the estimated coefficients for the linear probability model are unbiased and consistent (Wooldridge 2002). Although predicted values from the linear probability model may lie outside the limits of probability, [0,1] (Maddala 1983), predicted values at the center of the distribution should not have this problem. Consequently, estimates of the partial effects at the center of the distribution are acceptable (Wooldridge 2002). In our model, approximately 90 percent of the predicted values fall within the limits of probability [0,1], while most of the values outside the interval are found at the extreme values of the sample, suggesting that there should not be a problem interpreting results at the mean. Furthermore, because of our large sample size the standard errors are consistent.

The linear probability model likely produces biased results due to endogeneity issues stemming from reverse causality and unobservable personal characteristics. For example, we use an individual's employment history as a proxy for their expectations about the future probability of job loss occurring. However, if people who smoke are more likely to have lower wages or become unemployed—evidence suggests that they are (Levine *et al*. 1997)—regardless of their perceptions of risk, then the linear probability estimates of α will be biased. There are many reasons why an individual who smokes might lose a job, he may, for example, experience job loss due to unobservable personal characteristics (e.g., time preferences), employment discrimination, or finally, he could experience job loss because of an exogenous change in circumstance, such as a worsening local labor market. The area of interest in this paper is that of the last example—to see if personal job loss (and other measures of economic insecurity), resulting from exogenous shocks to the economy, cause smoking.

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[7] This includes both private and public health plans.

We control for endogeneity bias in two ways. We do so by first including a dummy variable indicating whether the individual smoked prior to 1983. This variable controls for permanent unobservable personal characteristics as well as pre-1983 economic insecurity that may affect 1998 smoking behavior. Controlling for pre-1983 smoking behavior however does not eliminate bias occurring from events after 1983, nor for personal characteristics that change over time.

In order to correct for endogeneity related to these issues we implement a second estimation technique, instrumental variables (IV). Because IV-logit approaches (e.g. Maddala 1983 and Rivers and Voung 1988) fail to generate consistent standard errors (Chen 2003 and Bollen *et al.* 1995), resulting in useless estimates, we use the traditional IV method which generates consistent standard errors and is acceptable in most cases when estimating binary dependent variables (Wooldridge 2002).

The IV approach attempts to eliminate bias that is introduced into the estimates due to reverse causality and/or unobservable personal characteristics that may jointly affect smoking behavior and various independent variables using a two-step estimation procedure. In particular, endogenous right hand side (RHS) variables (e.g. employment, family income, etc.) are regressed in the first stage on known exogenous RHS variables and state- and MSA- level instruments. This stage generates predicted values for the endogenous variables. In the final stage, the dependent variable is regressed on all exogenous RHS variables and the predicted values. By correcting for endogeneity using instruments in the two-step process, the IV approach isolates the causal relationship between economic security (and other independent variables) and smoking. The generalized method of moments (GMM) estimator is used in this two-step process as opposed to the traditional IV estimator because: first, it is more efficient than the IV estimator given heteroskedasticity, and second, because our equations are over-identified (we have more instruments than endogenous variables) the GMM approach allows us to test the validity of our instruments.

In order to generate unbiased estimates through the IV process it is vital to use valid instruments. For an instrument to be valid it must be uncorrelated with the error term (exogenous) and correctly excluded from the model while being highly correlated with the endogenous variable of interest. Accordingly, state-level variables are used as instruments in our regression. Instruments are exogenous and correctly excluded from the model at the 5% level in each case. The exogeneity of the instruments is determined by analyzing the Hansen J-Statistic, which is distributed as a chi-square with degrees of freedom equal to the number of over-identifying restrictions (Hansen 1978). The Hansen-J statistic is obtained by evaluating the GMM criterion function at the efficient GMM estimate. Our instruments, however, are arguably not as strong when it comes to being highly correlated with the endogenous variable. An F-statistic greater than 10 in the first stage regression for an equation with only one endogenous variable indicates that the instrument is highly correlated to the endogenous variable. A different approach however, must be employed when dealing with multiple endogenous variables as we have here. Several approaches are presented by Baum *et al*. (2003 & 2005). The first approach consists of comparing the Shea Partial R^2 (developed by Shea 1997) to the Partial R^2 in each of the first stage regressions. If the two values are "close" then the instruments contain sufficient relevance to explain the endogenous regressors. The problem is that no guidelines are provided as to what 'close' might be. Another approach compares the Kleibergen-Paap rank Wald F statistic to various critical values representing the relative bias between the OLS and IV estimates (Stock and Yogo 2005). But once again, the relative bias is user specific and does not offer a specific test for weak instruments. Finally, a formal test for weak instruments is achieved by evaluating the Kleibergen-Paap rank LM statistic (Kleibergen and Paap 2006), where the null hypothesis is that the model is under-identified, or that the smallest canonical correlation between the linear combinations of the independent variables and the instruments is zero. Rejection of the null implies that the instrumental process has full rank, or that the instruments pass the weak instruments test (i.e. they are highly correlated to the endogenous variables). Because none of our instruments pass the weak instruments test at the 5% level for the Kleibergen-Paap LM test we discuss evidence from the other two approaches that suggest the instruments are still correlated.[8] Tests for instrument validity are presented formally in tables 5a and 5b. In the following paragraph we present the instruments used to identify the effect of the endogenous variables.

Instruments

The series of annual BLS unemployment rates from 1983-1998 in the geographical area where the individual resides are used to identify the effect of the posterior probability of unemployment on smoking. The entire series is used as opposed to using the unemployment rate for 1998 because they likely play a role in determining perceptions of economic insecurity. State averages and the state median probability of falling below the poverty level are used to identify the probability of falling below the poverty line. State averages as well as the state median number of drops in real income are used as instruments for the number of drops in real family income over the period. The series of unemployment rates over the period are also used as instruments for these two variables.

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[8] Instruments with little explanatory power result in increased bias in the IV estimates Haun and Hausman (2002). We therefore, suggest caution when interpreting estimates in regressions that do not pass the weak

Series of data are used in these instances because the endogenous variables measure changes over the entire period. Instruments of state means and medians are constructed from the NLSY79 dataset with men and women pooled together. Because these instruments are formed directly from the dataset they are arguably not as exogenous as other state-level instruments. Specifically, if many of the respondents share an unobserved personal characteristic similar to respondent *i* then the identification problem cannot be solved and the estimates remain biased. However, inasmuch as this is not a problem the IV approach will produce unbiased estimates. Because unemployment rates are used to identify several different endogenous variables we are unable to estimate each effect using a single regression. Instead we analyze the effect of each measure of economic insecurity separately; this is justified because they arguably represent different measures of the same thing—economic insecurity. The instrument for family income is state median household income in 1998. A vector of dummy variables measuring state-level regulations for the individual and small-group markets for health insurance are used as instruments for health insurance.[9] Because health insurance is usually purchased in the private market or offered through employment, health insurance is endogenously related to smoking in at least three ways: i) healthy individuals are less likely to purchase health insurance at any given price than will be non-healthy individuals, ii) employment discrimination,[10] and iii) that of personal time preferences or unobservable characteristics. The effect of health insurance on smoking is analyzed in a separate regression as well. The posterior probability of unemployment is included in this specification to control for economic insecurity.

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instruments test.

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

Results

Estimation results are tabulated at the conclusion of the text. Table 2 presents the OLS estimates for the different specifications while Table 3 presents the IV estimates. A dummy variable representing smoking in 1998 is the dependent variable in each specification. Each table contains several columns representing the different specifications. The first three columns present estimates from regressions including insecurity proxies while the last column reports the safety net estimate specification. First stage results from the IV procedure are contained in Tables 5a-5d. Because the OLS specifications produce biased results the discussion in this section focuses on the IV estimates.

We briefly discuss general results before analyzing the proxies for economic insecurity. In each case, the number of years of education has a statistically significant, negative effect on smoking. Because education is treated as exogenous (and it may very likely be endogenous) the results must be interpreted with caution. Weight has a statistically significant negative effect (however small) on smoking. This is consistent with the literature that suggests the relationship between smoking and weight is negative (Wee *et al*. 2001, Chou *et al*. 2004, Honjo and Siegel 2003, Cawley *et al.* 2004). Having smoked prior to 1983 increases the probability of smoking by at least 36 percent, while individuals who live in a city are 3 percent less likely to smoke than individuals who do not live in a city.

Family income in 1998 is included in each regression as a control variable. IV results indicate that increases in income have a positive (and sometimes significant) causal effect on smoking. A $1,000 increase in family income increases the probability of

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[10] Employment plays a major role in deciding whether an individual has health insurance. 63% of the individuals included in our regressions receive health insurance from work.

smoking by 0.26 percent in specification (3).[11] This result suggests that although smoking is often correlated with poverty, marginal increases in income have a positive effect on smoking. The fact that the sign for family income switches from the expected biased sign in the OLS approach to the expected unbiased sign for the IV estimates suggests that the instruments we use are likely valid (Haun and Hausman 2002).

Economic Insecurity

The first measure of insecurity, the posterior probability of unemployment, positively affects smoking. The IV results suggest that an increase of one percent (0.01) in perceived future unemployment increases the probability of smoking by 1.2 percent. This result suggests that unemployment plays an important role in causing smoking behavior. The instruments, although exogenous, do not pass the weak instruments test using the Kleibergen-Paap LM test statistic, with a p-value of 0.16. The differences between the Shea Partial R^2 and the Partial R^2, however are quite small for the first stage regressions (0.0005 and 0.0005) indicating that the instruments have some explanatory power, the extent of the explanatory power however, is unknown.

The next insecurity proxy is the probability that an individual's predicted family income in 1998 falls below the poverty level threshold. An increase of one percent in the probability of falling below the poverty level increases the probability of smoking by 1.3 percent. This indicates a substantial increase in the probability of smoking given that the average probability of falling below the poverty threshold is nearly three percent. The instruments once again, although exogenous, do not pass the weak instruments test using the Kleibergen-Paap LM test statistic, with a p-value of 0.86. The differences between the

Shea Partial R^2 and the Partial R^2, however are quite small for the first stage regressions (0.0005 and 0.0008) indicating that once again the instruments and endogenous variables are likely correlated.

The last proxy for economic insecurity is the number of drops in real income greater than 10 percent that an individual faces over the 16-year period. The average number of drops for smokers over the time period is 3.18. IV estimates indicate that an increase in one 10 percent drop of real income increases the probability of smoking by over seven percent. This dramatic effect is justified by the likely catastrophic loss in income it measures. In this specification the Kleibergen-Paap test statistic has a p-value of 0.275, but once again the difference between the Shea Partial R^2 and the Partial R^2 is small (0.0017 and 0.00129).

Safety Nets

Health insurance has a large and statistically significant negative effect on smoking. As noted earlier, the health insurance estimate is plagued by endogeneity issues caused by adverse selection. The IV estimation technique eliminates the adverse selection problem and estimates the causal effect of health insurance on the probability of smoking. This estimate can be interpreted as the net effect of two forces acting in opposite directions: that of the safety net effect decreasing the probability of smoking, and that of the moral hazard effect increasing the probability of smoking.[12] The estimate indicates that the safety net effect outweighs the moral hazard effect: switching from having no health insurance to having health insurance in 1998 decreases the probability of daily smoking by nearly 30

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[11] These findings are consistent with Ruhm (2000) who finds that a $1000 increase in state median family income increases the number of predicted smokers by 0.3 percent.

[12] Upon purchasing health insurance the cost of smoking decreases, thus increasing the likelihood an individual will smoke (Shavell 1979).

percent. Furthermore, there is a difference of 27 percent between the OLS and IV estimates highlighting the endogeneity bias in the OLS estimates of health insurance on smoking, part of which is caused by adverse selection. Once again, although the instruments are exogenous they fail to pass the weak instruments test at the 5% level. As defined in terms of a maximum bias for an IV estimate (Stock and Yogo 2005) the Kleibergen-Paap Wald F statistic is 6.825 and falls between a 10 and 20% maximal IV relative bias.

Conclusion

In this paper we approached the smoking decision in a manner that has previously been overlooked. Motivated by neuroscience, we suggest that smoking is a form of self-medication that individuals pursue in times of economic insecurity. Using individual level data and IV we correct for endogeneity and estimate unbiased effects of perceived security on smoking.

The results from our estimation procedure support the hypothesis that economic insecurity causes smoking behavior among men in our sample. In fact, increasing the number of drops in real income by only one over the 16-year time period causes an individual to be 7 percent more likely to smoke, while increasing the posterior probability of unemployment by 0.01 increases the probability of smoking by 1.2 percent.

Furthermore, our results suggest that increases in financial safety nets, as demonstrated by health insurance, cause individuals to be less likely to smoke. Switching from having no health insurance to having health insurance causes a decrease in the probability of smoking by 30 percent. Certainly, under the conditions tested in this paper, the safety net theory presented earlier holds true to the situation faced by the potential smoker in our sample. Economic safety nets effectively cushion the blow of economic insecurity and cause an individual to feel less susceptible to economic stress.

This paper suggests that smoking is both a private and public health problem. In other words, smoking is a choice that individuals make, not solely based on individual preferences—it is also a function of various factors including an individual's perceived insecurity which is affected by both his personal economic wellbeing and the economic wellbeing of his surroundings. In this sense, health and public welfare organizations should work together to form programs that would increase the safety net offered to the individual. Current tobacco preventative and rehabilitative programs pay little attention to one of the causes of tobacco use—financial insecurity,[13] and might benefit from a shift toward more "holistic" approaches aimed at, for instance, bolstering the economic situation of those at risk of nicotine addiction. Such programs may include improved access to health insurance, education in the areas of financial planning and job seeking, or social support groups with micro financing. Our findings suggest that in addition to the usual economic justifications for ensuring access to a strong safety net, there may be another benefit: the improved health and well-being associated with smoking cessation.

[13] Current anti-tobacco campaigns in most states focus on anti-smoking advertising and clean indoor air laws to encourage decreased first- and second-hand tobacco consumption (Juliet Thompson, Washington State Department of Health. Washington Tobacco Prevention and Control Programs).

References

Ashton, H., V. Marsh, J. Millman, M. Rawlins, R. Stepney, R. Telford, J. Thompson (1979): "Pattern of Behavioural, Autonomic and Electro-physiological Response to Cigarette Smoking and Nicotine in Man" In A. Remond and C. Izard (eds) *Electrophysiological Effects of Nicotine*. Amsterdam: Elsevier/N. Holland Biomedical Press.

Ashton, H. and R. Stepney (1982; 110): *Smoking: Psychology and Pharmacology*, New York: Tavistock Publications.

Ashton, H. and D. Watson (1970): "Puffing Frequency and Nicotine Intake in Cigarette Smokers," *British Medical Journal* 3: 679-681.

Baker, T., T. Brandon, L. Chassin (2004): "Motivational Influences on Cigarette Smoking," *Annual Review of Psychology*, 55, 463-491.

Baum, C., M. Schaffer, and S. Stillman (2003): "Instrumental Variables and GMM: Estimation and Testing," *Boston College Working Paper 545*.

Baum, C., M. Schaffer, and S. Stillman (2007): "Enhanced Routines for instrumental variables/GMM estimation and testing," *Boston College Working Paper 667*.

Becker, G. and C. Mulligan (1997): "The Endogenous Determination of Time Preferences," *The Quarterly Journal of Economics*, 112(3), 729-758.

Becker, G. and K. Murphy (1988): "A Theory of Rational Addiction," *The Journal of Political Economy*, 96(4), 675-700.

Beyer, J., C. Lovelace and A. Yurekli (2001): "Poverty and Tobacco," *Tobacco Control*. (10), 210-211.

Bollen, K., D. Guilkey, T. Mroz (1995): "Binary Outcomes and Endogenous Explanatory

Variables: Tests and Solutions with an Application to the Demand for Contraceptive Use in Tunisia," *Demography*, 31(1), 111-131.

Cawley, J. (2000): "Body Weight and Women's Labor Market Outcomes," *NBER Working Paper 7841*.

Cawley, J., S. Markowitz, and J. Tauras (2004): "Lighting up and slimming down: the effects of body weight and cigarette prices on adolescent smoking initiation," *Journal of Health Economics*, 23, 293-311.

Chaloupka, F. and M. Grossman (1996): "Price, Tobacco Control Policies and Youth Smoking," *NBER Working Paper W5740*.

Chen, S. D. Guilkey (2003): "Determinants of Contraceptive Method Choice in Rural Tanzania between 1991 and 1999," *Studies in Family Planning*, 34(4), 263-276.

Chou, S.-Y., M. Grossman, H. Saffer (2004): "An economic analysis of adult obesity: results from the behavioral risk factor surveillance system," *Journal of Health Economics*, 23, 565-598.

Congdon, W. J., A. Kowalski, and M. H. Showalter (2005): "State Health Insurance Regulations and the Price of High-Deductible Policies," *Brigham Young University Working Paper*.

Cotman, C. and J. McGaugh (1980; 742): *Behavioral Neuroscience: An Introduction*, Academic Press, San Francisco.

Dominitz, J. and C. F. Manski (1997): "Perceptions of Economic Insecurity: Evidence From the Survey of Economic Expectations," *The Public Opinion Quarterly*, 61(2), Summer, 261-287

Dunn, W. (1973): *Smoking Behavior: Motives and Incentives*, Washington DC: V. H.

Winston & Sons.

Feather, N. (1982; 63): *Expectations and Actions: Expectancy-Value Models in Psychology*, New Jersey: Lawrence Erlbaum Associates, Publishers.

Fuchs, V. (1980): "Time Preference and Health: An Exploratory Study," *NBER Working Paper 539.*

Gilbert, D. (1995; 31): *Smoking: Individual Differences, Psychopathology, and Emotion*, Washington DC: Taylor & Francis.

Gilbert, D. (1997): "The Situation X Train Adaptive Response (STAR) model of drug use, effect, and craving," *Human Psychopharmacology*, 12, S89-S102.

Hacker, J. (1/22/2004): "The New Economic Insecurity", *On Point*, http://www.onpointradio.org/shows/2004/01/20040122_b_main.asp.

Hahn, J. and J. Hausman (2002): "Notes on bias in estimators for simultaneous equation models," *Economics Letters* 75 (2): 237-241.

Hansen, J. (1978): "Specification Tests in Econometrics," *Econometrica*, 46 (3): 1251-1271.

Hersch, J. (2000): "Gender, Income Levels, and the Demand for Cigarettes," *Journal of Risk and Uncertainty*, November, 21: 2/3, 263-282.

Honjo, K. and M. Siegel (2003): "Perceived importance of being thin and smoking initiaitn among young girls," *Tobacco Control*, September, 12(3), 289-294.

Kirsch, I. (1999), *How Expectancies Shape Experience*, Washington DC: American Psychological Association.

Kleibergen, F. and R. Paap (2006): "Generalized Reduced Rank Tests using the Singular Value Decomposition," *Journal of Econometrics*, 127 (1), 97-126.

Lawton, M. P. (1962): "Psychosocial Aspects of Cigarette Smoking," *Journal of Health and*

Human Behavior, 3(3), Autumn, 163-170.

Levine, P., T. Gustafson, A. Velenchik (1997): "More Bad News For Smokers? The Effects of Cigarette Smoking on Wages," *Industrial & Labor Relations Review*, 50(3), 493-509.

McNeill, A., M. Jarvis, R. West (1987): "Subjective effects of cigarette smoking in adolescents," *Psychopharmacology*, 92, 115-117.

Madalla, G. (1983): *Limited Dependent and Qualitative Variables in Econometrics*, Cambridge, UK: Cambridge University Press.

Mangan, G. and J. Golding (1978): "An enhancement model of smoking maintenance," In R. E. Thorton (Ed.), *Smoking behaviour: Physiological and psychological influences*, Edinburgh, Scotland: Churchill Livingstone, 87-114.

Morissette, S., S. Guilliver, B. Kamholz, M. Tull and R. Zimering (2007): "Anxiety, anxiety disorders, tobacco use, and nicotine: A critical review of interrelationships," *Psychological Bulletin*, 133 (2), 245-272.

Mulatu, M., and C. Schooler (2002): "Causal Connections between Socio-Economic Status Health: Reciprocal Effects and Mediating Mechanisms," *Journal of Health and Social Behavior*, 43(1), 22-41.

Rivers, D., Q. Vuong (1988): "Limited Information Estimators and Exogeneity Tests for Simultaneous Probit Models," *Journal of Econometrics*, 39: 347-366.

Ross, C. and C. Wu (1995): "The Links Between Education and Health," *American Sociological Review*, 60(5), 719-745.

Ruhm, C. J. (2000): "Are Recessions Good For Your Health?" *The Quarterly Journal of Economics*, May, 617-650.

Ruhm, C. J. (2005): “Healthy living in hard times,” *Journal of Health Economics*, 24, 341-363.

Schachter, S., B. Silverstein, L. Kozlowski, C. Herman, B. Liebling (1977): “Effects of Stress on Cigarette Smoking and Urinary pH,” *Journal of Experimental Psychology: General*, 106: 5-12.

Shavell, S. (1979): “On Moral Hazard and Insurance,” The Quarterly Journal of Economics, 93 (4), 541-562.

Shea, J. (1997): “Instrument relevance in multivariate linear models: A simple measure,” *Review of Economics & Statistics* 79 (2), 348-352.

Siahpush, M., R. Borland, M. Scollo (2005): “Smoking and financial stress,” *Tobacco Control*, 12, 60-66.

Siahpush, M. (2003): “Socioeconomic status and tobacco expenditures among Australian households: results from the 1998-1999 Household Expenditure Survey,” *Journal of Epidemiology and Community Health*, vol. 57, 798-801.

Smith, T. G. (2009): “Reconciling Psychology with Economics: Obesity, Behavioral Biology, and Rational Overeating,” forthcoming in *Journal of Bioeconomics*.

Smith, T. G., C. Stoddard, M. Barnes (2007): “Why the Poor Get Fat: Weight Gain and Economic Insecurity,” Working Paper, *Washington State University Working Paper 2007-16*.

Spielberger, C. (1986): “Psychological determinants of smoking behavior,” In R. D. Tollison (Ed.), *Smoking and society: Toward a more balanced assessment*, Lexington, MA: D. C. Health.

Stock, J. and M. Yogo (2005): “Testing for Weak Instruments in Linear IV Regression,” *In Identification and Inference for Econometric Models: Essays in Honor of Thomas Rothenberg*, ed. D.W. Andrews and J. H. Stock, 80–108. Cambridge University Press.

Tompkins, S. (1968): “A modified model of smoking behavior,” In E. F. Borgatta & R. Evans (Ed.), *Smoking, health and behavior*, Chicago: Aldine.

Tyas, L. T. and L. L. Pederson (1998): “Psychosocial factors related to adolescent smoking: a critical review of the literature,” *Tobacco Control*, 7, 409-420.

Wee, C. C., N. A. Rigotti, R. B. Davis, R. S. Phillips (2001): “Relationship Between Smoking and Weight Control Efforts Among Adults in the United States,” *Archives of Internal Medicine*, vol. 161, 546-550.

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

Zagorsky, J. (2004): “The Wealth Effects of Smoking,” *Tobacco Control*, 13, 370-374.

Tables

Table 1a: Means and Standard Deviations of Individual and State Characteristics
NLSY79 Men

Characteristic	Mean	Standard Deviation
Smoke daily in 1998	0.2438	0.4295
Smoked prior to 1983	0.4591	0.4984
Family income (in $1000) in 1998	56.2475	47.7792
Posterior probability of unemployment	0.0296	0.0788
Probability of being below the poverty level	0.0375	0.1228
Number of Drops greater than 10% in Real Family Income, 1983-1998	2.8672	1.4411
Covered by Health Insurance, 2000	0.8305	0.3753
State clean air regulations in 1998	3.3124	2.3193
Avg. state price of cigarettes (in cents) in 1998	233.7555	27.915
Years of education completed in 1998	13.2353	2.5372
Years of education respondent's mother completed	11.1006	3.1992
Age in 1998	36.7472	2.276
Weight in 1998 (in pounds)	193.9108	38.324
Height in 1985 (in inches)	67.6322	3.2748
Black	0.2477	-
Hispanic	0.1813	-
White	0.5711	-
Married	0.6175	-
Never Married	0.2179	-
Divorce or separated	0.1609	-
Widowed	0.0038	-
Live in Metropolitan Area	0.6901	-

N=2350
Sources: See Data Appendix.

Table 1b: Means and Standard Deviations of Individual and State Characteristics
NLSY79 Male Smokers in 1998

Characteristic	Mean	Standard Deviation
Smoked prior to 1983	0.9075	0.29
Family income (in $1000) in 1998	44.9663	41.3106
Posterior probability of unemployment	0.0508	0.1043
Probability of being below the poverty level	0.0535	0.138
Number of Drops greater than 10% in Real Family Income, 1983-1998	3.1798	1.4232
Covered by Health Insurance, 2000	0.7343	0.4421
State clean air regulations in 1998	3.2588	2.2513
Avg. state price of cigarettes (in cents) in 1998	233.7169	28.384
Years of education completed in 1998	12.0087	1.9731
Years of education respondent's mother completed	10.8719	2.7538
Age in 1998	36.8499	2.3186
Weight in 1998 (in pounds)	185.6127	37.3371
Height in 1985 (in inches)	67.6364	3.2517
Black	0.267	-
Hispanic	0.1483	-
White	0.5846	-
Married	0.4817	-
Never Married	0.2862	-
Divorce or separated	0.2269	-
Widowed	0.0052	-
Live in Metropolitan Area	0.6771	-

N=573
Sources: See Data Appendix.

Table 1c: Means and Standard Deviations of Individual and State Characteristics NLSY79 Male Non-Smokers in 1998

Characteristic	Mean	Standard Deviation
Smoked prior to 1983	0.3146	0.4645
Family income (in $1000) in 1998	59.8852	49.1471
Posterior probability of unemployment	0.0228	0.0672
Probability of being below the poverty level	0.0323	0.1171
Number of Drops greater than 10% in Real Family Income, 1983-1998	2.7665	1.4328
Covered by Health Insurance, 2000	0.8615	0.3455
State clean air regulations in 1998	3.3297	2.3412
Avg. state price of cigarettes (in cents) in 1998	233.7677	27.774
Years of education completed in 1998	13.6308	2.5727
Years of education respondent's mother completed	11.1716	3.3229
Age in 1998	36.7141	2.2617
Weight in 1998 (in pounds)	196.5894	38.265
Height in 1985 (in inches)	67.6308	3.2831
Black	0.2414	-
Hispanic	0.1918	-
White	0.5667	-
Married	0.6612	-
Never Married	0.1958	-
Divorce or separated	0.1396	-
Widowed	0.0034	-
Live within a city	0.6943	-

N=1777
Sources: See Data Appendix.

Table 1d: Means and Standard Deviations of State Characteristics, various years

Characteristic	Mean	Standard Deviation
Unemployment rate in local labor market, 1983	11.8314	3.9028
Unemployment rate in local labor market, 1984	8.821	3.2751
Unemployment rate in local labor market, 1985	8.2598	3.083
Unemployment rate in local labor market, 1986	7.9284	2.9421
Unemployment rate in local labor market, 1987	7.2214	2.6286
Unemployment rate in local labor market, 1988	6.3264	2.5744
Unemployment rate in local labor market, 1989	5.5443	2.0658
Unemployment rate in local labor market, 1990	5.6717	1.933
Unemployment rate in local labor market, 1991	7.3984	2.7473
Unemployment rate in local labor market, 1992	7.9961	2.5062
Unemployment rate in local labor market, 1993	7.5544	2.6346
Unemployment rate in local labor market, 1994	7.1454	2.7023
Unemployment rate in local labor market, 1996	6.8552	3.0824
Unemployment rate in local labor market, 1998	5.1519	2.8451
State median household income (in $1000), 1998	39.296	4.7839
Average State Probability of being below the poverty level	0.0752	0.018
Median State Probability of being below the poverty level	0.0009	0.001
Average State Number of Drops greater than 10% in Real Family Income, 1983-1998	2.2465	0.1822
Median State Number of Drops greater than 10% in Real Family Income, 1983-1998	2.0455	0.2477
State Small Group Health Insurance Regulation: NAIC Rating Bands, 1998	0.6277	-
State Small Group Health Insurance Regulation: Tight Rating Bands, 1998	0.1672	-
State Small Group Health Insurance Regulation: Community Rating, 1998	0.2774	-
State Individual Health Insurance Regulation: Any Market Reform, 1998	0.1872	-
State Individual Health Insurance Regulation: Guaranteed Issue, 1998	0.1911	-

N=2250
Sources: See Data Appendix

Table 2: OLS estimates of Economic Insecurity on Daily Cigarette Smoking for Men, 1998

Variables	(1)	(2)	(3)	(4)
Family income (in $1000)	-0.0001	-0.0001	-0.0001	-0.0001
	(0.000)	(0.000)	(0.000)	(0.000)
Posterior probability of unemployment	0.3662***	--	--	0.3484***
	(0.107)			(0.115)
Probability of falling below the poverty line	--	-0.0435	--	--
		(0.080)		
Number of drops in family income, 83-98	--	--	0.0178*	--
			(0.010)	
Health Insurance	--	--	--	-0.0202
				(0.018)
Smoked prior to 1983	0.3864***	0.3902***	0.3876***	0.3858***
	(0.021)	(0.022)	(0.021)	(0.021)
Weight (in pounds)	-0.0011***	-0.0011***	-0.0011***	-0.0011***
	(0.000)	(0.000)	(0.000)	(0.000)
Height (in inches)	0.0064*	0.0066*	0.0067*	0.0064*
	(0.003)	(0.003)	(0.003)	(0.003)
State clean air regulations	0.0047	0.0047	0.0044	0.0047
	(0.003)	(0.003)	(0.003)	(0.003)
State cigarette price (in cents)	-0.0000	0.0000	-0.0001	-0.0000
	(0.000)	(0.000)	(0.000)	(0.000)
Years of education	-0.0235***	-0.0252***	-0.0250***	-0.0231***
	(0.003)	(0.003)	(0.003)	(0.003)
Mother's education	0.0052*	0.0053*	0.0050*	0.0053*
	(0.003)	(0.003)	(0.003)	(0.003)
Age	-0.0036	-0.0035	-0.0023	-0.0036
	(0.003)	(0.003)	(0.003)	(0.003)
Black	-0.0407*	-0.0282	-0.0327	-0.0403*
	(0.024)	(0.024)	(0.024)	(0.024)
Hispanic	-0.0154	-0.0130	-0.0118	-0.0153
	(0.031)	(0.032)	(0.032)	(0.031)
Married	0.0289	0.0105	0.0290	0.0309
	(0.124)	(0.120)	(0.125)	(0.123)
Never Married	0.1038	0.0968	0.0999	0.1032
	(0.127)	(0.124)	(0.127)	(0.126)
Divorced or Separated	0.0778	0.0661	0.0772	0.0769
	(0.131)	(0.127)	(0.131)	(0.131)
Live within a city	-0.0212	-0.0194	-0.0192	-0.0216
	(0.016)	(0.016)	(0.016)	(0.016)
N	2095	2093	2095	2094
R^2	0.307	0.303	0.304	0.307

Sources: See Data Appendix; Variables are for the year 1998, unless otherwise specified; Robust standard errors (adjusted for within-state clustering) in parentheses; * significant at 10%, ** significant at 5%, *** significant at 1%

Table 3: IV estimates of Economic Insecurity on Daily Cigarette Smoking for Men, 1998

Variables	(1)	(2)	(3)	(4)
Family income (in	0.0014	0.0014	0.0026**	0.0024***
$1000)	(0.001)	(0.001)	(0.001)	(0.001)
Posterior probability	1.1711**	--	--	0.1498
of unemployment	(0.511)			(0.821)
Probability of being	--	1.2837***	--	--
below the poverty level		(0.365)		
Number of drops in	--	--	0.0768*	--
family income, 83-98			(0.046)	
Health Insurance	--	--	--	-0.2915***
				(0.112)
Smoked prior to 1983	0.3797***	0.3675***	0.3732***	0.3748***
	(0.015)	(0.015)	(0.014)	(0.013)
Weight (in pounds)	-0.0012***	-0.0011***	-0.0012***	-0.0008***
	(0.000)	(0.000)	(0.000)	(0.000)
Height (in inches)	0.0075***	0.0095***	0.0082***	0.0062**
	(0.002)	(0.002)	(0.002)	(0.003)
State clean air	0.0050*	0.0031	0.0051	0.0061**
regulations	(0.003)	(0.003)	(0.003)	(0.003)
State cigarette price (in	-0.0001	-0.0004	-0.0004	-0.0004**
cents)	(0.000)	(0.000)	(0.000)	(0.000)
Years of education	-0.0273***	-0.0277***	-0.0330***	-0.0279***
	(0.005)	(0.005)	(0.005)	(0.004)
Mother's education	0.0013	0.0011	0.0010	0.0043*
	(0.002)	(0.002)	(0.002)	(0.002)
Age	-0.0052*	-0.0010	-0.0015	-0.0059**
	(0.003)	(0.002)	(0.002)	(0.002)
Black	-0.0313	-0.0123	0.0240	-0.0023
	(0.025)	(0.019)	(0.018)	(0.033)
Hispanic	-0.0163	-0.0002	-0.0148	-0.0019
	(0.022)	(0.018)	(0.024)	(0.024)
Married	0.0476	0.1941	-0.0388	0.0534
	(0.118)	(0.122)	(0.100)	(0.085)
Never Married	0.1346	0.1913*	0.0741	0.1461*
	(0.111)	(0.109)	(0.089)	(0.086)
Divorced or Separated	0.1089	0.2420**	0.0229	0.1164
	(0.120)	(0.121)	(0.097)	(0.090)
Live within a city	-0.0374***	-0.0274**	-0.0300**	-0.0271*
	(0.013)	(0.012)	(0.012)	(0.015)
N	2072	2070	2072	2071
R^2	0.262	0.165	0.205	0.202

Sources: See Data Appendix; Variables are for the year 1998, unless otherwise specified; Robust standard errors (adjusted for within-state clustering) in parentheses. * significant at 10%, ** significant at 5%, *** significant at 1%

Instruments used in the IV regressions:

Variable: Family income — Instrument: State median household income
Variable: Posterior probability of unemployment — Instrument: Local unemployment rates, 1983-1998
Variable: Probability of Being in Poverty — Instrument: State median probability of being in poverty,

	Local Unemployment rates, 1983-1998
Variable: Number of Drops in Real Income	Instrument: State median number of drops, State mean number of drops, Local Unemployment rates, 1983-1998
Variable: Health Insurance	Instrument: Series of state health care regulations for 1998

Instrument Tests

Table 4a

Test 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)				
	(1)	(2)	(3)	(4)
Hansen J statistic (over-identification test of all instruments)	19.92	15.89	17.76	21.06
χ^2 distribution *p*-value	0.09	0.39	0.28	0.22

Table 4b

Test of Under-Identification (Instrument Relevance)				
Null: Equations are under-identified (implies instruments are not related to endogenous variables) (Note that "Fail to Reject the Null" implies *invalid* instruments)				
	(1)	(2)	(3)	(4)
Kleibergen-Paap rk LM statistic	19.131	9.973	18.916	16.72
χ^2 distribution *p*-value	0.16	0.86	0.27	0.54

Table 4c

Additional Tests of Instrument Relevance							
Specifications	(1)		(2)		(3)		(4)
	Posterior Probability	Family Income	Probability of Poverty	Family Income	Number of Drops	Family Income	
Shea Partial R^2	0.0163	0.0139	0.0089	0.0138	0.0108	0.0121	--
Partial R^2	0.0168	0.0144	0.0084	0.0146	0.0145	0.0163	--
Difference Between R^2s	0.0005	0.0005	0.0005	0.0008	0.0017	0.00129	--
Kleibergen-Paap Wald statistic	--	--	--	--	--	--	6.825
10% Maximum Relative Bias	--	--	--	--	--	--	10.6
20% Maximum Relative Bias	--	--	--	--	--	--	5.93

Table 5a

First Stage Results for Posterior Probability of Unemployment Regression

Instruments	**Endogenous Variables**	
	Family Income	Posterior Probability
Smoked prior to 1983	-2.4667	0.0099***
	(2.175)	(0.003)
Cigarette Prices	0.0795	0.0001
	(0.049)	(0.000)
Clean Indoor Air Laws	0.0698	-0.0012
	(0.619)	(0.001)
Years of School	4.1298***	-0.0045***
	(0.516)	(0.001)
Mother's Education	1.0573**	0.0002
	(0.325)	(0.001)
Age	1.0022*	0.0007
	(0.387)	(0.001)
Weight	-0.0089	-0.0000
	(0.033)	(0.000)
Height	0.3177	0.0007
	(0.318)	(0.001)
Black	-7.7113**	0.0331***
	(2.483)	(0.004)
Hispanic	5.4941	0.0051
	(4.910)	(0.004)
Married	37.5699***	-0.0296
	(7.253)	(0.059)
Never Married	10.1529	-0.0052
	(6.833)	(0.059)
Divorced/Separated	15.7893*	-0.0122
	(7.079)	(0.059)
Live in a City	2.7469	0.0056**
	(1.879)	(0.002)
State Median Household Income	0.5797	-0.0002
	(0.302)	(0.000)
Unemployment rate in local labor market, 1983	0.0550	-0.0010
	(0.582)	(0.001)
Unemployment rate in local labor market, 1984	-0.2469	0.0000
	(0.794)	(0.001)
Unemployment rate in local labor market, 1985	1.5661*	0.0004
	(0.629)	(0.001)
Unemployment rate in local labor market, 1986	-1.1336	0.0019
	(0.718)	(0.001)
Unemployment rate in local labor market, 1987	-0.1795	0.0007
	(0.918)	(0.001)
Unemployment rate in local labor market, 1988	-0.2297	-0.0000
	(0.894)	(0.001)
Unemployment rate in local labor market, 1989	0.3249	-0.0034***
	(0.982)	(0.001)
Unemployment rate in local labor market, 1990	-2.3867*	-0.0006
	(1.037)	(0.002)
Unemployment rate in local labor market, 1991	0.7773	0.0013
	(0.739)	(0.002)
Unemployment rate in	1.8224	0.0010

local labor market, 1992	(1.093)	(0.001)
Unemployment rate in	0.3080	-0.0012
local labor market, 1992	(0.889)	(0.002)
Unemployment rate in	-1.7722	-0.0010
local labor market, 1994	(1.242)	(0.002)
Unemployment rate in	0.5267	0.0030***
local labor market, 1996	(0.439)	(0.001)
Unemployment rate in	-0.7788	0.0016**
local labor market, 1998	(0.420)	(0.001)
Observations	2072	2072
R-squared	0.200	0.112
Adj. R-squared	0.187	0.098

Table 5b

First Stage Results for Probability of Being in Poverty Regression

Instruments	**Endogenous Variables**	
	Family Income	Probability of Poverty
Smoked prior to 1983	-2.4410	0.0105**
	(2.183)	(0.004)
Cigarette Prices	0.0865*	0.0003
	(0.050)	(0.000)
Clean Indoor Air Laws	0.1948	0.0001
	(0.657)	(0.002)
Years of School	4.1221***	-0.0046***
	(0.516)	(0.001)
Mother's Education	1.0547***	0.0014
	(0.325)	(0.001)
Age	1.0080**	-0.0025**
	(0.387)	(0.001)
Weight	-0.0095	-0.0000
	(0.033)	(0.000)
Height	0.3280	-0.0008
	(0.319)	(0.001)
Black	-7.4858***	0.0235***
	(2.478)	(0.008)
Hispanic	5.5084	-0.0083
	(4.915)	(0.009)
Married	36.5145***	-0.1772*
	(7.094)	(0.099)
Never Married	9.1288	-0.0896
	(6.813)	(0.100)
Divorced/Separated	14.6970**	-0.1487
	(7.023)	(0.097)
Live in a City	2.7174	0.0033
	(1.873)	(0.006)
State Median Household	0.5202	-0.0011
Income	(0.318)	(0.001)
Unemployment rate in	0.0201	-0.0005
local labor market, 1983	(0.579)	(0.002)
Unemployment rate in	-0.2253	0.0005
local labor market, 1984	(0.791)	(0.001)
Unemployment rate in	1.5901**	-0.0014
local labor market, 1985	(0.624)	(0.002)
Unemployment rate in	-1.1545	-0.0004
local labor market, 1986	(0.723)	(0.002)
Unemployment rate in	-0.2282	-0.0015
local labor market, 1987	(0.934)	(0.003)
Unemployment rate in	-0.2084	0.0052**
local labor market, 1988	(0.900)	(0.002)
Unemployment rate in	0.3623	-0.0041*
local labor market, 1989	(0.982)	(0.002)
Unemployment rate in	-2.3334**	-0.0009
local labor market, 1990	(1.046)	(0.003)
Unemployment rate in	0.6904	0.0027
local labor market, 1991	(0.746)	(0.003)
Unemployment rate in	1.8874*	-0.0012

local labor market, 1992	(1.090)	(0.003)
Unemployment rate in	0.2748	0.0008
local labor market, 1992	(0.891)	(0.004)
Unemployment rate in	-1.7751	0.0003
local labor market, 1994	(1.246)	(0.004)
Unemployment rate in	0.5110	0.0002
local labor market, 1996	(0.441)	(0.001)
Unemployment rate in	-0.7777*	-0.0000
local labor market, 1998	(0.421)	(0.002)
State Median Probability	-1,013.8797	5.5174
of Poverty	(772.436)	(4.363)
Observations	2072	2070
R-squared	0.200	0.153
Adj. R-squared	0.187	0.140

Table 5c

First Stage Results for Number of Drops in Real Income Regression

Instruments	**Endogenous Variables**	
	Family Income	Number of Drops
Smoked prior to 1983	-2.5699	0.1379*
	(2.174)	(0.072)
Cigarette Prices	0.0635	0.0014
	(0.047)	(0.001)
Clean Indoor Air Laws	0.1601	0.0017
	(0.623)	(0.019)
Years of School	4.0778***	-0.0730***
	(0.520)	(0.012)
Mother's Education	1.0551***	0.0177
	(0.323)	(0.013)
Age	0.9919**	-0.0290*
	(0.389)	(0.014)
Weight	-0.0094	-0.0009
	(0.033)	(0.001)
Height	0.3372	-0.0030
	(0.319)	(0.011)
Black	-7.7082***	-0.0295
	(2.434)	(0.096)
Hispanic	5.4661	0.0271
	(4.960)	(0.131)
Married	37.1930***	-0.0943
	(7.070)	(0.449)
Never Married	9.7977	0.3767
	(6.690)	(0.446)
Divorced/Separated	15.3395**	0.4783
	(6.843)	(0.447)
Live in a City	2.7074	-0.0474
	(1.871)	(0.073)
State Median Household	0.7026***	-0.0090
Income	(0.261)	(0.010)
Unemployment rate in	0.1693	-0.0296**
local labor market, 1983	(0.585)	(0.014)
Unemployment rate in	-0.3495	0.0203
local labor market, 1984	(0.791)	(0.021)
Unemployment rate in	1.4812**	-0.0528**
local labor market, 1985	(0.618)	(0.026)
Unemployment rate in	-0.9484	0.0517*
local labor market, 1986	(0.716)	(0.030)
Unemployment rate in	-0.3287	0.0320
local labor market, 1987	(0.951)	(0.039)
Unemployment rate in	-0.2987	0.0125
local labor market, 1988	(0.908)	(0.037)
Unemployment rate in	0.3769	-0.0497
local labor market, 1989	(0.969)	(0.033)
Unemployment rate in	-2.4719**	0.0150
local labor market, 1990	(0.975)	(0.034)
Unemployment rate in	0.8684	0.0182
local labor market, 1991	(0.733)	(0.033)
Unemployment rate in	2.0158*	-0.0259

local labor market, 1992	(1.092)	(0.038)
Unemployment rate in	0.0292	0.0419
local labor market, 1992	(0.944)	(0.031)
Unemployment rate in	-1.6221	-0.0235
local labor market, 1994	(1.195)	(0.037)
Unemployment rate in	0.5591	0.0199
local labor market, 1996	(0.444)	(0.012)
Unemployment rate in	-0.8816*	-0.0085
local labor market, 1998	(0.442)	(0.020)
State Average Number of	-11.3253	0.3857
Drops	(8.872)	(0.284)
State Median Number of	9.8298	0.0296
Drops	(5.880)	(0.146)
Observations	2072	2072
R-squared	0.201	0.076
Adj. R-squared	0.188	0.060

Table 5d

First Stage Results for Health Insurance Regression

Instruments	Endogenous Variables		
	Family Income	Posterior Probability	Health Insurance
Smoked prior to 1983	-2.5715	0.0098***	-0.0357**
	(2.151)	(0.003)	(0.016)
Cigarette Prices	0.1278**	0.0001	-0.0008**
	(0.057)	(0.000)	(0.000)
Clean Indoor Air Laws	-0.0578	-0.0011	0.0050
	(0.667)	(0.001)	(0.003)
Years of School	4.1143***	-0.0045***	0.0240***
	(0.515)	(0.001)	(0.004)
Mother's Education	1.0673***	0.0002	0.0049
	(0.324)	(0.001)	(0.005)
Age	0.9789**	0.0007	-0.0009
	(0.394)	(0.001)	(0.004)
Weight	-0.0104	-0.0000	0.0004*
	(0.034)	(0.000)	(0.000)
Height	0.3362	0.0007	-0.0012
	(0.320)	(0.001)	(0.003)
Black	-8.3582***	0.0330***	-0.0115
	(2.330)	(0.004)	(0.025)
Hispanic	5.6194	0.0050	0.0148
	(4.975)	(0.004)	(0.025)
Married	38.1662***	-0.0297	0.1625
	(6.997)	(0.059)	(0.149)
Never Married	10.8446	-0.0054	-0.0221
	(6.481)	(0.059)	(0.145)
Divorced/Separated	16.1778**	-0.0124	-0.0043
	(6.793)	(0.060)	(0.146)
Live in a City	2.7283	0.0057***	-0.0157
	(1.864)	(0.002)	(0.023)
Unemployment rate in local labor	0.0625	-0.0009	0.0016
market, 1983	(0.623)	(0.001)	(0.004)
Unemployment rate in local labor	-0.3526	0.0000	0.0027
market, 1984	(0.833)	(0.001)	(0.007)
Unemployment rate in local labor	1.5956**	0.0003	-0.0039
market, 1985	(0.672)	(0.001)	(0.005)
Unemployment rate in local labor	-1.2230	0.0021	0.0068
market, 1986	(0.740)	(0.001)	(0.004)
Unemployment rate in local labor	0.1155	0.0009	-0.0181**
market, 1987	(0.978)	(0.001)	(0.007)
Unemployment rate in local labor	-0.6194	-0.0003	-0.0027
market, 1988	(0.936)	(0.001)	(0.008)
Unemployment rate in local labor	0.7956	-0.0032**	0.0134
market, 1989	(1.015)	(0.001)	(0.009)
Unemployment rate in local labor	-2.3214**	-0.0005	0.0143
market, 1990	(1.021)	(0.002)	(0.009)
Unemployment rate in local labor	0.6940	0.0015	0.0004
market, 1991	(0.808)	(0.002)	(0.005)
Unemployment rate in local labor	1.9810*	0.0009	-0.0164**
market, 1992	(1.114)	(0.001)	(0.008)
Unemployment rate in local labor	0.0333	-0.0013	0.0033

market, 1992	(0.947)	(0.002)	(0.008)
Unemployment rate in local labor	-1.7425	-0.0011	-0.0055
market, 1994	(1.251)	(0.002)	(0.009)
Unemployment rate in local labor	0.1374	0.0031***	0.0008
market, 1996	(0.459)	(0.001)	(0.003)
Unemployment rate in local labor	-0.7421*	0.0015*	-0.0065
market, 1998	(0.437)	(0.001)	(0.004)
State Median Household Income	0.7201**	-0.0001	0.0055***
	(0.300)	(0.000)	(0.001)
State Health Insurance	5.4978	0.0061	0.0133
Regulation: Guaranteed Issue	(3.723)	(0.005)	(0.016)
State Small Group Health Insurance	-5.7094*	-0.0004	0.0070
Regulation: Community Rating	(3.377)	(0.004)	(0.016)
State Individual Health Insurance	-4.1788	-0.0027	-0.0155
Regulation: Any Market Reform	(3.717)	(0.004)	(0.023)
State Small Group Health Insurance	7.1260**	0.0024	-0.0542*
Regulation: Tight Rating Bands	(3.133)	(0.004)	(0.029)
State Small Group Health Insurance	1.2721	0.0028	-0.0261
Regulation: NAIC Rating Bands	(3.795)	(0.006)	(0.019)
Observations	2072	2072	2071
R-squared	0.202	0.112	0.158
Adj. R-squared	0.188	0.096	0.143

Data Appendix

Description of Constructed NLSY and non-NLSY Variables

Health Insurance Policies. Five state-level measures of health insurance-related regulation were obtained from the December 1997 *State Legislative Health Care and Insurance Issues* published by BlueCross BlueShield Association. *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.

Median Household Income. This variable represents the median household income in the respondent's state of residence in 1998 and comes from the U.S. Statistical Abstract.

Number of Drops in Real Family Income greater than 10 percent, 1983-1998. 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 less than 10 percent of the most recently reported previous income.

Posterior Probability of Unemployment. NLSY79 includes weekly data on employment status (working, unemployed, out of labor force, etc.) for each subject. From this information we derive an approximation of each respondent's subjective beliefs about the probability of experiencing involuntary job loss at the time of the 1998 survey. If one is willing to posit that this probability is fixed but unknown (to the worker) at the beginning of the worker's current career, and that workers adjust their beliefs in a Bayesian manner as time goes on, it is possible to calculate the worker's belief (i.e., his posterior probability) directly. We calculate posterior probability as follows:

We assume the worker has a fixed, but unknown probability π of being unemployed in any given week. He knows that there are k possible values of π, denoted π_i for $i = 1, 2, \ldots, k$ and prior probabilities $P(\pi = \pi_i)$. After n weeks the worker observes that he has been unemployed for $x \leq n$ weeks. The probability that he will be unemployed in week $n + 1$ is given by

$$\sum_{i=1}^{k} \pi_i P(\pi = \pi_i | x) \qquad (1)$$

where

$$P(\pi = \pi_i | x) = \frac{P(x | \pi = \pi_i) P(\pi = \pi_i)}{\sum_{j=1}^{k} P(x | \pi = \pi_j) P(\pi = \pi_j)} \qquad (2)$$

and because for any given value π_i, x is realized from a binomially distributed random variable,

$$P(x \mid \pi = \pi_i) = \frac{n!}{x!(n-x)!} (\pi_i)^x (1 - \pi_i)^{n-x} \qquad (3)$$

(1) is computed by generating values for π_i (job-loss hazard) and $P(\pi = \pi_i)$ (prior probability of a given hazard level) from the sample of 4625 male NLSY79 respondents for whom we have comprehensive weekly employment data from 1994-1998. Observations were sorted into 30 bins, with approximately 49 observations per bin, with the exception of the first bin, which represents the 3200 observations with prior probability of 0. π_i is then calculated as the mean hazard (number of weeks unemployed divided by total number of

weeks) for the each individuals in the same bin, and the prior probability $P(\pi = \pi_i)$ is given by the number of observations in bin *i* divided by the total number of observations.

Probability of Falling Below the Poverty Level. This variable is formed by finding the probability that individual *i*'s predicted family income in 1998 is below the poverty level. Poverty levels are obtained from the Department of Health and Human Services website, the poverty levels are specified by the *HHS Poverty Guidelines*. They are dependent on the number of family members living in the home, family income, and the state. In order to find the probability of being below the poverty level, we first apply separate regressions for each individual who has at least three annual income levels reported from 1983-1998. We regress annual family income (as reported in NLSY79 each year) on year for each individual, by applying ordinary least squares regression formulas. These formulas yield estimated coefficients for the slope, or rate of change and intercept for the linear time trend in family income. The slope is calculated by:

$$\frac{n\sum_{t=83}^{98} ty_t - \sum_{t=83}^{98} t \sum_{t=83}^{98} y_t}{n\sum_{t=83}^{98} t^2 - \left(\sum_{t=83}^{98} t\right)^2}$$

where *t* = two-digit year (*t* = 83, 84, 85, …, 98), *y* = income in year *t*, *n* = number of years when income is reported (i.e., data is not missing), and in years where data is missing (i.e., no income reported in year *t*) neither *t* nor y_t exist.

The intercept is calculated by:

$$\frac{\sum_{t=83}^{98} y_t}{n} - (slope)\frac{\sum_{t=83}^{98} t}{n}$$

Then, the predicted value of family income in 1998 is computed:

$$\hat{Y}_{98} = (\textit{intercept}) + (\textit{slope})(98)$$

Finally, a confidence interval is calculated, with the poverty level as the lower confidence limit:

$$\hat{Y}_{98} - t(1-\alpha/2; n-2)\sqrt{\frac{\sum_{i=1}^{n}(Y_i - \hat{Y}_i)^2}{n-2}\left(\frac{1}{n} + \frac{(x_h - \bar{x})^2}{\sum_{i=1}^{n}(x_i - \bar{x})^2}\right)} = \textit{poverty level}$$

We then solve for *t* and using the *ttail* command in Stata compute the probability of having a value below the poverty level.

Self Reported Weight and Height Corrections. Reporting bias are corrected for in self-reported weight and height 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.

State Cigarette Tax Data. Data on cigarette taxes for each state in 1998 is from *The Tax Burden on Tobacco*, by Orzechowski and Walker.

CHAPTER THREE

INCOME AND HEALTH AT RISK:

OPTIMAL FATTENING IN THE PRESENCE OF ECONOMIC INSECURITY

Introduction

An interesting relationship exists between food access and obesity in the willow tit, a small bird studied in the wooded forests of Northern Europe. It is observed that in each foraging site the dominant willow tit gets preferred access to foraging, while subordinate tits expend additional effort for access to lesser foraging ground accompanied by an increased risk of death by predation. Paradoxically, the subordinate tits tend to have *more* body fat than the dominant tit (Ekman and Lilliendahl 1993). Clark and Ekman (1995) hypothesize that subordinate willow tits store more body fat than the dominant tit because of their increased risk of food insecurity—allowing them to survive periods of food shortage. However, it is also seen that if food becomes too scarce, the direction of the dominance-body fat gradient changes: the dominant willow tit weighs more than the subordinate willow tit, suggesting that weight gain is only possible given sufficient resources.

Intriguing evidence suggests that a similar paradox exists in modern human populations: the poor tend to be fatter, ceteris paribus, than the rich. William Dietz (1995), for example, observed the fattening patterns of an obese seven year-old girl who lived with her single mother. He found that each month they suffered the risk of serious food shortage in the days prior to receiving their monthly welfare checks. As a possible explanation for the obese seven year-old's situation, Dietz suggests that obesity might be a response to the episodes of food insecurity. Similarly, in a study of longitudinal survey data Smith *et al.* (2007) find that perceptions of economic insecurity cause weight gain among men. These examples, and others, suggest that those who are more likely to suffer food insecurity are also more likely to become obese.[14] Weight gain can therefore be thought of as a type of precautionary fattening pursued in times of uncertainty. In essence, it is a form of self-insurance—a transfer of savings from one period to the next.

The central aim of this paper is to demonstrate that the notion of body fat, as an optimal response to food insecurity, can easily be incorporated into an economic theory of obesity, and that such a model captures many of the salient features of the modern obesity epidemic. This view, however, stands in stark contrast to most previous economic analysis of obesity, which typically places decisions about diet and exercise as undertaken with full information (and without risk) (e.g., Schroeter *et al*. 2008, Lakdawalla and Philipson 2007, Rashad *et al*. 2006, Lakdawalla *et al*. 2005, Cawley 2004, Chou *et al*. 2004, Philipson and Posner 2003 and Cutler *et al*. 2003). It is almost certainly true, of course, that prices (of food, or exercise, or time) matter but there is no *ex-ante* reason to expect that when it comes to body fat, the consumer "price/income response" will prove a more important source of variation in modern human populations than what might be called the "risk response". And there is, we hope to demonstrate, an elegant parsimony to be gained by eliminating the typical assumptions about exogenous preferences over body weight or gustatory indulgence. By taking a step back and making preferences for body weight endogenous by emphasizing the "precautionary savings" motive for weight gain, we develop a model that generates a richer set of predictions about consumer response to changes in income *and* risk.

[14] Morris *et al*. (1992) find that individuals who suffer unemployment gain a significantly greater percent of body fat than those who are continuously employed. Gerace and George (1996) find that firefighters who reported worrying about financial security gained, on average, nearly four more pounds than firefighters that

A two-period, two-state expected utility model is developed to evaluate the implications of the theory just discussed. We study the effects of changes in income and income insecurity (as measured by current and future income), the probability of receiving high income in period two, and health insurance on body weight using comparative statics. In so doing, our model sheds light on two anomalies found in the literature: first, although obesity disproportionately affects the poor (Chang and Lauderdale 2005 and Drewnowski and Specter 2004), empirical evidence suggests that when income is treated as endogenous increases in income correspond to increases in weight (Smith et al. 2007 and Ruhm 2000 and 2005), and second, although health insurance is a substitute for self-insurance (Ehrlich and Becker 1972 and Courbage 2001), and is expected to have a negative effect on self-insurance (or weight gain in our model, as defined by behavioral ecology), economic theory suggests that the presence of health insurance may also have an unexpected positive effect on weight via a moral hazard effect.[15] We discuss findings regarding these anomalies and their implications in greater detail in the pages that follow.

Theoretical Model

In this section we develop a theoretical model to examine changes in weight in the presence of uncertainty, as influenced by findings in behavioral ecology. We first analyze a univariate utility function with a consumption effect, $u(c_t)$. This simple model emphasizes the modeling strategy of endogenizing preferences for weight gain—something that previous literature has not done, it also emphasizes the role of body fat as a form of

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did not worry about financial security. See also: Lyons *et al*. 2008, Drewnowski and Specter 2004, Adams *et al*. 2003 and Townsend *et al*. 2001 for evidence of weight gain among humans in times of food insecurity.

[15] Moral hazard characterizes the tendency of insurance coverage to alter the insured individual's motive to prevent loss (Shavell 1979). In our case, the lower costs of weight gain that accompany health insurance makes individuals less likely to pursue preventative actions (see Arrow 1963, Pauly 1968, and Arrow 1968) and more likely to gain weight.

savings, as it is analogous to a savings model.

Consider a model where the consumer considers the current and following period when maximizing utility. Suppose a risk-averse consumer receives either high ($\breve{w}_t$) or low ($\hat{w}_t$) income in period *t*. Furthermore, he chooses first-period consumption of body fat (f_1) and other goods (x_1) such that he maximizes the sum of expected lifetime utility. The consumer's first-period decision is:

$$\max_{x_1, f_1} u(x_1) + E(u(\tilde{w}_2 + \delta f_1)) \qquad (1)$$

subject to:

$$w_1 + p_f \delta f_0 \geq p_x x_1 + p_f f_1$$

where $u(\cdot)$ is a twice differentiable, increasing, strictly concave function (*i.e.*, $u'(\cdot) > 0$ and $u''(\cdot) < 0$), w_1 is the realized income in period one (either high ($\breve{w}_1$) or low ($\hat{w}_1$)), $\tilde{w}_2$ is a random variable representing period two income (either high ($\breve{w}_2$) or low ($\hat{w}_2$)), $\delta \in (0,1)$ is the metabolic energy depreciation factor when stored as body fat, and p_f and p_x are prices for fat and other goods. Fat purchased in period one enters the utility function in the form of "savings" in period two. Because the second period is the final period in the model all of the "saved" body fat from period one, along with period two income are used for consumption of other goods in period two. Accordingly, there is no budget constraint for the second period.

It should be noted that current income can be thought of providing information about future income in our model. Assume, for instance, that the probability of high income $\breve{w}$ is fixed across periods but unknown and can take one of two values: ξ_G or ξ_B, where $\xi_G > \xi_B$. A realization of high (low) income in period one can then be used (via Bayes'

Law) to form a posterior probability of high (low) income, denoted $\pi_{h|h}$ ($\pi_{h|l}$).

Proposition 1: $\pi_{h|h} > \pi_{h|l}$ [16]

Posterior probabilities represent an individual's risk of receiving high income in period two based on the realized outcome of period one income. Conditional probabilities are used in place of non-conditional probabilities because they more accurately reflect an individual's probabilistic belief of period two income based on past income. The realized value of w_1, then, has two distinct income effects: it determines the income constraint while simultaneously affecting the probability of receiving high income in period two.

The updated decision problem with high income in period one is: [17]

$$\max_{x_1, f_1} u(x_1) + \pi_{h|h} u(\breve{w}_2 + \delta f_1) + (1 - \pi_{h|h}) u(\hat{w}_2 + \delta f_1) \qquad (2)$$

subject to:

$$\breve{w}_1 + p_f \delta f_0 \geq p_x x_1 + p_f f_1$$

Given that the utility function is twice differentiable, increasing, and strictly concave, comparative statics on the first order conditions (found in Appendix B) from equation (2) estimate the direction of the effect of changes in exogenous variables of interest on weight. These findings are presented formally in the following propositions and corollary and are discussed in detail in the following paragraphs:

Proposition 2 (i) Increases in current income (holding the distribution of future income

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[16] A complete list of notation and general assumptions used throughout the paper can be found in Appendix A. Appendix B contains proofs for each proposition and corollary presented.

[17] Although our discussion focuses on high income in period one, identical results are found for Propositions 2 (i)-2(iii) and Corollary 1 using low income in period one.

constant) increase current weight: $\frac{\partial f_1}{\partial \breve{w}_1} > 0$.

(ii) Increases in prospective income decrease current weight: $\frac{\partial f_1}{\partial \breve{w}_2} < 0$ and $\frac{\partial f_1}{\partial \hat{w}_2} < 0$.

(iii) Increases in the perceived probability of financial security decrease current weight:

$\frac{\partial f_1}{\partial \pi_{h|h}} < 0$.

Corollary 1 (following from Proposition 2 (iii))**:** Evolutionary mismatch leads to excessive fattening.

(i) An income effect causes the positive effect of increasing current income on current weight. Increasing income expands the income constraint and total consumption increases by virtue of a larger income constraint. This is the first of the two income effects mentioned earlier. Although not contained in this comparative static result one would also expect the increased time costs of making healthy food and exercising, that accompany increased income, to increase current fattening (Cutler *et al*. 2003). As the relative price of eating unhealthy food decreases, given higher income, consumption of unhealthy foods, and consequently weight, would increase, ceteris paribus.

(ii) While Proposition 2 (i) addresses the effect of income on weight this proposition addresses the effect of income security on weight. An increase in prospective income corresponds to higher income security (lower risk) and is expected to have a negative effect on current weight; less savings (in the form of fat) is needed to reach the same utility level with higher levels of income.

(iii) The negative effect of increasing the probability of high income on weight is consistent with the paradoxical examples of weight gain presented in the introduction. The positive effect of increasing current income on weight (discussed in Proposition 2 (i)) is offset by the unambiguous negative income security effect on weight presented in this proposition. Combined with Proposition 1 these effects constitute the two income effects, working in opposite directions, caused by increasing period one income. These results highlight the distinction between the effects of *income security* and *income* on changes in weight. They also suggest that both current income and the variability of expected income (as a function of current income) should increase fattening. Low current income then, makes the individual thinner by constraining the income constraint (fattening becomes too expensive) while concurrently making the individual fatter (because he is more likely to perceive lower income in the future). These results address the first anomaly presented earlier: poor people gain weight because their current economic state increases their perception of future insecurity, while rich people may also gain weight by virtue of their larger income constraint. The poor (insecure) then, gain weight to survive periods of food insecurity, given they have sufficient means to do so. While the rich (secure) gain weight, simply because they can. Although theoretical evidence suggests these two opposing effects exist the fact that it is unclear which is greater suggests the need for an empirical analysis.

Corollary 1: A theory known as the "thrifty gene hypothesis" suggests that humans have evolved to survive periods of food shortage (Neel 1962 and Smith 2009). In modern times these genes may be harmful because they cause humans to have a propensity to gain weight in preparation for a food shortage that never materializes. Jones (2001) describes this temporal mismatch between characteristics fitting for the past (when food insecurity was higher), yet detrimental for current conditions, as "time-shifted rationality".

It follows from Proposition 2 (iii) that if an individual incorrectly perceives his probability of high income to be lower than it is current body weight will be higher, *ceteris paribus*, than it would be if he perceived risk correctly.[18] This is known as an evolutionary mismatch. Evolutionary mismatch may be to blame for the time inconsistency (or self-control) problem so commonly linked to weight gain.[19]

In the preceding pages we develop a model that captures many of the previously unexplained features of the obesity epidemic and demonstrate the use of precautionary fattening as a form of self-insurance in the presence of uncertainty. Although this model offers valuable insights into the self-insurance/savings aspect of fattening it fails to capture other essential effects associated with weight gain. For example, although δ captures the relative cost of transferring fat from one period to the next, equation (2) fails to capture the negative health consequences that accompany weight gain.

We build upon our current model by adding a health effect to the utility function, $u(c_t, h_t)$, similar to Grossman (1972) and others (Jacobson 2000, Nyman 1999, and Ried 1998). By including a health effect we are able to capture negative health effects associated with excess weight gain, in addition to the relative cost of temporal fat transfers captured through δ. Although this specification continues to model preferences endogenously, it is similar to other models that include health in the utility function. The consumer's first-period decision with high income in the first period is:

[18] Smith and Tasnadi (2007) explain this probability mismatch dilemma as a problem of "subjective" probabilities versus "objective" probabilities, the former incorrectly being caused by the temporal mismatch. Dasgupta and Maskin (2005) propose a similar explanation. Our use of a subjective probability is the same as that used by Savage (1954).

[19] Nine of the top ten articles from econ journals using the keyword search self-control in the *Web of Science* mention dieting as an example. The remaining article references other papers in the introduction that use examples of dieting.

$$\max_{x_1, f_1} u(x_1, h(f_1, i)) + \pi_{h|h}(i) u(\breve{w}_2 + \delta f_1, h(f_2, i)) + (1 - \pi_{h|h}(i)) u(\hat{w}_2 + \delta f_1, h(f_2, i)) \qquad (3)$$

subject to:

$$\breve{w}_1 + p_f \delta f_0 \geq p_x x_1 + p_f f_1$$

The health function, $h(f_t, i)$, is continuously differentiable in body fat (f_t) and health insurance coverage (i), $\frac{\partial h}{\partial f_t} < 0$ and $\frac{\partial^2 h}{\partial f_t^{\,2}} < 0$ (*i.e.*, fattening has an increasingly detrimental effect on health) while $\frac{\partial h}{\partial i} > 0$ and $\frac{\partial^2 h}{\partial i^2} < 0$ (*i.e.*, health insurance coverage has a decreasingly marginal effect on health).

Fat is included in the health function to capture the negative health effects associated with gaining excessive weight. Without this effect there would be no penalty for weight gain besides the cost, δ, of transferring fat from one period to the next.[20] Body fat purchased in period one enters the utility function via a negative health effect in period one—fat has a negative effect on health in the period it is purchased, yet does not directly affect health in subsequent periods, and a positive consumption effect in period two.[21] Fat purchased in one period has a negative effect on health in subsequent periods if some of the fat savings from period *t-1* is used to purchase fat in period *t*—such is not the case in a two-period model. The optimal allocation of second period resources (δf_1 and $\tilde{w}_2$) in a two-period model is in the consumption of other goods—when this is done, the individual loses (or spends) all his period one fat on other goods. Substantial literature in the medical and science fields suggests that many of the negative health consequences of excessive

[20] If the cost of transfer were small enough that it did not deter consumers from always buying fat in anticipation for the following period consumers would eat to no bound.

[21] When first period fat is included in the period two health effect the comparative static results remain the same.

weight are actually reversible to a large extent upon weight loss. These conditions include, but are not limited to: premature mortality, cardiovascular disease, type 2 diabetes, osteoarthritis, certain cancers, hypertension, high cholesterol, sleep apnea, asthma, etc (See: USDHHS, Oster *et al.* 1999, Pi-Sunyer 1993, Stenius-Aarniala *et al*. 2000, Zamboni *et al*. 2005, and Blackburn 1995). This evidence confirms the modeling strategy of limiting the negative effects of weight gain to the period in which fat is purchased if the weight is lost in the following period.

Health insurance is included in the health function to capture two effects. The first is a positive effect on health: health insurance increases both the demand and consumption of medical care (Manning and Marquis 1989, Nyman 1999 and 2003) and consequently has a positive effect on health. Several case studies and secondary studies demonstrate a positive relationship between health insurance and health (See: Fihn *et al*. 1988, Hanratty 1996, Lurie 1984, as presented by Levy and Meltzer 2001). Furthermore, Levy and Metzer (2001) suggest that health insurance has a positive causal effect on health because of the improved access to medical care. Second, including fat and health insurance in the health function captures both the ex-ante (a change in preventative actions) and ex-post (a change in medical care consumption) aspects of moral hazard in the model. While other models either look at ex-ante or ex-post moral hazard separately, we are able to capture them concurrently because our health function is bivariate.[22] The positive effect of health insurance on health (through increased medical care consumption) captures the ex-post moral hazard, while the increase in weight due to the decreased marginal costs of fattening at higher levels of health (that accompanies increased levels of health insurance coverage) captures the ex-ante effect of moral hazard.

We study the effect of increases in health insurance coverage on weight, as opposed to the decision to buy a health policy because we are concerned with analyzing the security and moral hazard effects that accompany increases in coverage level instead of the adverse selection effect that accompanies purchasing a policy. Nyman (2003) suggests that when analyzing the choice to purchase insurance it is difficult to differentiate between the effects of moral hazard and adverse selection. This being the case, we would be unable to compare the contrasting effects (if present) of increased security and moral hazard on weight because the adverse selection effect would also be included in the choice to purchase insurance. Chiappari and Selanie (2000) suggest the ideal test for moral hazard occurs when consumers face a sudden exogenous change in the incentive structure (see Chiappari *et al*. 1998). Accordingly, because we are interested in analyzing the role of moral hazard in the health insurance-weight relationship we look at an exogenous increase in health insurance instead of including it in the budget constrain.

Traditionally, economists have modeled health insurance coverage in the consumption effect where the health insurance payment mitigates the loss that occurs in the "sick" state. We choose to model the health insurance effect in another way, as inspired by behavioral ecology. Earlier, we suggested that individuals gain weight based on their *perceptions* of future security, thus decreasing their perceived financial risk. Because health insurance mitigates, or eliminates (depending on the coverage) financial loss caused by costly medical care, health insurance *increases* an individual's perceptions of future security. Accordingly, we model the perceived probability of high income as a function of

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[22] Pauly (1974) and Shavell (1979) both look at ex-ante moral hazard. In their models, they make the probability of an event occurring a function of preventative actions, which is affected by health insurance

health insurance, $\pi_{h|h}(i)$.[23] It is assumed that $\frac{\partial \pi_{h|h}(i)}{\partial i} > 0$ and $\frac{\partial^2 \pi_{h|h}(i)}{\partial i^2} < 0$, the same is true for $\pi_{h|l}(i)$.

We also assume additive separability between effects—changes in health don't affect the marginal utility of consumption and vice versa.[24] Similarly, we assume that the effects of fattening and health insurance in the health effect are also additively separable. Comparative statics on the first order conditions from equation (3) yield the following propositions:[25]

Proposition 3 (i) -3 (iii) and Corollary 2: Results from Proposition 2 (i)-2 (iii) and Corollary 1 still hold.

(iv) Simultaneously increasing high income in both the current and future periods (i.e., the net effect of $\frac{\partial f_1}{\partial \breve{w}_1}$ and $\frac{\partial f_1}{\partial \breve{w}_2}$) has an ambiguous effect on current weight:[26]

$$\frac{\partial f_1}{\partial \breve{w}} = \frac{-\left(p_x^2 \delta \pi_{h|h}(i) \frac{\partial^2 u(\breve{w}_2)}{\partial f_1^{\,2}} - p_f \frac{\partial^2 u(x_1, h(\cdot))}{\partial x_1^{\,2}} \right)}{\left(p_x^{\,2} \left(\delta^2 \left(\pi_{h|h}(i) \frac{\partial^2 u(\breve{w}_2)}{\partial f_1^{\,2}} + (1-\pi_{h|h}(i)) \frac{\partial^2 u(\hat{w}_2)}{\partial f_1^{\,2}} \right) + \frac{\partial^2 u(x_1, h(\cdot))}{\partial h^2} \left(\frac{\partial h(\cdot)}{\partial f_1} \right)^2 + \frac{\partial u(x_1, h(\cdot))}{\partial h} \frac{\partial^2 h(\cdot)}{\partial f_1^{\,2}} \right) + p_f^{\,2} \frac{\partial^2 u(x_1, h(\cdot))}{\partial x_1^{\,2}} \right)} \quad (4)$$

(v) Increasing the amount health insurance coverage has an ambiguous effect on current weight:

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coverage.

[23] Although the traditional approach and our approach model health insurance differently, they are essentially equivalent and result in the same comparative static results.

[24] Recent literature suggests that it would be difficult to conclude which direction the effect would work, if indeed there is one between the two, see: Bardey and Lesur 2005 and Rey 2003.

[25] Identical results are found for Propositions 3 (i)-3(v) and Corollary 2 using low wage in period one.

[26] The same is true for simultaneously increasing low income in the first and second period when the respondent receives low income in period one.

$$\frac{\partial f_1}{\partial i} = \frac{-\left(p_x{}^2\left(\delta\frac{\partial \pi_{h|h}(i)}{\partial i}\left(\frac{\partial u(\breve{w}_2)}{\partial f_1} - \frac{\partial u(\hat{w}_2)}{\partial f_1}\right) + \frac{\partial h}{\partial i}\frac{\partial^2 u(x_1, h(\cdot))}{\partial h^2}\frac{\partial h}{\partial f_1}\right)\right)}{\left(p_x{}^2\left(\delta^2\left(\pi_{h|h}(i)\frac{\partial^2 u(\breve{w}_2)}{\partial f_1{}^2} + (1-\pi_{h|h}(i))\frac{\partial^2 u(\hat{w}_2)}{\partial f_1{}^2}\right) + \frac{\partial^2 u(x_1, h(\cdot))}{\partial h^2}\left(\frac{\partial h}{\partial f_1}\right)^2 + \frac{\partial u(x_1, h(\cdot))}{\partial h}\frac{\partial^2 h}{\partial f_1{}^2}\right) + p_f{}^2\frac{\partial^2 u(x_1, h(\cdot))}{\partial x_1{}^2}\right)} \tag{5}$$

A discussion for Propositions 3 (i) to 3 (iii) and Corollary 2 are omitted as the rationale is identical to what was presented for Propositions 2 (i) to 3 (iii) and Corollary 1. It should be mentioned however, that regardless of the negative health consequences of fattening an individual would still gain weight with increases in perceived economic insecurity and current income, and lose weight with increases in prospective income; thus validating our approach of endogenizing preferences for weight gain, as highlighted in the simple model.

(iv) Here, instead of analyzing the effect of a change in either current or prospective income on fattening we analyze the effect of "simultaneously" increasing high income in both current and future periods. It is unclear however, whether the increased 'security effect' that accompanies an increase in future income is greater than the income effect than accompanies increases in current income. In equation (4) the sign of the denominator is negative while the sign of the numerator is ambiguous. Because it is unclear whether the income effect (which has a positive effect on fattening), $p_f \frac{\partial^2 u(x_1, h(\cdot))}{\partial x_1{}^2}$ —the effect of a change in the marginal utility of consumption of other goods in period one, or the income security effect (which has a negative effect on fattening), $p_x^2 \delta \pi_{h|h} \frac{\partial^2 u(\breve{w}_2)}{\partial f_1{}^2}$ —the effect of a change in the marginal utility in period two caused by fat purchased in period one, is greater, it is unknown whether simultaneously increasing income in the current and future periods has a positive or negative effect on current weight. If the income security effect is greater than the income effect (i.e., the net effect of increasing current and future income is positive) the numerator is positive and a “simultaneous” increase in incomes decreases weight. But if the income effect is greater than the income security effect the numerator is negative and increasing incomes increases weight. These two effects, working in opposite directions, show once again that income security and income have drastically different effects on fattening.

(v) Comparative statics on the first order conditions indicate the presence of two health insurance effects working in opposite directions on fattening. The denominator is unambiguously negative while the sign of the numerator is ambiguous because of the presence of two opposing effects. The sign of the first element (the security effect), $\left(\delta\frac{\partial\pi_{h|h}(i)}{\partial i}\left(\frac{\partial u(\breve{w}_2)}{\partial f_1}-\frac{\partial u(\hat{w}_2)}{\partial f_1}\right)\right)$, is negative, while the sign of the second element (the moral hazard effect), $\left(\frac{\partial h}{\partial i}\frac{\partial^2 u(x_1,h(\cdot))}{\partial h^2}\frac{\partial h}{\partial f_1}\right)$, is positive. The security effect captures the marginal benefit of an increase in health insurance coverage while the moral hazard effect captures the increased weight that accompanies increases in health insurance coverage and the resultant decreased cost of fattening. If the safety net effect is larger than the moral hazard effect then the marginal benefit of health insurance is greater than the marginal cost of health insurance and an increase in health insurance makes the numerator positive and decreases weight. But if the moral hazard effect is greater than the safety net effect an increase in health insurance increases first period weight. Because the theoretical model does not offer insights on the size of the effects we are unable to conclude the net effect of increasing health insurance coverage on fattening. The limitations of the theoretical model highlight the importance of pursuing an empirical analysis to disentangle the opposing effects that remain ambiguous. Empirical evidence suggests that health insurance has a negative effect on fattening (Smith *et al.* 2007 and Rashad and Marokwitz 2007), implying that the security effect of increased health insurance coverage outweighs the moral hazard effect.

An empirical analysis of the theoretical findings is warranted. Such an analysis will clarify the ambiguous results and reveal the magnitude of the comparative static results as well. A possible proxy for subjective beliefs is a quantitative measure of the posterior probability of receiving high income based on an individual's employment history. In another paper Smith *et al*. (2007) use the posterior probability of unemployment as a proxy for perceived economic insecurity. Possible proxies for moral hazard include changes in the number of health care visits (or the number of hours spent exercising) as coverage increases. These effects are captured theoretically in the partial effect of insurance on health in our model. Proxies for economic security may include responses to a survey that asks questions on perceptions of financial wellbeing. This effect is captured theoretically in the partial effect of increasing insurance coverage on the posterior probability of high income. The empirical estimates for the measures just discussed are likely biased due to endogeneity issues and require the careful use of instruments in an instrumental variables approach to estimate unbiased effects.

Conclusion

Weight gain has consistently been modeled as a choice based on certainty where changes in weight have been explained by prices and income. Instead, in this paper we introduce uncertainty into the weight gain model and examine change in weight as a response to risk, in addition to prices and income. In so doing we demonstrate that body fat can be seen as an optimal response to economic insecurity and suggest that in addition to the income/price gradient affecting weight, another gradient warranting consideration is that of risk.

To examine the fattening choice we build a two-period, two-state expected utility model where the consumer purchases first period fat based on future perceptions of financial security. Evidence from comparative static results support the idea that fattening is a form of precautionary savings pursued in the presence of economic insecurity. Results suggest that increases in perceived insecurity cause increases in weight, while increases in security decrease fattening. Furthermore, results also suggest that inconsistent time preferences formed from an evolutionary mismatch may play an important role in non-optimal fattening—a behavior that has previously been blamed on problems of self-control. Comparative statics also shed light on the anomalies discussed in the introduction. First, we find that poor people are likely to gain weight because low income now causes increased perceptions of future insecurity, resulting in weight gain. However, at the same time, increases in current income also correlate with weight gain because of the expanded income constraint—ironically making people who receive more income fatter as well. Comparative static results also suggest an ambiguous effect of health insurance on fattening due to the opposing effects of security and moral hazard.

Important policy implications stem from these findings, first because preferences for fattening are endogenous they are influenced by changes in their surroundings, meaning public policy influencing economic insecurity can be influential in the weight loss (or weight gain) process. Second, given this relationship both public policy and health policy organizations can work together in developing effective programs aimed at decreasing weight by increasing perceptions of security. This paper takes an important step in endogenizing preferences with respect to weight and not only demonstrates precautionary fattening as a means of self-insurance, but also offers insight into the advantages of making preferences endogenous.

References

Adams, E., L. Grummer-Strawn, and G. Chavez (2003): "Food Insecurity is Associated with Increased Risk of Obesity in California Women," *Journal of Nutrition*, 133 (4), 1070-1074.

Arrow, K. (1963): "Uncertainty and the Welfare Economics of Medical Care," *The American Economic Review*, 53 (5), 941-973.

Arrow, K. (1968): "The Economics of Moral Hazard: Further Comment," *The American Economic Review*, 58 (3) part 1, 537-539.

Bardey, D. and R. Lesur (2005): "Optimal health insurance contract: Is a deductible useful?" *Economics Letters*, 87, 313-317.

Blackburn, G. (1995): "Effect of degree of weight loss on health benefits," *Obesity Research*, 3, 211S-216S.

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

Chang, V. and D. Lauderdale (2005): "Income Disparities in Body Mass Index and Obesity in the United States 1971-2002," *Archives of Internal Medicine*, 165 (18), 2122-2128.

Chiaparri, P.-Y. and B. Salanie (2000): "Testing for Asymmetric Information in Insurance Models," *The Journal of Political Economics*, 108 (1), 56-78.

Chiappari, P.-Y., F. Durrand, P.-Y. Geofard (1998): "Moral Hazard and the Demand for Physician Services: First Lessons from a French Natural Experiment," *European Economics Review*, 42 (3-5), 499-511.

Chou, S.-Y., M. Grossman, and H. Saffer (2004): "An Economic Analysis of Obesity:

Results from the Behavioral Risk Factor Surveillance System," *Journal of Health Economics*, 23, 565-587.

Clark, C. and J. Ekman (1995): "Dominant and Subordinate Fattening Strategies: a Dynamic Game," *Oikos*, 72, 205-212.

Courbage, C. (2001): "Self-Insurance, Self-Protection and Market Insurance within the Dual Theory of Choice," *The Geneva Papers on Risk and Insurance Theory*, 26, 43-56.

Cutler, D. E. Glaeser, and J. Shapiro (2003): "Why Have Americans Become More Obese?" *Journal of Economic Perspectives*, 17 (3), 93-118.

Dasgupta, P. and E. Maskin (2005): "Uncertainty and Hyperbolic Discounting," *The American Economic Review*, 95 (4), 1290-1298.

Dietz, W. (1995): "Does Hunger Cause Obesity?" *Pediactrics*, 95, 766-767.

Drewnowski, A. and S. Spector (2004): "Poverty and Obesity: the role of energy density and energy costs," *American Journal of Clinical Nutrition*, 79 (1), 6-16.

Ehrlich, I. and G. Becker (1972): "Market Insurance, Self-Insurance, and Self-Protection," *Journal of Political Economy*, 80 (4), 623-648.

Ekman, J. and K. Lilliendahl (1993): "Using Priority to Food Access: Fattening Strategies in Dominance-Structured Willow Tit (Parus montanus) Flocks," *Behavioral Ecology*, 4, 232-238.

Fihn, S. and J. Wicher (1988): "Withdrawing routine outpatient medical services: effects on access and health," *Journal of General Internal Medicine*, Jul/Aug, 356-362.

Gerace, T. and V. George (1996): "Predictors of Weight Increases Over 7 years in Fire Fighters and Paramedics," *Preventive Medicine*, 25 (5), 593-600.

Grossman, M. (1972): "On the Concept of Health Capital and the Demand for Health," *Journal of Political Economy*, 80, 223-255.

Hanratty, M. (1996): "Canadian National Health Insurance and Infant Health," *The American Economic Review*, 86 (1), 276-284.

Jacobson, L. (2000): "*The* Family as Producer of Health—an Extended Grossman Model," *Journal of Health Economics*, 19 (5) 611-637.

Jones, O. (2001): "Time-Shifted Rationality and the Law of Law's Leverage: Behavioral Economics Meets Behavioral Biology," *Northwestern University Law Review*, available at SSRN: http://ssrn.com//abstract:249419, 95.

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

Lakdawalla, D. and T. Philipson (2007): "Labor Supply and Weight," *Journal of Human Resources*, 42 (1), 85-116.

Levy, H. and D. Meltzer (2001): "What Do We Really Know About Whether Health Insurance Affects Health?" *ERIU Working Paper 6*.

Lurie, N. N. Ward, M. Shapiro, R. Brook (1984): "Termination from Medi-Cal—does it affect health?" *The New England Journal of Medicine*, Aug, 11 (7), 480-484.

Lyons, A., J. Pck, C. Nelson (2008): "Food Insecurity and Obesity: A Comparison of Self-Reported and Measured Height and Weight," *American Journal of Public Health*, 98 (4), 751-757.

Manning, W. and M. Marquis (1989): "Health Insurance: The Trade-Off Between Risk Pooling and Moral Hazard," *RAND*.

Morris, J., D. Cook, and A. Shaper (1992): "Nonemployment and Changes in Smoking, Drinking, and Body-Weight," *British Medical Journal*, 304 (6825), 536-541.

Neel, J. (1962): "Diabetes Mellitus: A "Thrifty" Genotype Rendered Detrimental by "Progress"?" *American Journal of Human Genetics*, 14 (4), 353-362.

Nyman, J. (1999): "The Value of Health Insurance: the Access Motive," *Journal of Health Economics*, 18, 141-152.

Nyman, J. (2003): *The Theory of Demand for Health Insurance*, Standord University Press, Stanford, CA, 44-45.

Oster, G., F. Contaldo, G. de Simone, M. Manicuno (1999): "Lifetime Health and Economic Benefits of Weight Loss among Obese Persons," *American Journal of Public Health*, 89 (10), 1536-1542.

Pauly, M. (1968): "The Economics of Moral Hazard: Comment," *The American Economic Review*, 58 (3) part 1, 531-537.

Pauly, M. (1974): "Overinsurance and Public Provision of Insurance: The Roles of Moral Hazard and Adverse Selection," *The Quarterly Journal of Economics*, 88 (1), 44-62.

Philipson, T. and R. Posner (2003): "The Long-Run Growth in Obesity as a Function of Technological Change," *Perspectives in Biology and Medicine*, 46 (3), S87.

Pi-Sunyer, F. (1993): "Short-term Medical Benefits and Adverse Effects of Weight loss," *Annals of Internal Medicine*, 199 (7)-2, 722-726.

Rashad, I., M. Grossman, S.-Y. Chou (2006): "The Super Size of America: An Economic Estimation of Body Mass Index and obesity in Adults," *Eastern Economic Journal*, 32 (1), 133-148.

Rashad, I. and S. Markowitz (2007): "Incentives in Obesity and Health Insurance," *NBER Working Paper 13113*.

Rey, B. (2003): “A Note On Optimal Insurance in the Presence of a Nonpecuniary Background Risk,” *Theory and Decision*, 54, 73-83.

Ried, W. (1998): “Comparative Dynamic Analysis of the Full Grossman Model,” *Journal of Health Economics*, 17 (4), 383-425.

Ruhm, C. J. (2000): “Are Recessions Good For Your Health?” *The Quarterly Journal of Economics*, May, 617-650.

Ruhm, C. J. (2005): “Healthy living in hard times,” *Journal of Health Economics*, 24, 341-363.

Savage, L. J. (1954): *The Foundations of Statistics*, John Wiley.

Schroeter, C., J. Lusk, W. Tyner (2008): “Determining the Impact of Food Price and Income Change on Body Weight,” *Journal of Health Economics*, 27 (1), 45-68.

Shavell, S. (1979): “On Moral Hazard and Insurance,” The Quarterly Journal of Economics, 93 (4), 541-562.

Smith, T. G. and A. Tasnadi (2007): “A Theory of Natural Addiction,” *Games and Economic Behavior*, 59, 316-344.

Smith, T. G. (2009): “Reconciling Psychology with Economics: Obesity, Behavioral Biology, and Rational Overeating,” forthcoming in *Journal of Bioeconomics*.

Smith, T. G., C. Stoddard, M. Barnes (2007): “Why the Poor Get Fat: Weight Gain and Economic Insecurity,” Working Paper, *Washington State University Working Paper 2007-16*.

Stenius-Aarnials, T. Poussa, J. Kvarnstrom, E. Gronlund, M. Ylikahri, P. Mustajoki (2000): “Immediate and Long-Term effects of weight reduction in obese people with asthma: Randomised Controlled Study,” *British Medicine Journal*, 320 (7238), 827-832.

Townsend, M., J. Peerson, B. Love, C. Achterberg, and S. Murphy (2001): "Food Insecurity is Positively Related to Overweight Women," *Journal of Nutrition*, 131, 1738-1745.

United States Department of Health and Human Services (2007): "Benefits of Weight Loss," http://www.surgeongeneral.gov/topics/obesity/calltoaction/fact_consequences.htm.

Zamboni, M., G. Mazzali, E. Zoico, T. Harris, J. Meiss, V. Francisco, F. Fantina, L. Bissoli (2005): "Health Consequences of obesity in the elderly: a review of four unresolved questions," *International Journal of Obesity*, 29 (9), 1011-1029.

Appendix A

Notation Index:

$\pi_{h|h} = P(\breve{w}_2 \mid \breve{w}_1)$

$\pi_{h|l} = P(\breve{w}_2 \mid \hat{w}_1)$

$u(x_1, h(\cdot)) = u(x_1, h(f_1, i))$

$u(\breve{w}_2) = u(\breve{w}_2 + \delta f_1, h(f_2, i))$

$u(\hat{w}_2) = u(\hat{w}_2 + \delta f_1, h(f_2, i))$

$h = h(f_t, i)$

General assumptions:

$u(c_t, h_t)$ is a concave, continuously differentiable, strictly increasing function. The usual properties follow ($u'(\cdot) > 0$ and $u''(\cdot) < 0$).

Inter-temporal and intra-temporal additive separability (*i.e.*, the marginal utility of consumption is not affected by changes in health, the same is true for the marginal utility of health).

$\frac{\partial h}{\partial f_1} < 0, \frac{\partial^2 h}{\partial f_1^2} < 0$} Weight gain has an increasingly detrimental effect on health

$\frac{\partial h}{\partial i} > 0, \frac{\partial^2 h}{\partial i^2} < 0$} Health insurance has a decreasingly important marginal effect on health

$\frac{\partial \pi_{h|h}(i)}{\partial i} > 0, \frac{\partial^2 \pi_{h|h}(i)}{\partial i^2} < 0$ } Health insurance has a decreasingly important marginal effect on the perceived probability of security (the same is true for $\pi_{h|l}$).

Appendix B

Proofs:

Proposition 1:

$\pi_{h|h} > \pi_{h|l}$:

Assume that the probability ξ_H of receiving high income is fixed but unknown. Consider the case in which the probability of high income takes on a hazard rate of two probabilities $H \in \{G,B\}$, where $\xi_G > \xi_B$, and the prior probability of ξ_G is p_G. Because we only have two probabilities of high wage, the prior probability of ξ_B is $1-p_G$. In period one the consumer observes either high or low income and updates his beliefs accordingly:

By Bayes' Law,

$$P(\xi_G \mid \breve{w}_1) = \frac{P(\breve{w}_1 \mid \xi_G) * p_G}{P(\breve{w}_1 \mid \xi_G) * p_G + (1-p_G) * P(\breve{w}_1 \mid \xi_B)} = \frac{\xi_G * p_G}{\xi_G * p_G + (1-p_G) * \xi_B} \text{ similarly}$$

$$P(\xi_B \mid \breve{w}_1) = \frac{\xi_B * (1-p_G)}{\xi_B * (1-p_G) + \xi_G * p_G} = 1 - P(\xi_G \mid \breve{w}_1).$$ It follows that:

$$P(\xi_G \mid \hat{w}_1) = \frac{(1-\xi_G) * p_G}{(1-\xi_G) * p_G + (1-p_G) * (1-\xi_B)}$$ and $P(\xi_B \mid \hat{w}_1) = (1 - P(\xi_G \mid \hat{w}_1))$. The probability of receiving high wage in period two is: $p(\breve{w}_2 \mid \breve{w}_1) + p(\breve{w}_2 \mid \hat{w}_1) =$

$p(\xi_G \mid \breve{w}_1) * \xi_G + (1 - p(\xi_G \mid \breve{w}_1))\xi_B + p(\xi_G \mid \hat{w}_1) * \xi_G + (1 - p(\xi_G \mid \hat{w}_1))\xi_B$. Then,

$$P(\breve{w}_2 \mid \breve{w}_1) - P(\breve{w}_2 \mid \hat{w}_1) = \frac{(-1+p_G) * p_G * (\xi_G - \xi_B)^2}{(-1+p_G * (\xi_G - \xi_B) + \xi_B) * (p_G * (\xi_G - \xi_B) + \xi_B)} > 0.$$ The numerator is negative because $p_G < 1$. The denominator is also negative because the first

term is negative because the weighted sum of ξ_G and ξ_B is less than one, and the second term is positive because $\xi_G > \xi_B$. It follows directly that $\pi_{h|h} > \pi_{h|l}$.

Self-Insurance Maximization Problem:

$$\max_{x_1, f_1} u(x_1) + \pi_{h|h} u(\breve{w}_2 + \delta f_1) + (1-\pi_{h|h}) u(\hat{w}_2 + \delta f_1)$$

subject to:

$$\breve{w}_1 + p_f \delta f_0 \geq p_x x_1 + p_f f_1$$

The corresponding first order conditions are:

i) $\dfrac{\partial u(x_1)}{\partial x_1} - \lambda p_x = 0$

ii) $\delta \pi_{h|h} \dfrac{\partial u(\breve{w}_2 + \delta f_1)}{\partial f_1} + \delta (1-\pi_{h|h}) \dfrac{\partial u(\hat{w}_2 + \delta f)}{\partial f_1} - \lambda p_f = 0$

iii) $\breve{w}_1 + \delta p_f f_0 - p_f f_1 - p_x x_1 = 0$

Proposition 2 (i):

$$\frac{\partial f_1}{\partial \breve{w}_1} = \frac{\left(p_f^2 \dfrac{\partial u^2(x_1)}{\partial x_1^{\;2}} \right)}{p_f \left(p_x^2 \left(\dfrac{\partial u^2(x_1)}{\partial x_1^{\;2}} + \delta^2 \left(\pi_{h|h} \dfrac{\partial u^2(\breve{w}_2 + \delta f_1)}{\partial f_1^{\;2}} + (1-\pi_{h|h}) \dfrac{\partial u^2(\hat{w}_2 + \delta f_1)}{\partial f_1^{\;2}} \right) \right) \right)}$$

where $\dfrac{\partial f_1}{\partial \breve{w}_1} = \dfrac{(-)}{(-) + ((-) + (-))} = \dfrac{(-)}{(-)} > 0$.

Proposition 2 (ii):

$$\frac{\partial f_1}{\partial \breve{w}_2} = -\frac{\left(\pi_{h|h} p_x^2 \delta \frac{\partial u^2(\breve{w}_2 + \delta f_1)}{\partial f_1^{\,2}}\right)}{p_f\left(p_x^2\left(\frac{\partial u^2(x_1)}{\partial x_1^{\,2}} + \delta^2\left(\pi_{h|h}\frac{\partial u^2(\breve{w}_2 + \delta f_1)}{\partial f_1^{\,2}} + (1-\pi_{h|h})\frac{\partial u^2(\hat{w}_2 + \delta f_1)}{\partial f_1^{\,2}}\right)\right)\right)}$$

where $\frac{\partial f_1}{\partial \breve{w}_2} = -\frac{(-)}{(-)+\left((-)+(-)\right)} = -\frac{(-)}{(-)} < 0$

and

$$\frac{\partial f_1}{\partial \hat{w}_2} = -\frac{\left((1-\pi_{h|h}) p_x^2 \delta \frac{\partial u^2(\hat{w}_2 + \delta f_1)}{\partial f_1^{\,2}}\right)}{p_f\left(p_x^2\left(\frac{\partial u^2(x_1)}{\partial x_1^{\,2}} + \delta^2\left(\pi_{h|h}\frac{\partial u^2(\breve{w}_2 + \delta f_1)}{\partial f_1^{\,2}} + (1-\pi_{h|h})\frac{\partial u^2(\hat{w}_2 + \delta f_1)}{\partial f_1^{\,2}}\right)\right)\right)}$$

where $\frac{\partial f_1}{\partial \hat{w}_2} = -\frac{(-)}{(-)+\left((-)+(-)\right)} = -\frac{(-)}{(-)} < 0$.

Proposition 2 (iii):

$$\frac{\partial f_1}{\partial \pi_{h|h}} = -\frac{p_x^2 \delta\left(\frac{\partial u(\breve{w}_2 + \delta f_1)}{\partial f_1} - \frac{\partial u(\hat{w}_2 + \delta f_1)}{\partial f_1}\right)}{\left(p_f^2\frac{\partial u^2(x_1)}{\partial x_1^{\,2}} + p_x^2\delta^2\left(\pi_{h|h}\frac{\partial u^2(\breve{w}_2 + \delta f_1)}{\partial f_1^{\,2}} + (1-\pi_{h|h})\frac{\partial u^2(\hat{w}_2 + \delta f_1)}{\partial f_1^{\,2}}\right)\right)}$$

Because $u(\breve{w}_2 + \delta f_1) > u(\hat{w}_2 + \delta f)$, it follows that $\frac{\partial u(\breve{w}_2 + \delta f)}{\partial f_1} < \frac{\partial u(\hat{w}_2 + \delta f)}{\partial f_1}$.

Consequently, $\frac{\partial f_1}{\partial \pi_{h|h}} = -\frac{((+)-(+))}{(-)+((-)+(-))} = -\frac{(-)}{(-)} < 0$.

Corollary 1:

Consider two problems, one with an objective function, p, which is the true probability of high wage, and another with, sp, which is the subjective probability of high wage and represents the perceived probability of future security. Assume that an individual incorrectly perceives the probability of security to be lower than it actually is: $sp < p$. It follows that because an evolutionary mismatch exists ($\frac{\partial f_1}{\partial sp} > \frac{\partial f_1}{\partial p}$) individuals incorrectly gain weight when their perceptions of future income are incorrectly too low.

Optimization Problem for Self-Insurance/Health Insurance Model:

$$\max_{x_1, f_1} u(x_1, h(f_1, i)) + \pi_{h|h}(i)u(\breve{w}_2 + \delta f_1, h(f_2, i)) + (1-\pi_{h|h}(i))u(\widehat{w}_2 + \delta f_1, h(f_2, i))$$

subject to:

$$\breve{w}_1 + p_f \delta f_0 \geq p_x x_1 + p_f f_1$$

First order conditions are:

a) $\frac{\partial u(x_1, h(\cdot))}{\partial x_1} - \lambda p_x = 0$

b) $\frac{\partial u(x_1, h(\cdot))}{\partial h(\cdot)} \frac{\partial h(\cdot)}{\partial f_1} + \pi_{h|h}(i)\delta \frac{\partial u(\breve{w}_2)}{\partial f_1} + \delta(1-\pi_{h|h}(i)) \frac{\partial u(\widehat{w}_2)}{\partial f_1} - \lambda p_f = 0$

c) $\breve{w}_1 + \delta p_f f_0 - p_f f_1 - p_x x_1 = 0$

Proposition 3 (i):

$$\frac{\partial f_1}{\partial \breve{w}_1} = \frac{\left(p_f \frac{\partial^2 u(x_1, h(\cdot))}{\partial x_1^{\,2}} \right)}{\left(p_x^{\,2} \left(\delta^2 \left(\pi_{h|h}(i) \frac{\partial^2 u(\breve{w}_2)}{\partial f_1^{\,2}} + (1-\pi_{h|h}(i)) \frac{\partial^2 u(\hat{w}_2)}{\partial f_1^{\,2}} \right) + \frac{\partial^2 u(x_1, h(\cdot))}{\partial h^2} \left(\frac{\partial h}{\partial f_1} \right)^2 + \frac{\partial u(x_1, h(\cdot))}{\partial h} \frac{\partial^2 h}{\partial f_1^{\,2}} \right) + p_f^{\,2} \frac{\partial^2 u(x_1, h(\cdot))}{\partial x_1^{\,2}} \right)}$$

Definition 1: $\left(\frac{\partial h}{\partial f_1} \right)^2 = (-)^2 = (+)$

$$\frac{\partial f_1}{\partial \breve{w}_1} = \frac{(-)}{\Big(\big(((-)+(-))+(-)+(-)\big)+(-)\Big)} = \frac{(-)}{(-)} > 0 \quad .$$

Proposition 3 (ii):

$$\frac{\partial f_1}{\partial \breve{w}_2} = \frac{-\left(p_x^2 \delta \pi_{h|h}(i) \frac{\partial^2 u(\breve{w}_2)}{\partial f_1^{\,2}} \right)}{\left(p_x^{\,2} \left(\delta^2 \left(\pi_{h|h}(i) \frac{\partial^2 u(\breve{w}_2)}{\partial f_1^{\,2}} + (1-\pi_{h|h}(i)) \frac{\partial^2 u(\hat{w}_2)}{\partial f_1^{\,2}} \right) + \frac{\partial^2 u(x_1, h(\cdot))}{\partial h^2} \left(\frac{\partial h}{\partial f_1} \right)^2 + \frac{\partial u(x_1, h(\cdot))}{\partial h} \frac{\partial^2 h}{\partial f_1^{\,2}} \right) + p_f^{\,2} \frac{\partial^2 u(x_1, h(\cdot))}{\partial x_1^{\,2}} \right)}$$

by Definition 1:

$$\frac{\partial f_1}{\partial \breve{w}_2} = \frac{-\big((-)\big)}{\Big(\big(((-)+(-))+(-)+(-)\big)+(-)\Big)} = \frac{-(-)}{(-)} < 0$$

and

$$\frac{\partial f_1}{\partial \hat{w}_2} = \frac{-\left(p_x^2 \delta (1-\pi_{h|h}(i)) \frac{\partial^2 u(\hat{w}_2)}{\partial f_1^{\,2}} \right)}{\left(p_x^{\,2} \left(\delta^2 \left(\pi_{h|h}(i) \frac{\partial^2 u(\breve{w}_2)}{\partial f_1^{\,2}} + (1-\pi_{h|h}(i)) \frac{\partial^2 u(\hat{w}_2)}{\partial f_1^{\,2}} \right) + \frac{\partial^2 u(x_1, h(\cdot))}{\partial h^2} \left(\frac{\partial h}{\partial f_1} \right)^2 + \frac{\partial u(x_1, h(\cdot))}{\partial h} \frac{\partial^2 h}{\partial f_1^{\,2}} \right) + p_f^{\,2} \frac{\partial^2 u(x_1, h(\cdot))}{\partial x_1^{\,2}} \right)}$$

by Definition 1:

$$\frac{\partial f_1}{\partial \hat{w}_2} = \frac{-((-))}{\left(\left(\left((-)+(-)\right)+(-)+(-)\right)+(-)\right)} = \frac{-(-)}{(-)} < 0\,.$$

Proposition 3 (iii):

$$\frac{\partial f_1}{\partial \pi_{h|h}(i)} = \frac{-\left(p_x^2\delta\left(\frac{\partial u(\breve{w}_2)}{\partial f_1} - \frac{\partial u(\hat{w}_2)}{\partial f_1}\right)\right)}{\left(p_x{}^2\left(\delta^2\left(\pi_{h|h}(i)\frac{\partial^2 u(\breve{w}_2)}{\partial f_1{}^2} + (1-\pi_{h|h}(i))\frac{\partial^2 u(\hat{w}_2)}{\partial f_1{}^2}\right) + \frac{\partial^2 u(x_1,h(\cdot))}{\partial h^2}\left(\frac{\partial h}{\partial f_1}\right)^2 + \frac{\partial u(x_1,h(\cdot))}{\partial h}\frac{\partial^2 h}{\partial f_1{}^2}\right) + p_f{}^2\frac{\partial^2 u(x_1,h(\cdot))}{\partial x_1{}^2}\right)}$$

Because $u(\breve{w}_2) > u(\hat{w}_2)$, then $\frac{\partial u(\breve{w}_2)}{\partial f_1} < \frac{\partial u(\hat{w}_2)}{\partial f_1}$, also by Definition 1 it follows that:

$$\frac{\partial f_1}{\partial \pi_{h|h}} = \frac{-\left((+)-(+)\right)}{\left(\left(\left((-)+(-)\right)+(-)+(-)\right)+(-)\right)} = \frac{-(-)}{(-)} < 0 \quad .$$

Proposition 3 (iv):

Because we are looking at simultaneous changes in high or low income (in period one and two) we omit subscripts from the income variable. The rest of the objective function is the same.

High Wage in Period One

Objective Function:

$$\max_{x_1, f_1} u(x_1, h(f_1, i)) + \pi_{h|h}(i)u(\breve{w} + \delta f_1, h(f_2, i)) + (1-\pi_{h|h}(i))u(\hat{w} + \delta f_1, h(f_2, i))$$

subject to:

$$\breve{w} + p_f\delta f_0 \geq p_x x_1 + p_f f_1,$$

with the following FOCs:

a.1) $\frac{\partial u(x_1, h(\cdot))}{\partial x_1} - \lambda p_x = 0$

b.1) $\frac{\partial u(x_1,h(\cdot))}{\partial h}\frac{\partial h}{\partial f_1}+\pi_{h|h}(i)\delta\frac{\partial u(\breve{w})}{\partial f_1}+\delta(1-\pi_{h|h}(i))\frac{\partial u(\hat{w})}{\partial f_1}-\lambda p_f=0$

c.1) $\breve{w}+\delta p_f f_0-p_f f_1-p_x x_1=0$

Comparative statics on a.1), b.1) and c.1) yield the following result:

$$\frac{\partial f_1}{\partial \breve{w}}=\frac{-\left(p_x^2\delta\pi_{h|h}(i)\frac{\partial^2 u(\breve{w})}{\partial f_1^{\,2}}-p_f\frac{\partial^2 u(x_1,h(\cdot))}{\partial x_1^{\,2}}\right)}{\left(p_x^{\,2}\left(\delta^2\left(\pi_{h|h}(i)\frac{\partial^2 u(\breve{w})}{\partial f_1^{\,2}}+(1-\pi_{h|h}(i))\frac{\partial^2 u(\hat{w})}{\partial f_1^{\,2}}\right)+\frac{\partial^2 u(x_1,h(\cdot))}{\partial h^2}\left(\frac{\partial h}{\partial f_1}\right)^2+\frac{\partial u(x_1,h(\cdot))}{\partial h}\frac{\partial^2 h}{\partial f_1^{\,2}}\right)+p_f^{\,2}\frac{\partial^2 u(x_1,h(\cdot))}{\partial x_1^{\,2}}\right)}$$

where $\frac{\partial f_1}{\partial \breve{w}}=\frac{-((-)-(-))}{(((({-})+(-))+(-)+(-))+(-))}=\frac{ambiguous}{(-)}$

$\frac{\partial f_1}{\partial \breve{w}}$ is ambiguous because it is unclear whether $p_x^2\delta\pi_{h|h}(i)\frac{\partial^2 u(\breve{w})}{\partial f_1^{\,2}}>p_f\frac{\partial^2 u(x_1)}{\partial x_1^{\,2}}$.

Low Wage in Period One

Objective Function:

$$\max_{x_1,f_1} u(x_1,h(f_1,i))+\pi_{h|h}(i)u(\breve{w}+\delta f_1,h(f_2,i))+(1-\pi_{h|h},(i))u(\hat{w}+\delta f_1,h(f_2,i))$$

subject to:

$\hat{w}+p_f\delta f_0\geq p_x x_1+p_f f_1,$

with the following FOCs:

a.2) $\frac{\partial u(x_1,h(\cdot))}{\partial x_1}-\lambda p_x=0$

b.2) $\frac{\partial u(x_1,h(\cdot))}{\partial h}\frac{\partial h}{\partial f_1}+\pi_{h|h}(i)\delta\frac{\partial u(\breve{w})}{\partial f_1}+\delta(1-\pi_{h|h}(i))\frac{\partial u(\hat{w})}{\partial f_1}-\lambda p_f=0$

c.2) $\hat{w}+\delta p_f f_0-p_f f_1-p_x x_1=0$

Comparative statics on a.2), b.2) and c.2) yield the following result:

$$\frac{\partial f_1}{\partial \widehat{w}} = \frac{-\left(p_x^2 \delta \pi_{h|l}(i) \frac{\partial^2 u(\widehat{w})}{\partial f_1{}^2} - p_f \frac{\partial^2 u(x_1, h(\cdot))}{\partial x_1{}^2}\right)}{\left(p_x{}^2 \left(\delta^2 \left(\pi_{h|h}(i) \frac{\partial^2 u(\breve{w})}{\partial f_1{}^2} + (1-\pi_{h|h}(i)) \frac{\partial^2 u(\widehat{w})}{\partial f_1{}^2}\right) + \frac{\partial^2 u(x_1, h(\cdot))}{\partial h^2}\left(\frac{\partial h}{\partial f_1}\right)^2 + \frac{\partial u(x_1, h(\cdot))}{\partial h}\frac{\partial^2 h}{\partial f_1{}^2}\right) + p_f{}^2 \frac{\partial^2 u(x_1, h(\cdot))}{\partial x_1{}^2}\right)}$$

where $\frac{\partial f_1}{\partial \widehat{w}} = \frac{-((-)-(-))}{\left(\left(\left((-)+(-)\right)+(-)+(-)\right)+(-)\right)} = \frac{ambiguous}{(-)}$

$\frac{\partial f_1}{\partial \widehat{w}}$ is ambiguous because it is unclear whether $p_x^2 \delta \pi_{h|l}(i) \frac{\partial^2 u(\widehat{w})}{\partial f_1{}^2} > p_f \frac{\partial^2 u(x_1)}{\partial x_1{}^2}$.

Proposition 3 (v):

$$\frac{\partial f_1}{\partial i} = \frac{-\left(p_x{}^2\left(\delta \frac{\partial \pi_{h|h}(i)}{\partial i}\left(\frac{\partial u(\breve{w}_2)}{\partial f_1} - \frac{\partial u(\widehat{w}_2)}{\partial f_1}\right) + \frac{\partial h}{\partial i}\frac{\partial^2 u(x_1, h(\cdot))}{\partial h^2}\frac{\partial h}{\partial f_1}\right)\right)}{\left(p_x{}^2 \left(\delta^2 \left(\pi_{h|h}(i) \frac{\partial^2 u(\breve{w}_2)}{\partial f_1{}^2} + (1-\pi_{h|h}(i)) \frac{\partial^2 u(\widehat{w}_2)}{\partial f_1{}^2}\right) + \frac{\partial^2 u(x_1, h(\cdot))}{\partial h^2}\left(\frac{\partial h}{\partial f_1}\right)^2 + \frac{\partial u(x_1, h(\cdot))}{\partial h}\frac{\partial^2 h}{\partial f_1{}^2}\right) + p_f{}^2 \frac{\partial^2 u(x_1, h(\cdot))}{\partial x_1{}^2}\right)}$$

where $\frac{\partial f_1}{\partial i} = \frac{-\left(\left((+)-(+)\right)+(+)\right)}{\left(\left(\left((-)+(-)\right)+(-)+(-)\right)+(-)\right)} = \frac{ambiguous}{(-)}$,

$\frac{\partial f_1}{\partial i}$ is ambiguous because $\delta \frac{\partial \pi_{h|h}(i)}{\partial i}\left(\frac{\partial u(\breve{w}_2)}{\partial f_1} - \frac{\partial u(\widehat{w}_2)}{\partial f_1}\right) < 0$, and $\frac{\partial h}{\partial i}\frac{\partial^2 u(x_1, h(\cdot))}{\partial h^2}\frac{\partial h}{\partial f_1} > 0$,

however, it remains unclear whether $\delta \frac{\partial \pi_{h|h}(i)}{\partial i}\left(\frac{\partial u(\breve{w}_2)}{\partial f_1} - \frac{\partial u(\widehat{w}_2)}{\partial f_1}\right) > \frac{\partial h}{\partial i}\frac{\partial^2 u(x_1, h(\cdot))}{\partial h^2}\frac{\partial h}{\partial f_1}\frac{\partial f_1}{\partial i}$.

Corollary 2:

See proof for Corollary 1A.

CHAPTER FOUR

FRIENDS (WITH MONEY) DON'T LET FRIENDS GET FAT—A THEORETICAL AND EMPIRICAL ANALYSIS OF HOUSEHOLD WORKERS AND WEIGHT GAIN

Introduction

Many economic theories exist for the prevalence of obesity in modern society. Increased obesity rates have been associated with a number of causes including: an increase in sedentary lifestyles (Lakdawalla and Philipson 2002), increases in the relative price of living a healthy lifestyle (Cutler *et al*. 2003 and Ruhm 2000 and 2005),[27] reductions in the relative price of food (Chou *et al*. 2003) as well as reductions in the price of high calorie density foods (Martin and Ferris 2005 and Drewnowski and Specter 2004), and economic insecurity (Smith *et al*. 2007 and Barnes and Smith 2008). These theories suggest that income, relative prices, and financial risk influence changes in weight, they also suggest that weight gain should accompany not only the economically challenged, but the well to do as well.[28]

Many economic determinants of obesity, however, remain largely unexplored. In this paper we study the effect of household composition—roughly defined as the number of workers and non-workers in the home—on individual weight. Although several papers in

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[27] Producing healthy food and exercising takes time, while consuming high caloric type foods can be either prepared quickly at home or purchased outside the home with little time costs to the individual.

[28] The high time costs that accompany eating healthy foods and exercising suggest that wealthy individuals should gain weight because they are less likely to consume activities that have a relatively high time cost. On the other hand, poor individuals are also more likely to gain weight because their budget constraint limits their dietary consumption to high caloric foods.

the fields of sociology, medicine, epidemiology, and economics address the effects of social networks outside the home on obesity (Christakis and Fowler 2007, Halliday and Kwak 2007, Holtgrave and Crosby 2005, Costa-Font and Gil 2004 and Burk and Heiland 2007), we are the first to analyze the effects of household composition on weight.

Three of the effects already recognized as causes of weight gain (financial risk, income, and both relative and actual costs) appear to be the mechanisms through which household composition affects weight. In the pages that follow we present findings from previous research that establishes the role of these three effects in influencing the relationship between household composition and changes in weight. After a brief discussion on these topics we develop a theoretical model to analyze these effects, followed by an empirical analysis.

Background

Recent obesity research demonstrates that social networks and obesity are both positively *and* negatively correlated. Christakis and Fowler (2007) purport that obesity spreads through networks over time with epidemic like characteristics, and that individuals tend to cluster socially based on weight, exerting a force on adjacent social contacts resulting in the spread of obesity.[29] They suggest that this network phenomenon is influenced by behavioral traits—unobservable personal characteristics (including time preferences and economic insecurity) common to individuals in the group may be one of the behavioral traits driving this network phenomenon. That obesity would spread through social contacts because of shared interests or behaviors is of little doubt. Conversely, Holtgrave and Crosby (2005), Costa-Font and Gil (2004), and Burk and Heiland (2007) argue that social networks and weight are negatively correlated. They propose that peer networks exert a pressure on those within the network to stay thin, resulting in weight loss. The fact that correlation between social networks and weight is shown to go both ways implies that no single determinant decides this relationship, instead it is likely affected by various factors including the composition of the network. Previous research identifies risk, income, and time costs as likely determinants of this relationship. We discuss evidence of these determinants in the following paragraphs.

Substantial evidence suggests that social networks (including those within the home) play an important role in regulating financial security through risk sharing and income pooling (Dekker 2004, Hayashi *et al*. 1996, and Altonji *et al*. 1992). In fact, social networks significantly decrease the likelihood of a household evaluating its food, economic, and housing conditions as vulnerable (Dershem and Gzirishvili 1998). Extended households are often formed to cope with the destructive consequences of poverty (Tienda and Angel 1982) and to buffer against the economic effects of labor market disadvantages (Angel and Tienda 1982). One way to buffer against labor market disadvantages, or labor lost to illness, is through intra-household labor substitution where large households with more workers can compensate for lost income (Sauerborn *et al*. 1996). Because changes in household composition often accompany entry or exit into poverty and unemployment within the home (Jenkins and Schulter 2003 and McKernan and Ratcliffe 2005) there is no doubt that household composition plays a decisive role in combating adverse economic shocks. In so doing, household composition is seen as one form of risk management. Previous economic theory (Smith *et al*. 2007 and Barnes and Smith 2008) would suggest

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[29] These findings are brought into question by Halliday and Kwak (2007) who suggest that if this correlation exists, it is weak at best. Halliday and Kwak address endogeneity issues related to this relationship.

that the added security that accompanies additional household workers would have a negative effect on weight. This implies that households with more workers would enjoy greater levels of security and accordingly would correspond to lower levels of weight.

The mere presence of additional household members however, says little about their contribution to financial security in the home. Dependents (defined as members of the home that do not contribute financially or otherwise) are predicted to have a very different effect on weight than workers. Musgrove (1980) finds that the number of dependents in the home affects whether households may be poor. Smith *et al*. (2007) find that the probability of falling below the poverty level has a positive effect on weight. Households with more dependents are expected to have the opposite effect on weight than households with additional workers, as increasing the number of dependents appears to correspond to decreased economic security as well as decreased income.

The final characteristic vital to this relationship is that of increased production within the home. Dovie *et al*. (2005) find that a positive correlation exists between the number of people in the home and the amount of "goods" produced. One of the "goods" produced in the home may be healthy food. Additional members in the home—by participating in the preparation and cooking of healthy food—decrease the relative price of eating healthy, and are expected to have a negative effect on weight (Cutler *et al*. 2003).

Each element of the social network in the home just discussed appears to play an important role in regulating weight through risk management, income effects, and decreasing the relative price of eating healthy. While it appears that workers decrease risk within the home and would presumably have a negative effect on weight (Smith *et al.* 2007), the effect of non-workers remains unclear—as non-workers could be either contributors or dependents. The relationship between social networks and obesity is not one of mere correlations, instead it appears to be driven by several distinct factors related to the composition of the home. In the following section we develop a theoretical model to analyze the effects of different aspects of household composition on weight.

Theory

In a previous paper we motivated the idea that weight gain is a type of precautionary savings and that individuals gain weight (perhaps subconsciously) to survive periods of food shortages, as demonstrated by examples from behavioral ecology (Barnes and Smith 2008). We use a similar theoretical model in this paper to analyze the effect of increasing workers, dependents, and contributors on weight.

Consider a two-period, two-state model where the consumer considers the current and following period when maximizing utility. Suppose a risk-averse consumer will receive either high ($\breve{w}_2$) or low ($\hat{w}_2$) income in period two. Furthermore, he chooses first-period consumption of body fat (f_1) and other goods (x_1) such that he maximizes the sum of expected lifetime utility. The consumer's first-period decision is:

$$\max_{x_1, f_1} u(x_1) + \pi u(\breve{w}_2 + \delta f_1) + (1-\pi)u(\hat{w}_2 + \delta f_1) = \max_{x_1, f_1} u(x_1, f_1) \quad (1)$$

subject to:

$$w_1 + p_f \delta f_0 \geq p_x x_1 + p_f f_1$$

Where $u(\cdot)$ is a twice differentiable, increasing, strictly concave function (*i.e.*, $u'(\cdot) > 0$ and $u''(\cdot) < 0$), f_0 is an endowment of fat, w_1 is first period income, π is the probability of high income in period two, $\delta \in (0,1)$ is the metabolic energy depreciation factor when stored as body fat, and p_f and p_x are prices for fat and other goods. Period one wealth is $w_1 + p_f \delta f_0$, where $p_f \delta f_0$ is the value of the discounted fat endowment. Fat purchased in period one enters the utility function as a form of savings in period two.

To analyze the effect of increasing the number of workers in the home on weight we compare the expected utility function for individual *i* in the second period, $E(u(\tilde{w}_2 + \delta f_1))$, for *n* and *n-1* workers. Where $E(u(\tilde{w}_2 + \delta f_1)) = u(x_1, f_1) - u(x_1)$ and $\tilde{w}_2$ is a random variable representing period two income, either high ($\breve{w}_2$) or low ($\hat{w}_2$). In order to perform this analysis we make three formal assumptions:

Assumption 1: The realization of the random variable, period two income $(\tilde{w}_2)$, is independent across workers.

Assumption 2: Each worker faces the same probability of high income in period two (*i.e.*, $\pi_j = \pi_k$ for worker *j* and *k*).

Assumption 3: The *n* workers in the home pool income equally.

Given these three assumptions, the second period expected utility function for an individual with *n* workers in the home pooling income equally is found using the following expressions:

When *n* is odd $E(u(\tilde{w}_2 + \delta f_1))$ equals:

$$\sum_{i=0}^{\frac{n-1}{2}}\left(\frac{n!}{(n-i)!i!}\left[(1-\pi)^{n-i}\pi^{i}u\left(\frac{(n-i)\hat{w}_2+(i)\breve{w}_2}{n}+\delta f_1\right)\right]+\frac{n!}{(n-i)!i!}\left[(1-\pi)^{i}\pi^{n-i}u\left(\frac{(i)\hat{w}_2+(n-i)\breve{w}_2}{n}+\delta f_1\right)\right]\right) \tag{2}$$

When *n* is even $E(u(\tilde{w}_2 + \delta f_1))$ equals:

$$\sum_{i=0}^{\frac{n-2}{2}}\left(\frac{n!}{(n-i)!i!}\left[(1-\pi)^{n-i}\pi^{i}u\left(\frac{(n-i)\hat{w}_2+(i)\breve{w}_2}{n}+\delta f_1\right)\right]+\frac{n!}{(n-i)!i!}\left[(1-\pi)^{i}\pi^{n-i}u\left(\frac{(i)\hat{w}_2+(n-i)\breve{w}_2}{n}+\delta f_1\right)\right]\right)$$
$$+\left(\frac{n!}{(n-i)!i!}\left[(1-\pi)^{n-i}\pi^{i}u\left(\frac{(n-i)\hat{w}_2+(i)\breve{w}_2}{n}+\delta f_1\right)\right]\right)\Bigg|_{i=\left(\frac{n-2}{2}+1\right)} \tag{3}$$

Let *E(u(n))* and *E(u(n-1))* represent the second period expected utility function for individual *i* with *n* and *n-1* workers in the home. Given the second period distribution of income and holding x_1 constant for *n* and *n-1* workers the marginal rate of substitution for "other goods" and "fat" for individual *i* in the first period $\left(\frac{u(x_1, f_1)_{x_1}}{u(x_1, f_1)_{f_1}}\right)$ is greater (steeper) for *n* workers than for *n-1* workers because the marginal utility of "fat" is smaller for *E(u(n))* than it is for *E(u(n-1))*, while the marginal utility of "other goods" is the same for the two, leading us to our Proposition 1.

Proposition 1: Given Assumptions 1-3, increasing the number of workers in the home decreases current weight for the consumer.

See Appendix A for a proof.

Increasing the number of dependents in the home in both periods is analogous to decreasing current and future income because the consumer has less income for himself as he distributes it with more people in the home. Proposition 3 (iv) in Barnes and Smith (2008) indicates that decreasing current and future income has an ambiguous effect on current weight because lower current income decreases the budget constraint resulting in weight loss, while decreasing future income increases insecurity, resulting in weight gain. It is unclear, however, which effect dominates, implying that increasing the number of dependents in the home has an ambiguous effect on weight.

To analyze the effect of increasing the number of contributors (or producers) in the home it is necessary to consider the effects of changes in both actual and relative costs on weight. We first analyze the effect of relative costs by observing the impact of decreasing the relative price of eating healthy. Contributors decrease the relative price of eating healthy within the home by preparing and cooking healthy food—something that takes time.

Increasing the relative price of eating healthy (x_1) has an ambiguous effect on weight:[30]

$$\frac{\partial f_1}{\partial p_x} = \frac{p_f^2 u''(x_1)\left(-p_x \lambda - x_1 u''(x_1)\right)}{p_f u''(x_1)\left[p_f^2 u''(x_1) + p_x^2\left(\pi\delta^2 u''(\breve{w}_2 + \delta f_1\right) + (1-\pi)\delta^2 u''(\hat{w}_2 + \delta f_1)\right]} \qquad (4)$$

This effect is ambiguous because it is unclear whether the sign of the numerator is positive or negative, while the denominator is unambiguously negative. The numerator consists of two effects working in opposite directions, a substitution effect and an income effect. The substitution effect $(-p_x \lambda)$ emits a positive effect on current weight, while the income effect $\left(-x_1 u''(x_1)\right)$ emits a negative effect on current weight. If the substitution effect of increasing the price of eating healthy outweighs the income effect, then increasing the price of eating healthy increases current weight—Cutler *et al*.'s (2003) argument for increased obesity rates. Conversely, given that the substitution effect outweighs the income effect, decreasing the relative price of eating healthy decreases current weight. It is also important, however, to consider the actual costs associated with having relatively less workers per person in the home as the number of contributors increase. Such a relationship would result in fewer resources to buy healthy food and although contributors have the time to prepare healthy foods they might not have the resources to buy the food. However, given the resources to purchase healthy food is sufficiently large, increasing the number of contributors in the home will only be a function of the decreased time costs associated with eating healthy. Because it is unclear which of the several effects dominate the net effect of contributors on weight is unclear.

These findings confirm that risk, income, and relative and actual prices are the mechanisms through which workers, dependents, and contributors affect weight. They also suggest that increasing the number of workers decreases weight, yet the effect of

[30] See Appendix A for a proof.

dependents and contributors on weight is unclear. In the following section we estimate the magnitudes of these effects.

Empirical Analysis

In this section we develop an empirical model to estimate the effects of various measures of household composition and other individual-level measures on weight. We begin by presenting our model, followed by a discussion on the estimation procedure and the data, and end with a discussion of our results.

Empirical Model

A linear regression model is used to estimate the effects of household composition and other individual, demographic, and regional variables on weight:

$$W_{2000,ij} = HHC_{2000,ij}\beta + X_{t,ij}\alpha + \eta_j + \sigma_{ij}$$

where $W_{t,ij}$ is individual *i*'s weight in year *t*, $HHC_{2000,ij}$ is a measure of household composition in the home of individual *i*, $X_{t,ij}$ is a vector of individual characteristics for respondent *i* in year *t*, η_j is a regional fixed effect for region *j*, and σ_{ij} is a disturbance term for individual *i*. Because the data implemented in this model is cross-sectional the estimate of the effects of household composition on weight in 2000 can be considered as the effect of differences across individuals on weight, controlling for the remaining variables. Measures of household composition and individual characteristics are explained in greater detail in the data section.

Estimation Procedure

Two approaches are used to estimate the linear model. The first approach is ordinary least squares (OLS). These results however, will be biased if weight is endogenously related to the independent variables, i.e., $E(\sigma_{ij}| X) \neq 0$. Reverse causality and unobservable personal characteristics that are correlated with body weight are two causes of endogeneity in our model. Reverse causation is present when weight exerts an influence on one of the right hand side variables. Cawley (2004), for example, finds that higher weights for women correspond to lowers wages. If true, the OLS estimate of wages not only includes the effect of wages on weight, but the effect of weight on wages as well, making the estimate upward biased. Bias relating to unobservable personal characteristics is present when weight gain is endogenously related to a right hand side variable. It could be, for example, that an individual who suffers from economic insecurity will gain weight, while simultaneously inviting others to live with him in an attempt to alleviate the effects of financial insecurity. In this case the estimate, β, incorrectly includes the effect of the latent variable "economic insecurity" and does not represent the unbiased, causal effect of household composition on weight. Such is the case with many possible scenarios in our data.

We correct for endogeneity bias in two ways. We do so by first including weight in 1994 in the model. Including 1994 weight in the model controls for permanent unobservable characteristics unique to the individual as well as pre-1994 economic insecurity that may introduce bias into the estimates. 1994 weight is used because it allows us to examine the effects of household composition and other individual-level measures on changes in weight over a six-year time span. 1994 is chosen over 1999 (or an earlier date) because there is less error in a long-term specification than a short-term specification and 1994 is the most recent year that is not included in any of the measurements used in our regression. Controlling for 1994 weight, however, does not eliminate bias occurring from events after 1994, nor for personal characteristics that change over time.

In order to correct for endogeneity related to these issues we implement a second estimation technique, instrumental variables (IV). This procedure uses a two-stage estimation process in which endogenous variables are regressed on instruments in the first stage; weight is then regressed in the second stage on the predicted values for the endogenous variables generated in the first stage regression, as well as all exogenous right hand side variables. The generalized method of moments (GMM) estimator is used in the IV approach. The GMM estimator is implemented because first, it is more efficient than the IV estimator given heteroskedasticity, and second, because the equations are over identified (we use more instruments than there are endogenous variables) the GMM approach allows us to test the validity of our instruments.

For the instruments to be valid they must be: 1) highly correlated with the endogenous RHS variable of interest, 2) exogenous to the errors, and 3) correctly excluded from the equation (i.e., have no independent effects on weight). To test whether the instruments are highly correlated with the endogenous variables a test of instrument relevance is performed, also known as a weak instruments test. This test makes use of the Kleibergen-Paap rk LM statistic (Kleibergen Paap 2006), where the null hypothesis is that the model is under-identified, or that the smallest canonical correlation between the linear combinations of the independent variables and the instruments is zero. Rejecting the test statistic indicates that the instruments are valid, as they pass the weak instruments test. The Hansen J-statistic (Hansen 1982), which is found by evaluating the GMM criterion function at the efficient GMM estimator has a chi-square distribution with degrees of freedom equal to the number of excluded instruments minus endogenous variables, is a joint test of the final two requirements: exogeneity of the instrument and correct model specification (the instruments are justly excluded). In this case, rejecting the null hypothesis indicates that the instruments do not satisfy the orthogonality conditions. Failing to reject the null hypothesis suggests that there is not substantial evidence to suggest that the instruments are not exogenous or incorrectly excluded, and we conclude that the instruments are valid according to the criteria of exogeneity and exclusion. To ensure that our instruments are valid we use state and MSA-level variables whenever possible. Our instruments are discussed in greater details in the data and results sections.

Data

The data used in our analysis comes from the National Longitudinal Survey of Youth, Cohort 1979 (NLSY79) survey. This longitudinal survey follows 12,686 individuals born between 1957 and 1964. It is administered annually until 1993, and biennially since then. Although our study incorporates data from 1994-2000 the analysis is cross-sectional in nature. The nature of the dataset allows a comprehensive study of different measures of household composition for the respondent in 2000 as well as their personal experience with unemployment over the five-year period previous to 2000, and other individual level data.

Although women are included as members of the household in our analysis they are not included as the measure of observation (the dependent variable) because the women in our sample are ages 29-42, peak child bearing years. Because these are the peak child bearing years women’s weight may not be easily explained by measures of household composition or other individual-level data. Fertility decisions may also be related to the economic security they face.

Several individual-level variables, which are expected to play a role in determining weight, are included in the regression. They are: 1994 weight,[31] height in 1985,[32] height

[31] NLSY79 uses reported weights. We correct for reporting error as Cawley (2004) does.

squared in 1985, various measure of unemployment, family income, age, race, marital status, years of schooling, a dummy variable indicating whether the respondent lives in a metropolitan area, and a dummy variable indicating whether the respondent smokes daily. Unless otherwise specified, variables are from 2000. Although these variables are expected to determine weight in 2000 they are primarily included as control variables. Specifically, height and height squared are both included as control variables. Including height and height squared on the right hand side of the equation is statistically equivalent to having body mass index $\left(\frac{wt(kg)}{ht^2(m)}\right)$ as the dependent variable. Three measures of unemployment are used, they are: the posterior probability of unemployment in 2000, a dummy variable indicating whether the individual was unemployed at the time of interview in 2000, and a dummy variable indicating whether the individual was unemployed at anytime in 2000. The posterior probability of unemployment is a proxy for an individual's perceived economic insecurity. This variable is formed using the last five years of unemployment history and represents an individual's perception of whether they will be unemployed the following year (see Smith *et al*. 2007). Previous findings suggest that higher levels of insecurity correspond to weight gain. Unemployed at the time of the survey and unemployed anytime during the year are included in the same specification and are expected to have two distinct effects on weight as they measure difference aspects of unemployment. An individual who is unemployed at the time of the survey likely has a relatively low price of healthy living because individuals that are not employed have more time to exercise and eat healthy and are expected to weigh less (Cutler *et al*. 2003 and Ruhm

[32] 1985 height is included because we don't have more recent reported measures of height. It is likely that most of the height growth occurs prior to 1985, as all respondents are at least 20 years old in 1985.

2000 and 2005). This variable is treated as exogenous as the particular day the individual is interviewed should not be related to unobservable personal characteristics. Unemployed anytime during the year, however, indicates whether the individual faces unemployment risk based on having been unemployed in the past year and is treated as endogenous. Individuals facing unemployment risk are expected to weigh more. Means and standard deviations for all the variables included in the analysis are presented formally in Tables 1a and 1b.

Our data includes several measures of household composition. As was explained earlier we propose that these measures play a role in risk management as well as decreasing the relative price of living healthy. The household composition variables include: a dummy variable indicating whether the individual lives with others, the number of workers in the home, the number of workers squared in the home, the number of non-workers in the home, the number of workers excluding the spouse, the number of non-workers excluding the spouse, the number of adult workers, the number of adult non-workers, the number of non-working children, the ratio of workers to non-workers, and the ratio of working adults to adults. Because we expect the effect of workers to be different than working adults and working spouses, several measures of similar variables are included in our analysis. Subsets of these variables are included in different estimation specifications because the same instruments are used to estimate various measures of household composition and including them in the same regression makes it impossible to identify the unbiased effects of these measures on weight. The different specifications also allow us to analyze and compare differences in the effects. Specifications with ratios as measures of household composition contain the same amount of information as other specifications but with greater efficiency because they contain less endogenous variables. Data limitations do not allow us the luxury of knowing whether workers actually pool income, or whether non-working adults contribute to household production and decrease the cost of eating healthy, or whether non-working children take on the traditional role of "dependents". Thus our estimates of household composition variables do not measure the effects of risk sharing or decreasing the relative price of eating healthy on weight, but rather measure the direct effects of specific measures of household composition on weight.

About 75% of the individuals in our analysis live with other people. The average weight for people that live with others is 198.1 pounds, compared to 194.1 for individuals that live alone. Nearly 61% of the people in our sample live with someone who works. The average weight of people that live with someone who works is 199.83 pounds, while 192.89 is the average weight of people that don't live with workers. The average number of workers in the home, in addition to the respondent is 0.749, with some homes having as many as five additional workers. The average number of workers in the sample for obese individuals is 0.816, while the average for non-obese people is 0.718. Furthermore, the average number of people in the home (in addition to the respondent) for obese people is 2.368, while the average for non-obese is 2.236. These statistics indicate that, on average, higher weights correspond to more workers and more people in the home. Without correcting for endogeneity these raw correlations incorrectly infer that increasing the number of workers in the home causes an gain weight, when in reality the relationship may be the other way around.

To further investigate the relationship between various measures of household composition and weight and economic security we analyze the Pearson Correlation Coefficients for these relationships. The correlation coefficients between changes in weight to changes in measures of household composition (including the number of workers in the home, the number of people in the home, and whether they live with someone) from 1998 to 2000 are less than 4%. The correlation coefficients between changes in unemployment and the same measures of household composition are 1% or less over the same time period. These statistics suggests that there is little statistical evidence that households invite additional workers (or non-workers) into the home to alleviate economic insecurity in the short term implying that any bias relating to this issue of endogeneity is likely very small.

Instruments

State- and MSA-level instruments are used whenever possible to ensure that the instruments are exogenous to the errors and that they do not have an independent effect on weight. Because it is not possible to use only state- or MSA-level instruments to identify the effect of various measures of household composition on weight, individual-level instruments are used as well. Although this approach is unconventional, the use of individual-level instruments allows us to estimate the (otherwise by un-estimable) unbiased effects of household composition on weight. Because many of the instruments for various measures of household composition include individual-level instruments caution must be used when interpreting these results. Our instruments are as follows: State median household income from the U.S. Census Bureau is used to estimate the causal effect of family income on weight. A series of local unemployment rates identify the causal effect of various measures of unemployment on weight. A series of cigarette taxes (as proposed by Gruber and Frakes 2006) are used to identify the individual effect of smoking on weight. County ethnicity percentages are used to estimate the causal effect of living with others on weight as evidence from sociology suggests that certain ethnicities are more likely to live together (Tienda and Angel 1982 and Angel and Tienda 1982). State median home prices from the U.S. Census Bureau, as well as the number of adults in the home are used to estimate the causal effect of various measures of workers in the home on weight. The number of children in the home is used to identify the effect of non-workers in the home. Although the choice to have kids may be dependent on unobservable personal characteristics and economic insecurity, the number of children in the home at any given time is arguably exogenous to economic insecurity. Finally, county ethnicity percentages and the number of children in the home are used to identify the effects of adult non-workers on weight because once again, evidence suggests that certain ethnicities are more likely to have more adults (e.g., grandparents and extended family members) in the home (Tienda and Angel 1982 and Angel and Tienda 1982). Tests for instrument validity are discussed in the results section.

Results

We perform regression analysis on several different specifications of household composition. Each specification addresses distinct issues related to the social network in the home. OLS results are presented in Tables 2a and 2b while IV results are presented in Tables 3a and 3b. Each column represents a different specification, which differs only in the variable(s) that are used to measure household composition and unemployment. Because the OLS estimates are biased we focus our discussion on the IV estimates.

The instruments appear to be exogenous to the error term as well as correctly excluded from the regression, as we fail to reject the Hansen J-Statistic in every specification. Results for this test are found in Table 4. Our instruments, however, fail to pass the weak instruments test implying that they may not be highly correlated with the endogenous variables. After experimenting with several different specifications we have identified smoking as the source of under-identification (with cigarette taxes as the instruments) in the final eight specifications, while family income is identified as the source of under-identification in the first specification, and smoking and live with others are the sources of under-identification in the second specification. Table 4 also reports the Kleibergen-Paap rk LM test statistics with corresponding p-values for regressions that treat the sources of under-identification as endogenous as well as the test statistics for the regressions where the sources of under-identification are treated as exogenous.[33] The regression results for the two are very similar in magnitude. We discuss the estimates for the specifications where the sources of under-identification are treated as endogenous. The fact that the estimates for most of our endogenous variables switch signs from the expected biased sign in the OLS regressions to the expected unbiased sign in the IV regression suggests that the instruments used are likely valid (Hahn and Hausman 2002). However, because multiple endogenous variables are used in each regression this may not necessarily be the case.

We begin our discussion of the regression results by focusing on the estimates for family income and the various measures of unemployment. Family income has a small, but significant effect (in most specifications) on weight. Increasing income by $1000 increases weight by anywhere between 0.04 and 0.06 pounds indicating that individuals are more likely to gain (not lose) weight as current income rises. Increasing an individual's perceived probability of unemployment by 0.01 increases weight by nearly a pound in some specifications. This result initially appears contradictory to Ruhm (2000 and 2005) who finds that employment rates and weight are positively related and suggests that the opportunity cost of time might be the cause of this relationship. Specification (1), however,

[33] The Hansen J-Statistic is not rejected in the specification where the sources of under-identification are treated as exogenous indicating that in both specifications the instruments are exogenous and properly

reconciles these findings as we see that being currently unemployed has a negative effect on weight (the time cost argument), while having been unemployed at anytime over the year has a positive effect on weight (the insecurity argument). These findings suggest that weight is a function of both time costs and economic insecurity, as previously established. They also relate directly to the relationship between various measures of household composition and weight as workers are expected to affect weight through an increased security effect and contributors are expected to affect weight through a decreased time cost effect. We now study the effects of these and other measures of household composition on weight.

Our first household specification, specification (2), seeks to address the issue of whether social networks in the home have a positive or negative effect on weight, if any. To address this issue we include a dummy variable indicating whether the respondent lives with others. IV results suggest that living with others has a negative effect on weight. In fact, switching from living alone to living with others decreases weight by over 12 pounds. We do not know whether these people are workers, non-workers, adults, or children, but we do know that living with others has a large negative effect on weight suggesting the importance of social networks in the home with regard to weight loss.

Specification (3) indicates that increasing the number of workers in the household by 1 person decreases weight by just over 3 pounds. We hypothesize that the increased security that accompanies more workers in the home is the mechanism fueling the negative relationship with weight. Household workers serve as a financial safety net as intra-household labor substitutions minimize the effects of adverse economic shocks caused by illness, job loss, or a number of other factors. It seems however, that a quadratic

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excluded.

relationship should exist between weight and the number of workers in the home. Workers then, would presumably have a negative effect on weight while workers squared would have a positive effect on weight. Such is the case. Our model indicates that when the number of workers squared is included in the specification, the number of workers continues to have a negative effect on weight, while the number of workers squared has a positive effect. These results suggest that a strong nonlinear relationship exists in this relationship. The number of workers (in addition to the respondent) at which the marginal effect on weight equals zero is 1.5, implying that by the time there are two workers in the home (in addition to the respondent) there are already negative returns to their contribution. This relationship is explained by the fact that the marginal cost of additional workers in the home outweighs the marginal benefit of the security they offer.

Specification (5) indicates that both workers and non-workers have a negative effect on weight, with the effect of workers (the security effect) greater than the effect of non-workers (hypothesized to be a time costs effect). It should be noted that the effect of workers in this specification is smaller in magnitude (-2.73) than the effect in specification (3) (-3.14) implying that missing variable bias (although not too large) likely exists in the third specification because non-workers was not included. These results are consistent with our findings in specification (1) where various measures of unemployment are estimated. Specification (1) indicates that the effect of decreasing the relative cost of eating healthy (being currently unemployed) decreases weight, while increasing insecurity (being unemployed anytime during the year) increases weight. In this regression, increasing the number of workers (increasing security) decreases weight, as does increasing the number of non-workers, or contributors (by decreasing the relative cost of eating healthy). In specification (6) the spouse (if present) is excluded from the same measures:

household workers excluding spouse and household non-workers excluding spouse, but our estimates do not change much suggesting that working spouses do not drive the household workers effect. The magnitude of non-workers including the spouse, however, is greater than the effect of non-workers excluding the spouse suggesting that the impact of wives on decreasing the cost of eating healthy is greater than non-wives. This is not surprising as the wife often takes an active roll in preparing food within the home. The specification including the ratio of workers to non-workers confirms these findings, as increasing the ratio by one unit decreases weight by 2.4 pounds, a result that seems fairly consistent with the magnitude of the effects for workers and non-workers.

The effect of increasing the number of adult workers and non-workers in the home on weight is negative (as was the effect of increasing the number of workers and non-workers in the home on weight). The effect of adult non-workers, however is not statistically different from zero. The same is true in Specification (9), where adults, non-working adults, and non-working children are included in the regression. Increasing the number of working adults has a negative and significant effect on weight, as does non-working children, while non-working adults has a negative and insignificant effect on weight. Because the number of non-working children in the home is treated as exogenous the estimate may be biased by the fact that homes where children do not work are often of a higher socioeconomic status. Because individuals of high socioeconomic status generally weigh less than individuals of a low socioeconomic status, the variable, non-working children, may capture this association. Finally, specification (10) indicates that increasing the ratio of working adults to adults by one decreases weight by over 9 pounds. As expected the magnitude associated with this effect is greater than the magnitude associated with the effect of the ratio of workers to non-workers because of the differences in the magnitudes of the measures in household composition.

These empirical results offer valuable insights into the effect of household composition on weight. First, living with others (having a social network in your home) decreases fattening. Evidence also suggests, that in general, both workers and non-workers have a negative effect on weight. The effect of workers on weight is undeniable and supports our previous findings (Smith *et al*. 2007 and Barnes and Smith 2008) that decreasing economic insecurity decreases weight.

Conclusion

Economic theory suggests that there are many reasons why people gain weight. Until now however, the effect of household composition on weight has been unexplored in the economics field, and although the medical and epidemiology literature have recognized a relationship between weight and social networks they have failed to analyze the social network within the home and have ignored the economic determinants in the relationship. We build upon findings in these fields by studying the relationship between the social network in the home (household composition) and weight and suggest that household composition appears to work on weight through the economic mechanisms of risk, time costs, and income.

Using an expected utility model we explain theoretical implications of these effects and determine the expected signs of the mechanisms on weight. Theoretical evidence suggests that decreasing risk (by increasing the number of workers) decreases weight, while decreasing the relative price of living healthy (increasing contributors) and decreasing current and future income (increasing dependents) have an ambiguous effect on weight. Using NLSY79 data and IV estimation techniques we estimate the unbiased effects of various measures of household composition on weight and find overwhelming evidence that workers in the home (through an increased security effect) decrease weight.

References

Altonji, J., F. Hayashi, and L. Kotlikoff (1992): "Is the Extended Family Altruistically Linked? Direct Tests Using Micro Data," *The American Economic Review*, 82 (5), 1177-1198.

Angel, R. and M. Tienda (1982): "Determinants of Extended Household Structure: Cultural Pattern or Economic Need?" *The American Journal of Sociology*, 87 (6), 1360-1383.

Barnes, M. and T. Smith (2008): "Income and Health at Risk: Optimal Fattening in the Presence of Economic Insecurity," Dissertation Chapter.

Burk, M. and F. Heiland (2007): "Social Dynamics of Obesity," *Economic Inquiry*, 45 (3), 571-591.

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

Christakis, N. J. Fowler (2007): "The Spread of Obesity in a Large Social Network over 32 Years," *The New England Journal of Medicine*, 357; 4, 370-379.

Chou, S.-Y., M. Grossman and H. Saffer (2004): "An Economic Analysis of Obesity: Results from the Behavioral Risk Factor Surveillance System," *Journal of Health Economics*, 23, 565-587.

Costa-Font, J. and J. Gil (2004): "Social Interactions and the Contemporaneous Determinants of Individual's Weight," *Applied Economics*, 36, 2253-2263.

Cutler, D. E. Glaeser, and J. Shapiro (2003): "Why Have Americans Become More Obese?" *Journal of Economic Perspectives*, 17 (3), 93-118.

Dekker, M. (2004): "Sustainability and Resourcefulness: Support Networks During Periods of Stress," *World Development*, 10, 1735-1751.

Dershem, L. and D. Gzirishvili (1998): "Informal Social Support Networks and Household Vulnerability: Empirical Findings From Georgia," *World Development*, 26 (10), 1827-1838.

Dovie, D., E. Witkowski, C. Shackleton (2005): “Monetary valuation of livelihoods for understanding the composition and complexity of rural households,” *Agriculture and Human Values*, 22, 87-103.

Drewnowski, A. and S. Specter (2004): “Poverty and obesity: the role of energy density and energy costs,” *American Journal of Clinical Nutrition*, 79 (1), 6-16.

Gruber, J. and M. Frakes (2006): “Does Falling Smoking Lead to Risking Obesity?” *Journal of Health Economics*, 25, 183-197.

Hahn, J. and J. Hausman (2002): “Notes on bias in estimators for simultaneous equation models,” *Economics Letters* 75 (2): 237-241.

Halliday, T. and S. Kwak (2007): “Identifying Endogenous Peer Effects in the Spread of Obesity,” University of Hawaii-Manoa.

Hansen, J. (1978): “Specification Tests in Econometrics,” *Econometrica*, 46 (3): 1251-1271.

Hayashi, F., J. Altonji and L Kotlikoff (1996): “Risk-Sharing Between and Within Families,” *Econometrica*, 64 (2), 261-294.

Holtgrave, D. and R. Crosby (2006): “Is Social Capital a Protective Factor Against Obesity and Diabetes? Findings from an Exploratory Study,” *Annals of Epidemiology*, 16 (5), 406-408.

Jenkins, S. and C. Schluter (2003): “Why Are Child Poverty Rates Higher in Britain than in Germany? A Longitudinal Perspective,” *The Journal of Human Resources*, 38 (2), 441-465.

Kleibergen, F. and R. Paap (2006): “Generalized Reduced Rank Tests using the Singular Value Decomposition,” *Journal of Econometrics*, 127 (1), 97-126.

Lakdawalla, D and T. Philipson (2002): “The growth of obesity and technological change: A theoretical and empirical examination," *NBER Working Paper W8946*.

Martin, K. and A. Ferris (2005): "Food Insecurity and Gender are Risk Factors for Obesity," *Journal of Nutrition Education and Behavior*, 39 (1), 31-36.

McKernan, S-M. and C. Ratcliffe (2005): "Events that Trigger Poverty Entries and Exits," *Social Science Quarterly*, 86, 1146-1169.

Musgrove, P. (1980): "Household Size and Composition, Employment, and Poverty in Urban Latin America," *Economic Development and Cultural Change*, 28 (2), 249-266.

Ruhm, C. J. (2000): "Are Recessions Good For Your Health?" *The Quarterly Journal of Economics*, May, 617-650.

Ruhm, C. J. (2005): "Healthy living in hard times," *Journal of Health Economics*, 24, 341-363.

Sauerborn, R., A. Adams, M. Hien (1996): "Household Strategies to Cope with the Economic Costs of Illness," *Social Science & Medicine*, 43 (3), 291-301.

Snyder, A. and D. McLaughlin, J. Findeis (2006): "Household Composition and Poverty among Female-Headed Households with Children: Differences by Race and Residence," *Rural Sociology*, 71 (4), 597-624.

Smith, T., C. Stoddard, M. Barnes (2007): "Why the Poor Get Fat: Weight gain and Economic Insecurity," *Working Paper, Washington State University Working Papers 2007-16*.

Tienda, M and R. Angel (1982): "Headship and Household Composition among Blacks, Hispanics, and Other Whites," *Social Forces*, 61 (2), 508-531.

APPENDIX A

PROOFS:

$$\max_{x_1, f_1} u(x_1) + \pi u(\breve{w}_2 + \delta f_1) + (1-\pi) u(\widehat{w}_2 + \delta f_1) \quad (1)$$

subject to:

$$w_1 + p_f \delta f_0 \geq p_x x_1 + p_f f_1$$

First order conditions for (1) are:

i) $\frac{\partial u(x_1)}{\partial x_1} - \lambda p_x = 0$

ii) $\delta * \pi * \frac{\partial u(\widehat{w}_2 + \delta f_1)}{\partial f_1} + \delta * (1-\pi) * \frac{\partial u(\breve{w}_2 + \delta f)}{\partial f_1} - \lambda p_f = 0$

iii) $w_1 + \delta p_f f_0 - p_f f_1 - p_x x_1 = 0$

Assumption 1: The realization of the random variable, period two income $(\tilde{w}_2)$, is independent across workers.

Assumption 2: Each worker faces the same probability of high income in period two (*i.e.*, $\pi_j = \pi_k$ for worker *j* and *k*).

Assumption 3: The *n* workers in the home pool income equally.

Proposition 1: Given Assumptions 1-3, increasing the number of workers in the home decreases current weight for the consumer.

Proof:

A series of steps are followed to show that $E(u(n)) \geq E(u(n-1))$. Utilize one of the expressions below (depending on whether n is even or odd) in the following steps:

Given even *n*, odd *n-1*:

$$\frac{n-1!}{(n-1-i)!i!} \pi^{n-i} (1-\pi)^i u\left(\frac{(n-1-i)\breve{w}_2 + (i)\widehat{w}_2}{n-1} + \delta f_1\right) \text{ and}$$

$$\frac{n-1!}{(n-1-i)!i!}\pi^{i}(1-\pi)^{n-i}u(\frac{(i)\breve{w}_2+(n-1-i)\widehat{w}_2}{n-1}+\delta f_1)$$

repeat from i=0 to $\frac{n-2}{2}$. (5)

Given odd n, even n-1:

$$\frac{n-1!}{(n-1-i)!i!}\pi^{n-i}(1-\pi)^{i}u(\frac{(n-1-i)\breve{w}_2+(i)\widehat{w}_2}{n-1}+\delta f_1) \text{ and}$$

$$\frac{n-1!}{(n-1-i)!i!}\pi^{i}(1-\pi)^{n-i}u(\frac{(i)\breve{w}_2+(n-1-i)\widehat{w}_2}{n-1}+\delta f_1)$$

repeat from i=0 to $\frac{n-3}{2}$, and for the final manipulation, use:

$$\left.\frac{n-1!}{(n-1-(i))!(i)!}\pi^{n-(i)}(1-\pi)^{(i)}u(\frac{(n-1-i)\breve{w}_2+(i)\widehat{w}_2}{n-1}+\delta f_1)\right|_{i=\left(\frac{n-3}{2}+1\right)}. \quad (6)$$

Add and subtract element (i) from equation (5) (or (6)) to element (i) in *E(u(n-1))*.

E.g.:

$$\frac{n-1!}{(n-1-i)!i!}\pi^{n-i}(1-\pi)^{i}u(\frac{(n-1-i)\breve{w}_2+(i)\widehat{w}_2}{n-1}+\delta f_1)+\frac{n-1!}{(n-1-i)!i!}u(\frac{(n-1-i)\breve{w}_2+(i)\widehat{w}_2}{n-1}+\delta f_1)\left[\pi^{n-1-i}(1-\pi)^{i}-\pi^{n-i}(1-\pi)^{i}\right]$$

$$+\frac{n-1!}{(n-1-i)!i!}\pi^{i}(1-\pi)^{n-i}u(\frac{(i)\breve{w}_2+(n-1-i)\widehat{w}_2}{n-1}+\delta f_1)+\frac{n-1!}{(n-1-i)!i!}u(\frac{(i)\breve{w}_2+(n-1-i)\widehat{w}_2}{n-1}+\delta f_1)\left[(1-\pi)^{n-1-i}\pi^{i}-\pi^{i}(1-\pi)^{n-i}\right]$$

Repeat for each *i* in *E(u(n-1))*. Excluding the elements for *i=0* from *E(u(n))*, form *n-1* groupings with the remaining elements. Add to each group the elements from *E(u(n-1))* formed in the previous step that share the same probability of occurring as the element from *E(u(n))* that is already in the group. Dividing each group by the probabilities and magnitude that accompany *E(u(n))*, it follows directly from Jensen's Inequality that $E(u(n))>E(u(n-1))$ for each group, and consequently, $E(u(n))>E(u(n-1))$ for the entire function. Because $E(u(n))>Eu((n-1))\Rightarrow E(u(n))_{f_1}<Eu((n-1))_{f_1}$ where

$E(u(n))_{f_1}$ represents the marginal utility of period one fat for individual *i*, that lives with *n* workers . Because $u(n)(x_1, f_1)_{x_1} = u(n-1)(x_1, f_1)_{x_1}$, then $\frac{u(n)(x_1, f_1)_{x_1}}{u(n)(x_1, f_1)_{f_1}} > \frac{u(n-1)(x_1, f_1)_{x_1}}{u(n-1)(x_1, f_1)_{f_1}}$, indicating that the marginal rate of substitution between "fat" and "other goods" for individual *i* is steeper with *n* workers than with *n-1* workers. Because preferences are concave, given then same budget constraint for *n* and *n-1* workers in the home, individual *i* would consume more fat in period one with *n-1* workers in the home.

Decreasing the relative price of healthy living on weight:

$$\frac{\partial f_1}{\partial p_x} = \frac{p_f^2 u''(x_1)\left(-p_x\lambda - x_1 u''(x_1)\right)}{p_f u''(x_1)\left[p_f^2 u''(x_1) + p_x^2\left(\pi\delta^2 u''(\breve{w}_2 + \delta f_1\right) + (1-\pi)\delta^2 u''(\hat{w}_2 + \delta f_1)\right]}$$

where $\frac{\partial f_1}{\partial p_x} = \frac{(-)\left(-(+) - (-)\right)}{(-)\left[(-) + (+)\left((-) + (-)\right)\right]} = \frac{ambiguous}{(+)}$.

$\frac{\partial f_1}{\partial p_x}$ is ambiguous because it is unclear whether $p_x\lambda > x_1 u''(x_1)$. If the substitution effect is greater than the income effect the numerator becomes positive, and the comparative static is greater than zero. Conversely, decreasing the relative price of healthy eating decreases fat, given the substitution effect is greater than the income effect.

Tables

Table 1a: Means and Standard Deviations of Individual Characteristics NLSY Men, 2000

Characteristic	Mean	Standard Deviation
Weight (in lbs) in 2000	197.121	39.069
Dummy Variable for Live with Others	0.747	--
Number of Workers in the Home	0.75	0.732
Number of Workers in the Home Squared	1.098	1.89
Number of Non-Workers in the Home	1.528	1.469
Number of Workers in the Home Excluding Spouse	0.298	0.601
Number of Non-Workers in the Home Excluding Spouse	1.163	1.418
Number of Working Adults	0.685	0.651
Number of Non-Working Adults	0.295	0.58
Number of Non-Working Children	1.234	1.281
Ratio of Workers to Non-Workers	0.515	0.563
Ratio of Working Adults to Adults	0.301	0.254
Number of Adults in the Home	0.98	0.743
Number of Kids in the Home	1.299	1.321
Family Income	57.163	53.245
Posterior Probability of Unemployment	0.03	0.076
Unemployed at any time in 2000	0.119	--
Unemployed at time of Interview in 2000	0.026	--
Currently Smoke	0.309	--
1994 Weight (in lbs.)	187.708	35.872
Height in 1985 (in inches)	69.659	2.586
Height squared in 1985 (in inches)	4859.127	358.576
Age	38.846	2.264
Black	0.274	--
Hispanic	0.184	--
White	0.542	--
Married	0.605	--
Divorce or separated	0.185	--
Widowed	0.004	--
Never Married	0.206	--
BA	0.219	--
Some college	0.216	--
High school graduate	0.447	--
High School Dropout	0.117	--
Live within a metropolitan area	2.243	--
Sample Size: 2880		

Table 1b: Means and Standard Deviations of State Characteristics
NLSY79, various years

Characteristic	Mean	Standard Deviation
Percent of Whites in County	0.77	0.145
Percent of Blacks in County	0.131	0.137
Percent of Indians in County	0.007	0.016
Percent of Asians in County	0.023	0.033
Percent of Hispanics in County	0.094	0.141
State Median Home Prices (in $1000)	125.395	5.0552
State Median household income (in $1000)	42.608	5.292
Unemployment rate in local labor market, 1988	6.334	2.605
Unemployment rate in local labor market, 1989	5.555	2.09
Unemployment rate in local labor market, 1990	5.686	1.974
Unemployment rate in local labor market, 1991	7.404	2.763
Unemployment rate in local labor market, 1992	8.027	2.504
Unemployment rate in local labor market, 1993	7.561	2.629
Unemployment rate in local labor market, 1994	7.155	2.709
Unemployment rate in local labor market, 1996	6.85	3.095
Unemployment rate in local labor market, 1998	5.121	2.829
Unemployment rate in local labor market, 2000	4.483	2.544
State cigarette tax (in cents), 1988	34.646	8.245
State cigarette tax (in cents), 1989	39.209	9.835
State cigarette tax (in cents), 1990	41.739	11.799
State cigarette tax (in cents), 1991	46.606	11.749
State cigarette tax (in cents), 1992	47.384	12.178
State cigarette tax (in cents), 1993	54.104	14.462
State cigarette tax (in cents), 1994	56.787	17.518
State cigarette tax (in cents), 1996	58.157	19.425
State cigarette tax (in cents), 1998	60.692	22.058
State cigarette tax (in cents), 2000	79.191	30.744
Sample Size: 2854		

Table 2a: OLS Estimates of Household Composition on Men's Weight, 2000

Variables	(1)	(2)	(3)	(4)	(5)
Family income	-0.0050	-0.0041	-0.0044	-0.0044	-0.0047
(in $1000)	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)
Unemployed at any time during	-0.8504	--	--	--	--
the Year	(1.450)	--	--	--	--
Unemployed at time of Interview	2.4260				
	(2.950)				
Posterior Probability	--	4.8987	4.6838	4.7052	4.8361
of Unemployment		(6.295)	(6.313)	(6.319)	(6.312)
Live with Others	--	-0.9930	--	--	--
		(1.185)			
Number of Workers in the Home	--	--	0.7382	1.0553	0.6048
			(0.495)	(1.033)	(0.508)
Number of Workers squared in the	--	--	--	-0.1322	--
Home				(0.357)	
Number of Non-Workers in the Home	--	--	--	--	-0.3696
					(0.249)
Smoke Daily	-2.3090***	-2.3674***	-2.4113***	-2.4110***	-2.4272***
	(0.849)	(0.843)	(0.844)	(0.844)	(0.844)
Weight in 1994 (in pounds)	0.9337***	0.9337***	0.9333***	0.9333***	0.9331***
	(0.017)	(0.017)	(0.017)	(0.017)	(0.017)
Height (in inches)	3.8442	3.8470	3.8680	3.9251	3.6544
	(4.969)	(4.975)	(4.972)	(4.974)	(4.970)
Height (in inches) squared	-0.0222	-0.0222	-0.0224	-0.0228	-0.0209
	(0.036)	(0.036)	(0.036)	(0.036)	(0.036)
Age	-0.2045	-0.2069	-0.2219	-0.2193	-0.2306
	(0.156)	(0.156)	(0.156)	(0.156)	(0.155)
Black	3.0581***	2.9972***	2.8830***	2.8843***	2.9528***
	(0.892)	(0.898)	(0.900)	(0.901)	(0.900)
Hispanic	0.5405	0.5200	0.4452	0.4476	0.5970
	(1.025)	(1.019)	(1.017)	(1.017)	(1.016)
Married	1.8933*	2.5926*	1.5159	1.4469	2.1046*
	(1.073)	(1.333)	(1.097)	(1.114)	(1.172)
Divorced or Separated	-0.9486	-0.9254	-0.9236	-0.9162	-0.9264
	(1.208)	(1.204)	(1.205)	(1.205)	(1.205)
Widow	2.3300	2.3858	2.1646	2.1935	2.2582
	(6.576)	(6.534)	(6.587)	(6.583)	(6.548)
BA Degree	-1.9114	-1.8868	-1.7097	-1.7335	-1.8515
	(1.418)	(1.432)	(1.433)	(1.433)	(1.445)
Some College	-0.0887	-0.0762	0.0333	0.0089	-0.0986
	(1.435)	(1.443)	(1.443)	(1.444)	(1.451)
High School Graduate	0.3157	0.3715	0.3848	0.3620	0.2985
	(1.297)	(1.309)	(1.311)	(1.310)	(1.316)
Live Within a	0.6090	0.6055	0.6142	0.6129	0.6323
Metropolitan Area	(0.662)	(0.663)	(0.663)	(0.663)	(0.664)
N	2865	2865	2865	2865	2865
R^2	0.780	0.780	0.780	0.780	0.780

Variables are for the year 2000, unless otherwise specified; Robust standard errors (adjusted for within-state clustering) in parentheses. * significant at 10%, ** significant at 5%, *** significant at 1%

Table 2b: OLS Estimates of Household Composition on Men's Weight, 2000

Variables	(6)	(7)	(8)	(9)	(10)
Family income	-0.0073	-0.0046	-0.0045	-0.0046	-0.0045
(in $1000)	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)
Posterior Probability	4.3503	4.8555	5.3203	5.2785	1.3827
of Unemployment	(7.657)	(6.310)	(6.306)	(6.316)	(6.523)
Ratio of Workers to Non-Workers	1.5014**	--	--	--	--
	(0.733)				
Number of Workers in the Home	--	0.6000	--	--	--
Excluding the Spouse		(0.570)			
Number of Non-Workers in the Home	--	-0.3902*	--	--	--
Excluding Spouse		(0.227)			
Number of Working Adults in the	--	--	0.3697	--	--
Home			(0.594)		
Number of Non-Working Adults in	--	--	-1.1579*	-1.0799*	--
the Home			(0.637)	(0.635)	
Number of Workers in the Home	--	--	--	0.4443	--
				(0.529)	
Number of Non-Working Children	--	--	--	-0.1681	--
in the Home				(0.287)	
Ratio of Workers to Adults	--	--	--	--	2.9885**
					(1.391)
Smoke Daily	-1.7123*	-2.4239***	-2.4108***	-2.4237***	-2.1884***
	(1.012)	(0.844)	(0.844)	(0.844)	(0.847)
Weight in 1994 (in pounds)	0.9180***	0.9332***	0.9330***	0.9329***	0.9335***
	(0.019)	(0.017)	(0.017)	(0.017)	(0.018)
Height (in inches)	3.9347	3.6325	3.7165	3.6038	4.4689
	(5.472)	(4.973)	(4.962)	(4.965)	(5.008)
Height (in inches) squared	-0.0224	-0.0207	-0.0213	-0.0205	-0.0271
	(0.040)	(0.036)	(0.036)	(0.036)	(0.036)
Age	-0.1084	-0.2298	-0.2018	-0.2145	-0.2275
	(0.179)	(0.155)	(0.156)	(0.156)	(0.157)
Black	2.9900***	2.9517***	2.9752***	2.9812***	2.6878***
	(1.107)	(0.899)	(0.904)	(0.902)	(0.896)
Hispanic	0.9506	0.5883	0.5802	0.6188	0.5068
	(1.215)	(1.019)	(1.022)	(1.018)	(1.034)
Married	2.3588	2.3392**	1.7361	1.9004	1.8782*
	(1.686)	(1.097)	(1.098)	(1.186)	(1.088)
Divorced or Separated	0.4268	-0.9280	-1.1032	-1.0658	-1.3809
	(1.928)	(1.205)	(1.212)	(1.214)	(1.218)
Widow	-7.3784	2.2585	2.0885	2.1272	1.9602
	(7.446)	(6.546)	(6.589)	(6.565)	(6.552)
BA Degree	-0.9421	-1.8489	-2.0560	-2.0268	-1.8848
	(1.647)	(1.453)	(1.458)	(1.457)	(1.459)
Some College	1.0654	-0.0993	-0.2409	-0.2297	-0.0320
	(1.635)	(1.458)	(1.460)	(1.460)	(1.470)
High School Graduate	1.5155	0.3101	0.2012	0.2043	0.3243
	(1.503)	(1.321)	(1.322)	(1.323)	(1.342)
Live Within a	0.7598	0.6378	0.6117	0.6255	0.6005
Metropolitan Area	(0.844)	(0.664)	(0.662)	(0.664)	(0.667)
N	1907	2865	2865	2865	2791
R^2	0.795	0.780	0.780	0.780	0.781

Variables are for the year 2000, unless otherwise specified; Robust standard errors (adjusted for within-state clustering) in parentheses. * significant at 10%, ** significant at 5%, *** significant at 1%

Table 3a: IV Estimates of Household Composition on Men's Weight, 2000

Variables	(1)	(2)	(3)	(4)	(5)
Family income	0.0476*	0.0495**	0.0472	0.0661**	0.0471
(in $1000)	(0.028)	(0.020)	(0.034)	(0.033)	(0.033)
Unemployed at any time during	23.8274***	--	--	--	--
the Year	(5.346)				
Unemployed at time of Interview	-13.9714***	--	--	--	--
	(4.389)				
Posterior Probability	--	98.4231***	59.7271***	65.1398***	63.504***
of Unemployment		(16.573)	(23.098)	(24.976)	(23.499)
Live with Others	--	-12.6062**	--	--	--
		(5.202)			
Number of Workers in the Home	--	--	-3.1469***	-19.392***	-2.7316***
			(1.051)	(5.105)	(1.038)
Number of Workers squared in the	--	--	--	6.2350***	--
Home				(1.683)	
Number of Non-Workers in the Home	--	--	--	--	-0.4212**
					(0.172)
Smoke Daily	-14.5259***	-1.2502	-7.6233	-10.2202*	-7.5824
	(3.998)	(3.408)	(5.303)	(5.281)	(5.228)
Weight in 1994 (in pounds)	0.9385***	0.9499***	0.9352***	0.9302***	0.9362***
	(0.012)	(0.013)	(0.013)	(0.011)	(0.013)
Height (in inches)	0.4234	3.2106	-0.4199	-4.2395	-1.1735
	(4.307)	(3.304)	(3.900)	(4.721)	(3.913)
Height (in inches) squared	0.0016	-0.0189	0.0086	0.0361	0.0140
	(0.031)	(0.024)	(0.029)	(0.034)	(0.029)
Age	-0.2291*	-0.2521**	-0.0984	-0.1702	-0.1271
	(0.133)	(0.115)	(0.138)	(0.138)	(0.135)
Black	2.6963***	2.4163***	3.0563***	3.4348***	3.068***
	(0.804)	(0.646)	(0.846)	(0.886)	(0.854)
Hispanic	-1.7962***	-0.4399	-0.7697	-1.3938*	-0.5805
	(0.629)	(0.550)	(0.659)	(0.772)	(0.670)
Married	-0.3542	9.7152***	2.2664	5.7332**	2.6581
	(1.624)	(3.750)	(1.903)	(2.297)	(1.891)
Divorced or Separated	-1.4264	-0.5828	-1.3403	-1.7838*	-1.2634
	(0.920)	(0.949)	(0.967)	(0.948)	(0.962)
Widow	1.9894	10.9512***	5.8011	4.9137	6.2007
	(4.870)	(4.040)	(4.478)	(4.502)	(4.439)
BA Degree	-7.7437**	-1.4337	-5.3397	-6.4676	-5.3652
	(3.550)	(2.223)	(4.146)	(4.217)	(4.113)
Some College	-3.131	1.7772	-1.4408	-1.5289	-1.5713
	(2.186)	(1.470)	(2.257)	(2.307)	(2.239)
High School Graduate	-1.4331	1.6787*	-0.0729	0.4058	-0.1870
	(1.475)	(0.969)	(1.594)	(1.804)	(1.581)
Live Within a	0.5428	0.6276	-0.1992	-0.2131	-0.1671
Metropolitan Area	(0.631)	(0.458)	(0.512)	(0.473)	(0.514)
N	2541	2532	2541	2541	2541
R^2	0.729	0.738	0.759	0.725	0.759

Variables are for the year 2000, unless otherwise specified; Robust standard errors (adjusted for within-state clustering) in parentheses. * significant at 10%, ** significant at 5%, *** significant at 1%

Instruments used in the IV regressions:

Variable: Family income	Instrument: State median household income
Variable: Posterior probability of unemployment	Instrument: Local unemployment rates, 1988-2000
Variable: Unemployed any time during 2000	Instrument: Local unemployment rates, 1988-2000
Variable: Smoke	Instrument: History of Cigarette Taxes, 1988-2000
Variable: Live with Others	Instrument: County Ethnicity Data
Variable: Number of household workers	Instrument: State Median Home Prices, Number of Adults in the home

Variable: Number of household non-workers Instrument: Number of children in the home

Table 3b: IV Estimates of Household Composition on Men's Weight, 2000

Variables	(6)	(7)	(8)	(9)	(10)
Family income	-0.0146	0.0520	0.0543***	0.0590***	0.0604***
(in $1000)	(0.017)	(0.033)	(0.019)	(0.020)	(0.019)
Posterior Probability	20.2128	62.7704***	82.5507***	84.8817***	67.8946***
of Unemployment	(21.290)	(23.915)	(16.369)	(15.186)	(9.801)
Ratio of Workers to Non-Workers	-2.4292**	--	--	--	--
	(1.211)				
Number of Workers in the Home	--	-2.7241**	--	--	--
Excluding the Spouse		(1.128)			
Number of Non-Workers in the Home	--	-0.3428*	--	--	--
Excluding Spouse		(0.195)			
Number of Working Adults in the	--	--	-1.6934*	--	--
Home			(0.990)		
Number of Non-Working Adults in	--	--	-1.5057	-0.9671	--
the Home			(1.275)	(1.312)	
Number of Workers in the Home	--	--	--	-2.3198**	--
				(1.087)	
Number of Non-Working Children	--	--	--	-0.5535***	--
in the Home				(0.174)	
Ratio of Working Adults to Adults	--	--	--	--	-9.8802***
					(2.907)
Smoke Daily	-2.9596	-6.0480	-1.0105	-1.0425	1.5167
	(2.909)	(5.255)	(3.895)	(3.841)	(3.031)
Weight in 1994 (in pounds)	0.9242***	0.9385***	0.9451***	0.9463***	0.9453***
	(0.010)	(0.013)	(0.011)	(0.010)	(0.010)
Height (in inches)	0.5623	-0.9120	1.3087	3.0013	3.2031
	(3.483)	(3.775)	(2.947)	(2.554)	(2.435)
Height (in inches) squared	0.0021	0.0119	-0.0048	-0.0170	-0.0188
	(0.025)	(0.028)	(0.021)	(0.019)	(0.018)
Age	-0.0919	-0.1435	-0.2038*	-0.2223*	-0.1980*
	(0.128)	(0.130)	(0.117)	(0.122)	(0.114)
Black	3.0238***	3.0860***	2.7087***	2.8303***	2.9989***
	(1.046)	(0.864)	(0.580)	(0.532)	(0.542)
Hispanic	0.2959	-0.4486	-0.8405	-0.4426	-0.8109
	(0.756)	(0.663)	(0.647)	(0.576)	(0.570)
Married	5.0282***	0.3606	2.0983**	3.4504***	3.8241***
	(1.698)	(1.770)	(1.030)	(0.904)	(0.885)
Divorced or Separated	1.1528	-1.3363	-1.5317*	-1.2239	-1.2387
	(1.289)	(0.940)	(0.786)	(0.767)	(0.794)
Widow	-3.4040	6.2754	7.2562	6.8490	3.0250
	(3.970)	(4.400)	(4.862)	(4.665)	(4.223)
BA Degree	-1.1167	-5.2808	-2.5034	-3.0662	-1.4322
	(2.196)	(4.132)	(2.460)	(2.317)	(2.074)
Some College	1.0938	-1.5715	0.3757	0.0845	1.2403
	(1.331)	(2.242)	(1.486)	(1.389)	(1.173)
High School Graduate	1.4851	-0.3012	0.9185	0.7262	1.7692**
	(1.063)	(1.568)	(1.053)	(0.985)	(0.882)
Live Within a	0.6036	-0.0716	0.2804	0.1198	0.4515
Metropolitan Area	(0.520)	(0.506)	(0.401)	(0.425)	(0.379)
N	1700	2541	2532	2532	2532
R^2	0.787	0.761	0.753	0.749	0.752

Variables are for the year 2000, unless otherwise specified; Robust standard errors (adjusted for within-state clustering) in parentheses. * significant at 10%, ** significant at 5%, *** significant at 1%

Instruments used in the IV regressions:

Variable: Family income	Instrument: State median household income
Variable: Posterior probability of unemployment	Instrument: Local unemployment rates, 1988-2000
Variable: Smoke	Instrument: History of Cigarette Taxes, 1988-2000
Variable: Number of household workers	Instrument: State Median Home Prices, Number of Adults in

	the home
Variable: Ratio of workers to non-workers	Instrument: State Median Home Prices, Number of Adults and Children in the Home
Variable: Number of Workers Excluding Spouse	Instrument: State Median Home Prices, Number of Adults in the home
Variable: Number of Non-Workers Excluding Spouse	Instrument: Number of children in the home
Variable: Number of Adult Workers in the Home	Instrument: State Median Home Prices, Number of Adults in the home
Variable: Number of Adult Non-Workers in the Home	Instrument: County Ethnicity Data
Variable: Ratio of Workers to Adult Non-Workers	Instrument: State Median Home Prices, Number of Adults in the home, Number of Children in the Home, County Ethnicity Data

Table 4: Tests of Validity of Instruments

Columns Index Specifications as Reported in Table 2 and 3

	(1)	**(2)**	**(3)**	**(4)**	**(5)**
Test 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)	16.36	23.299	24.14	21.6	23.56
χ^2 distribution *p*-value	.56	.385	.19	.3	.21
Test of Under-Identification (Instrument Relevance)					
Null: Equations are under-identified (implies instruments are not related to endogenous variables) (Note that "Fail to Reject the Null" implies *invalid* instruments)					
For full set of instruments					
Kleibergen-Paap rk LM statistic	18.39	26.562	21.26	20.49	21.1
χ^2 distribution *p*-value	.49	.27	.38	.42	.39
For specifications treating sources of under-identification as exogenous					
Kleibergen-Paap rk LM statistic	32.772	23.52	23.89	24.48	24.33
χ^2 distribution *p*-value	.02	.009	.01	.01	.01

Sources of under-identification, and their corresponding specifications: Family Income (1), Live with Others (2), Smoke (2)-(5).

	(6)	**(7)**	**(8)**	**(9)**	**(10)**
Test 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)	24.11	24.43	26.73	25.02	28.03
χ^2 distribution *p*-value	.23	.17	.26	.34	.3
Test of Under-Identification (Instrument Relevance)					
Null: Equations are under-identified (implies instruments are not related to endogenous variables) (Note that "Fail to Reject the Null" implies *invalid* instruments)					
For full set of instruments					
Kleibergen-Paap rk LM statistic	22.72	21.25	19.53	19.79	32.95
χ^2 distribution *p*-value	.35	.38	.72	.7	.16
For specifications treating sources of under-identification as exogenous					
Kleibergen-Paap rk LM statistic	20.41	23.84	29.16	29.21	30.49
χ^2 distribution *p*-value	.05	.01	.01	01	0

Sources of under-identification, and their corresponding specifications: Smoke (6)-(10).

Table 5a

First Stage Results for Time Costs Regression

Instruments	**Endogenous Variables**		
	Unemployed in 2000	Smoke	Family Income
Weight in 1994	-0.0001	-0.0017***	-0.0001
	(0.000)	(0.000)	(0.021)
Height	-0.0913	-0.2739**	-4.7415
	(0.077)	(0.105)	(11.735)
Height Squared	0.0007	0.0021***	0.0396
	(0.001)	(0.001)	(0.086)
Age	0.0015	0.0046	0.8429**
	(0.003)	(0.004)	(0.363)
Black	0.0578***	-0.0037	-9.3953***
	(0.016)	(0.021)	(1.649)
Hispanic	0.0214	-0.0220	-2.1835
	(0.012)	(0.030)	(2.617)
Married	-0.0763***	-0.1050***	36.3292***
	(0.021)	(0.025)	(1.970)
Divorced/Separated	-0.0384*	0.0171	9.0998***
	(0.016)	(0.028)	(2.962)
Widow	0.0433	0.0982	10.6806
	(0.100)	(0.109)	(7.689)
College Graduate	-0.1316***	-0.4532***	54.9935***
	(0.026)	(0.032)	(2.319)
Some college	-0.0891***	-0.2870***	23.9299***
	(0.024)	(0.028)	(2.214)
High School Graduate	-0.0824***	-0.1824***	11.2889***
	(0.025)	(0.031)	(1.277)
Live in a City	0.0004	-0.0280*	-0.9084
	(0.011)	(0.015)	(1.339)
State Median	0.0000	-0.0000	0.0002
Household Income	(0.000)	(0.000)	(0.000)
State cigarette tax (in	-0.0035	-0.0039*	-0.0647
cents), 1988	(0.002)	(0.002)	(0.396)
State cigarette tax (in	0.0037	0.0037	-0.1848
cents), 1989	(0.002)	(0.003)	(0.392)
State cigarette tax (in	-0.0002	0.0005	-0.1104
cents), 1990	(0.002)	(0.003)	(0.375)
State cigarette tax (in	-0.0007	-0.0021	0.5694
cents), 1991	(0.003)	(0.004)	(0.356)
State cigarette tax (in	-0.0016	0.0007	-0.2103
cents), 1991	(0.002)	(0.003)	(0.206)
State cigarette tax (in	0.0018	-0.0019	0.0767
cents), 1993	(0.001)	(0.002)	(0.160)
State cigarette tax (in	0.0000	0.0020	0.3153**
cents), 1994	(0.001)	(0.001)	(0.147)
State cigarette tax (in	-0.0019	-0.0010	-0.4333**
cents), 1996	(0.001)	(0.001)	(0.182)
State cigarette tax (in	0.0026***	0.0013	0.2353*
cents), 1998	(0.001)	(0.002)	(0.139)
State cigarette tax (in	-0.0003	0.0006	0.0355
cents), 2000	(0.001)	(0.001)	(0.078)
Unemployment rate in	0.0049	-0.0036	-0.5705
local labor market, 1988	(0.004)	(0.005)	(0.851)

Unemployment rate in local labor market, 1989	-0.0101 (0.009)	0.0121* (0.007)	-1.0268 (1.076)
Unemployment rate in local labor market, 1990	0.0065 (0.011)	-0.0162** (0.007)	-1.7194 (1.050)
Unemployment rate in local labor market, 1991	-0.0015 (0.006)	-0.0007 (0.007)	0.1031 (0.911)
Unemployment rate in local labor market, 1992	-0.0051 (0.008)	0.0095 (0.009)	3.2638*** (1.162)
Unemployment rate in local labor market, 1993	-0.0070 (0.009)	0.0003 (0.009)	-1.4627 (1.066)
Unemployment rate in local labor market, 1994	0.0049 (0.006)	-0.0149 (0.011)	-0.1284 (1.052)
Unemployment rate in local labor market, 1996	-0.0004 (0.004)	0.0019 (0.005)	-0.0695 (0.497)
Unemployment rate in local labor market, 1998	0.0047 (0.005)	0.0134* (0.008)	-0.9493 (1.321)
Unemployment rate in local labor market, 2000	0.0054 (0.006)	-0.0166*** (0.006)	-0.2983 (1.233)
Observations	2538	2538	2538
R-squared	0.057	0.144	0.313

Table 5b

First Stage Results for Live with Others Regression

Instruments	**Endogenous Variables**			
	Live with others	Family Income	Posterior Probability	Smoke
Weight in 1994	-0.0001	0.0042	0.0000	-0.0017***
	(0.000)	(0.021)	(0.000)	(0.000)
Height	-0.1397	-3.7360	-0.0193	-0.2814**
	(0.091)	(12.294)	(0.018)	(0.107)
Height Squared	0.0010	0.0323	0.0001	0.0021***
	(0.001)	(0.090)	(0.000)	(0.001)
Age	0.0013	0.8482**	0.0003	0.0045
	(0.002)	(0.370)	(0.001)	(0.004)
Black	0.0475*	-10.2960***	0.0208***	-0.0063
	(0.021)	(1.868)	(0.004)	(0.023)
Hispanic	0.0387*	-3.1868	-0.0020	-0.0028
	(0.018)	(2.593)	(0.004)	(0.031)
Married	0.6182***	36.5145***	-0.0241***	-0.1066***
	(0.025)	(1.982)	(0.005)	(0.026)
Divorced/Separated	-0.0050	9.4756***	-0.0172***	0.0177
	(0.027)	(2.846)	(0.006)	(0.029)
Widow	-0.0243	11.2702	-0.0346***	0.1209
	(0.114)	(9.364)	(0.011)	(0.101)
College Graduate	-0.0554*	54.7567***	-0.0324***	-0.4457***
	(0.021)	(2.410)	(0.006)	(0.032)
Some college	-0.0346	24.2510***	-0.0233***	-0.2822***
	(0.021)	(2.157)	(0.008)	(0.028)
High School Graduate	-0.0023	11.5973***	-0.0180***	-0.1800***
	(0.017)	(1.356)	(0.007)	(0.031)
Live in a City	0.0001	-2.2872	-0.0009	-0.0169
	(0.015)	(1.469)	(0.002)	(0.016)
State cigarette tax (in	0.0003	0.0254	0.0002	-0.0040*
cents), 1988	(0.001)	(0.398)	(0.000)	(0.002)
State cigarette tax (in	-0.0017	-0.1850	0.0003	0.0031
cents), 1989	(0.001)	(0.376)	(0.000)	(0.003)
State cigarette tax (in	0.0001	-0.1764	0.0003	0.0012
cents), 1990	(0.001)	(0.377)	(0.000)	(0.003)
State cigarette tax (in	0.0020	0.5021	-0.0010**	-0.0012
cents), 1991	(0.002)	(0.347)	(0.000)	(0.004)
State cigarette tax (in	-0.0020	-0.1495	0.0005	-0.0001
cents), 1991	(0.002)	(0.200)	(0.000)	(0.003)
State cigarette tax (in	0.0006	0.0692	0.0003*	-0.0013
cents), 1993	(0.001)	(0.166)	(0.000)	(0.002)
State cigarette tax (in	0.0010	0.3369**	-0.0001	0.0016
cents), 1994	(0.001)	(0.156)	(0.000)	(0.001)
State cigarette tax (in	-0.0008	-0.4654**	-0.0001	-0.0011
cents), 1996	(0.001)	(0.187)	(0.000)	(0.002)
State cigarette tax (in	-0.0008	0.2918**	-0.0001	0.0007
cents), 1998	(0.001)	(0.139)	(0.000)	(0.002)
State cigarette tax (in	0.0005	-0.0234	0.0001	0.0012**
cents), 2000	(0.000)	(0.081)	(0.000)	(0.001)
Percent of Whites in	0.2736	-55.9572	0.1086***	-0.0613
County	(0.200)	(35.006)	(0.039)	(0.275)
Percent of Blacks in	0.2696	-47.9012	0.1359***	-0.0171

County	(0.196)	(33.146)	(0.042)	(0.251)
Percent of Indians in	0.5533*	-116.5774**	0.0206	0.4387
County	(0.260)	(57.106)	(0.055)	(0.737)
Percent of Asians in	-0.0599	14.7368	-0.0291	-0.8369**
County	(0.357)	(50.225)	(0.074)	(0.349)
Percent of Hispanics	0.2143*	-8.2253	0.0652***	-0.2108**
in County	(0.090)	(20.059)	(0.016)	(0.082)
State Median	-0.0000	0.0001	0.0000	-0.0000
Household Income	(0.000)	(0.000)	(0.000)	(0.000)
Unemployment rate in	-0.0009	-0.7102	0.0010	-0.0024
local labor market, 1988	(0.004)	(0.888)	(0.001)	(0.005)
Unemployment rate in	0.0009	-0.5864	-0.0016*	0.0083
local labor market, 1989	(0.006)	(1.099)	(0.001)	(0.007)
Unemployment rate in	-0.0085	-1.9400	0.0000	-0.0136*
local labor market, 1990	(0.005)	(1.162)	(0.002)	(0.007)
Unemployment rate in	0.0169*	0.4725	0.0027	-0.0022
local labor market, 1991	(0.007)	(0.961)	(0.002)	(0.007)
Unemployment rate in	-0.0023	3.1947**	-0.0019	0.0101
local labor market, 1992	(0.007)	(1.213)	(0.001)	(0.009)
Unemployment rate in	0.0055	-1.5031	-0.0004	-0.0038
local labor market, 1993	(0.006)	(1.064)	(0.001)	(0.010)
Unemployment rate in	-0.0115*	-0.1900	-0.0014	-0.0109
local labor market, 1994	(0.005)	(1.116)	(0.001)	(0.011)
Unemployment rate in	0.0026	-0.3071	0.0020**	0.0058
local labor market, 1996	(0.005)	(0.555)	(0.001)	(0.005)
Unemployment rate in	-0.0107	-0.8596	0.0008	0.0154**
local labor market, 1998	(0.006)	(1.264)	(0.001)	(0.008)
Unemployment rate in	0.0132*	-0.5348	0.0019**	-0.0195***
local labor market, 2000	(0.006)	(1.151)	(0.001)	(0.007)
Observations	2529	2529	2529	2529
R-squared	0.475	0.315	0.090	0.146

Table 5c

First Stage Results for Number of Workers Regression

Instruments	**Endogenous Variables**			
	Number of Workers	Family Income	Posterior Probability	Smoke
Weight in 1994	0.0008*	-0.0006	0.0000	-0.0017***
	(0.000)	(0.020)	(0.000)	(0.000)
Height	0.1772	-4.8391	-0.0189	-0.2784**
	(0.164)	(11.774)	(0.018)	(0.105)
Height Squared	-0.0013	0.0404	0.0001	0.0021***
	(0.001)	(0.087)	(0.000)	(0.001)
Age	0.0091*	0.8405**	0.0001	0.0049
	(0.004)	(0.366)	(0.001)	(0.004)
Black	0.0198	-9.6140***	0.0222***	-0.0035
	(0.028)	(1.680)	(0.004)	(0.020)
Hispanic	-0.0087	-2.2352	0.0000	-0.0209
	(0.037)	(2.639)	(0.005)	(0.029)
Married	0.3535***	36.0089***	-0.0285***	-0.1014***
	(0.033)	(2.083)	(0.005)	(0.023)
Divorced/Separated	0.1002***	9.0435***	-0.0163***	0.0139
	(0.023)	(2.921)	(0.005)	(0.028)
Widow	0.1340	10.7116	-0.0312***	0.0974
	(0.173)	(8.047)	(0.008)	(0.108)
College Graduate	0.0371	55.3777***	-0.0305***	-0.4540***
	(0.047)	(2.505)	(0.007)	(0.032)
Some college	0.0522	24.3399***	-0.0208**	-0.2861***
	(0.048)	(2.247)	(0.008)	(0.029)
High School Graduate	0.0564	11.6162***	-0.0171**	-0.1805***
	(0.038)	(1.320)	(0.006)	(0.031)
Live in a City	-0.0079	-0.8151	0.0005	-0.0269*
	(0.015)	(1.328)	(0.003)	(0.015)
State cigarette tax (in	0.0041*	-0.0092	0.0002	-0.0033
cents), 1988	(0.002)	(0.396)	(0.000)	(0.002)
State cigarette tax (in	-0.0006	-0.2640	0.0001	0.0028
cents), 1989	(0.002)	(0.387)	(0.000)	(0.003)
State cigarette tax (in	-0.0076***	-0.1898	0.0004	-0.0002
cents), 1990	(0.003)	(0.384)	(0.000)	(0.003)
State cigarette tax (in	0.0023	0.5850	-0.0011**	-0.0020
cents), 1991	(0.004)	(0.353)	(0.000)	(0.004)
State cigarette tax (in	0.0003	-0.1221	0.0005	0.0016
cents), 1991	(0.003)	(0.190)	(0.000)	(0.003)
State cigarette tax (in	0.0031	0.0500	0.0004**	-0.0021
cents), 1993	(0.002)	(0.162)	(0.000)	(0.002)
State cigarette tax (in	-0.0015	0.3485**	-0.0000	0.0024*
cents), 1994	(0.001)	(0.146)	(0.000)	(0.001)
State cigarette tax (in	-0.0003	-0.4310**	-0.0002	-0.0010
cents), 1996	(0.002)	(0.174)	(0.000)	(0.001)
State cigarette tax (in	-0.0007	0.2741**	-0.0000	0.0017
cents), 1998	(0.001)	(0.123)	(0.000)	(0.001)
State cigarette tax (in	-0.0003	-0.0468	0.0000	-0.0003
cents), 2000	(0.001)	(0.077)	(0.000)	(0.001)
State Median	0.0000***	-0.0002	0.0000	-0.0000**
Household Income	(0.000)	(0.000)	(0.000)	(0.000)
Unemployment rate in	-0.0123	-0.4395	0.0008	-0.0021

local labor market, 1988	(0.010)	(0.846)	(0.001)	(0.005)
Unemployment rate in	0.0241	-0.8820	-0.0016*	0.0133*
local labor market, 1989	(0.020)	(1.078)	(0.001)	(0.007)
Unemployment rate in	0.0099	-1.5847	0.0004	-0.0147**
local labor market, 1990	(0.018)	(1.050)	(0.003)	(0.007)
Unemployment rate in	-0.0053	-0.2070	0.0028	-0.0040
local labor market, 1991	(0.009)	(0.926)	(0.002)	(0.007)
Unemployment rate in	0.0048	3.3440***	-0.0020	0.0105
local labor market, 1992	(0.011)	(1.160)	(0.001)	(0.008)
Unemployment rate in	-0.0117	-1.6406	-0.0007	-0.0013
local labor market, 1993	(0.015)	(1.023)	(0.001)	(0.009)
Unemployment rate in	0.0118	-0.2188	-0.0010	-0.0162
local labor market, 1994	(0.012)	(1.050)	(0.001)	(0.011)
Unemployment rate in	-0.0044	-0.0139	0.0020***	0.0027
local labor market, 1996	(0.007)	(0.483)	(0.001)	(0.005)
Unemployment rate in	-0.0224	-1.2097	0.0012	0.0105
local labor market, 1998	(0.011)	(1.282)	(0.001)	(0.008)
Unemployment rate in	0.0172*	0.0863	0.0015**	-0.0124**
local labor market, 2000	(0.008)	(1.180)	(0.001)	(0.006)
State Median Price of	-0.0003	0.1044**	-0.0001	0.0011***
a Home	(0.000)	(0.045)	(0.000)	(0.000)
Number of Adults in the	0.5351***	0.4190	0.0077**	-0.0097
Home	(0.042)	(0.936)	(0.003)	(0.015)
Observations	2538	2538	2538	2538
R-squared	0.435	0.314	0.090	0.145

Table 5d

First Stage Results for Number of Workers and Workers Squared Regression

Instruments	**Endogenous Variables**			
	Number of Workers	Family Income	Posterior Probability	Smoke
Weight in 1994	0.0008*	-0.0006	0.0000	-0.0017***
	(0.000)	(0.020)	(0.000)	(0.000)
Height	0.1772	-4.8391	-0.0189	-0.2784**
	(0.164)	(11.774)	(0.018)	(0.105)
Height Squared	-0.0013	0.0404	0.0001	0.0021***
	(0.001)	(0.087)	(0.000)	(0.001)
Age	0.0091*	0.8405**	0.0001	0.0049
	(0.004)	(0.366)	(0.001)	(0.004)
Black	0.0198	-9.6140***	0.0222***	-0.0035
	(0.028)	(1.680)	(0.004)	(0.020)
Hispanic	-0.0087	-2.2352	0.0000	-0.0209
	(0.037)	(2.639)	(0.005)	(0.029)
Married	0.3535***	36.0089***	-0.0285***	-0.1014***
	(0.033)	(2.083)	(0.005)	(0.023)
Divorced/Separated	0.1002***	9.0435***	-0.0163***	0.0139
	(0.023)	(2.921)	(0.005)	(0.028)
Widow	0.1340	10.7116	-0.0312***	0.0974
	(0.173)	(8.047)	(0.008)	(0.108)
College Graduate	0.0371	55.3777***	-0.0305***	-0.4540***
	(0.047)	(2.505)	(0.007)	(0.032)
Some college	0.0522	24.3399***	-0.0208**	-0.2861***
	(0.048)	(2.247)	(0.008)	(0.029)
High School Graduate	0.0564	11.6162***	-0.0171**	-0.1805***
	(0.038)	(1.320)	(0.006)	(0.031)
Live in a City	-0.0079	-0.8151	0.0005	-0.0269*
	(0.015)	(1.328)	(0.003)	(0.015)
State cigarette tax (in	0.0041*	-0.0092	0.0002	-0.0033
cents), 1988	(0.002)	(0.396)	(0.000)	(0.002)
State cigarette tax (in	-0.0006	-0.2640	0.0001	0.0028
cents), 1989	(0.002)	(0.387)	(0.000)	(0.003)
State cigarette tax (in	-0.0076***	-0.1898	0.0004	-0.0002
cents), 1990	(0.003)	(0.384)	(0.000)	(0.003)
State cigarette tax (in	0.0023	0.5850	-0.0011**	-0.0020
cents), 1991	(0.004)	(0.353)	(0.000)	(0.004)
State cigarette tax (in	0.0003	-0.1221	0.0005	0.0016
cents), 1991	(0.003)	(0.190)	(0.000)	(0.003)
State cigarette tax (in	0.0031	0.0500	0.0004**	-0.0021
cents), 1993	(0.002)	(0.162)	(0.000)	(0.002)
State cigarette tax (in	-0.0015	0.3485**	-0.0000	0.0024*
cents), 1994	(0.001)	(0.146)	(0.000)	(0.001)
State cigarette tax (in	-0.0003	-0.4310**	-0.0002	-0.0010
cents), 1996	(0.002)	(0.174)	(0.000)	(0.001)
State cigarette tax (in	-0.0007	0.2741**	-0.0000	0.0017
cents), 1998	(0.001)	(0.123)	(0.000)	(0.001)
State cigarette tax (in	-0.0003	-0.0468	0.0000	-0.0003
cents), 2000	(0.001)	(0.077)	(0.000)	(0.001)
State Median	0.0000***	-0.0002	0.0000	-0.0000**
Household Income	(0.000)	(0.000)	(0.000)	(0.000)
Unemployment rate in	-0.0123	-0.4395	0.0008	-0.0021

local labor market, 1988	(0.010)	(0.846)	(0.001)	(0.005)
Unemployment rate in	0.0241	-0.8820	-0.0016*	0.0133*
local labor market, 1989	(0.020)	(1.078)	(0.001)	(0.007)
Unemployment rate in	0.0099	-1.5847	0.0004	-0.0147**
local labor market, 1990	(0.018)	(1.050)	(0.003)	(0.007)
Unemployment rate in	-0.0053	-0.2070	0.0028	-0.0040
local labor market, 1991	(0.009)	(0.926)	(0.002)	(0.007)
Unemployment rate in	0.0048	3.3440***	-0.0020	0.0105
local labor market, 1992	(0.011)	(1.160)	(0.001)	(0.008)
Unemployment rate in	-0.0117	-1.6406	-0.0007	-0.0013
local labor market, 1993	(0.015)	(1.023)	(0.001)	(0.009)
Unemployment rate in	0.0118	-0.2188	-0.0010	-0.0162
local labor market, 1994	(0.012)	(1.050)	(0.001)	(0.011)
Unemployment rate in	-0.0044	-0.0139	0.0020***	0.0027
local labor market, 1996	(0.007)	(0.483)	(0.001)	(0.005)
Unemployment rate in	-0.0224	-1.2097	0.0012	0.0105
local labor market, 1998	(0.011)	(1.282)	(0.001)	(0.008)
Unemployment rate in	0.0172*	0.0863	0.0015**	-0.0124**
local labor market, 2000	(0.008)	(1.180)	(0.001)	(0.006)
State Median Price of	-0.0003	0.1044**	-0.0001	0.0011***
a Home	(0.000)	(0.045)	(0.000)	(0.000)
Number of Adults in the	0.5351***	0.4190	0.0077**	-0.0097
Home	(0.042)	(0.936)	(0.003)	(0.015)
Observations	2538	2538	2538	2538
R-squared	0.435	0.314	0.090	0.145

Table 5e

First Stage Results for Number of Workers and Non-Workers Regression

Instruments	**Endogenous Variables**				
	Workers	Family Income	Posterior Probability	Smoke	Non-Workers
Weight in 1994	0.0008*	-0.0007	0.0000	-0.0017***	-0.0008**
	(0.000)	(0.020)	(0.000)	(0.000)	(0.000)
Height	0.1801	-5.0938	-0.0194	-0.2788**	-0.1801
	(0.163)	(11.786)	(0.018)	(0.105)	(0.163)
Height Squared	-0.0013	0.0422	0.0001	0.0021***	0.0013
	(0.001)	(0.087)	(0.000)	(0.001)	(0.001)
Age	0.0093*	0.8198**	0.0001	0.0049	-0.0093**
	(0.004)	(0.368)	(0.001)	(0.004)	(0.004)
Black	0.0185	-9.4931***	0.0224***	-0.0034	-0.0185
	(0.028)	(1.746)	(0.004)	(0.020)	(0.028)
Hispanic	-0.0111	-2.0249	0.0004	-0.0207	0.0111
	(0.038)	(2.727)	(0.005)	(0.029)	(0.038)
Married	0.3427***	36.9611***	-0.0269***	-0.1002***	-0.3427***
	(0.040)	(2.372)	(0.006)	(0.027)	(0.040)
Divorced/Separated	0.0986***	9.1768***	-0.0161***	0.0141	-0.0986***
	(0.022)	(2.917)	(0.005)	(0.029)	(0.022)
Widow	0.1312	10.9609	-0.0307***	0.0977	-0.1312
	(0.172)	(8.039)	(0.009)	(0.108)	(0.172)
College Graduate	0.0376	55.3368***	-0.0306***	-0.4540***	-0.0376
	(0.047)	(2.531)	(0.007)	(0.032)	(0.047)
Some college	0.0529	24.2754***	-0.0209**	-0.2862***	-0.0529
	(0.049)	(2.258)	(0.008)	(0.029)	(0.049)
High School Graduate	0.0570	11.5653***	-0.0171**	-0.1806***	-0.0570
	(0.038)	(1.353)	(0.006)	(0.031)	(0.038)
Live in a City	-0.0080	-0.8080	0.0005	-0.0269*	0.0080
	(0.015)	(1.330)	(0.003)	(0.015)	(0.015)
State cigarette tax (in cents), 1988	0.0041*	-0.0070	0.0002	-0.0033	-0.0041**
	(0.002)	(0.395)	(0.000)	(0.002)	(0.002)
State cigarette tax (in cents), 1989	-0.0006	-0.2642	0.0001	0.0028	0.0006
	(0.002)	(0.387)	(0.000)	(0.003)	(0.002)
State cigarette tax (in cents), 1990	-0.0076***	-0.1929	0.0004	-0.0002	0.0076***
	(0.003)	(0.383)	(0.000)	(0.003)	(0.003)
State cigarette tax (in cents), 1991	0.0022	0.5943	-0.0010**	-0.0020	-0.0022
	(0.004)	(0.356)	(0.000)	(0.004)	(0.004)
State cigarette tax (in cents), 1991	0.0003	-0.1291	0.0005	0.0016	-0.0003
	(0.003)	(0.192)	(0.000)	(0.003)	(0.003)
State cigarette tax (in cents), 1993	0.0031	0.0497	0.0004**	-0.0021	-0.0031*
	(0.002)	(0.162)	(0.000)	(0.002)	(0.002)
State cigarette tax (in cents), 1994	-0.0016	0.3523**	-0.0000	0.0024*	0.0016
	(0.001)	(0.146)	(0.000)	(0.001)	(0.001)
State cigarette tax (in cents), 1996	-0.0003	-0.4299**	-0.0002	-0.0010	0.0003
	(0.002)	(0.173)	(0.000)	(0.001)	(0.002)
State cigarette tax (in cents), 1998	-0.0006	0.2699**	-0.0000	0.0017	0.0006
	(0.001)	(0.123)	(0.000)	(0.001)	(0.001)
State cigarette tax (in cents), 2000	-0.0003	-0.0455	0.0000	-0.0003	0.0003
	(0.001)	(0.077)	(0.000)	(0.001)	(0.001)
Number of Kids	0.0076	-0.6735	-0.0012	-0.0009	0.9924***
	(0.016)	(0.819)	(0.001)	(0.007)	(0.016)

Median State Household Income	0.0000*** (0.000)	-0.0002 (0.000)	0.0000 (0.000)	-0.0000** (0.000)	-0.0000*** (0.000)
Unemployment rate in local labor market, 1988	-0.0120 (0.010)	-0.4671 (0.839)	0.0008 (0.001)	-0.0021 (0.005)	0.0120 (0.010)
Unemployment rate in local labor market, 1989	0.0240 (0.020)	-0.8745 (1.079)	-0.0016* (0.001)	0.0133* (0.007)	-0.0240 (0.020)
Unemployment rate in local labor market, 1990	0.0098 (0.018)	-1.5739 (1.034)	0.0004 (0.003)	-0.0147** (0.007)	-0.0098 (0.018)
Unemployment rate in local labor market, 1991	-0.0054 (0.009)	-0.1931 (0.918)	0.0028 (0.002)	-0.0040 (0.007)	0.0054 (0.009)
Unemployment rate in local labor market, 1992	0.0051 (0.011)	3.3155*** (1.157)	-0.0020 (0.001)	0.0105 (0.008)	-0.0051 (0.011)
Unemployment rate in local labor market, 1993	-0.0119 (0.015)	-1.6208 (1.018)	-0.0007 (0.001)	-0.0013 (0.009)	0.0119 (0.015)
Unemployment rate in local labor market, 1994	0.0117 (0.012)	-0.2092 (1.043)	-0.0010 (0.001)	-0.0162 (0.011)	-0.0117 (0.012)
Unemployment rate in local labor market, 1996	-0.0043 (0.007)	-0.0246 (0.479)	0.0020*** (0.001)	0.0027 (0.005)	0.0043 (0.007)
Unemployment rate in local labor market, 1998	-0.0223 (0.011)	-1.2168 (1.279)	0.0012 (0.001)	0.0105 (0.008)	0.0223* (0.011)
Unemployment rate in local labor market, 2000	0.0169* (0.007)	0.1096 (1.182)	0.0016** (0.001)	-0.0124** (0.006)	-0.0169** (0.007)
Number of Adults in the Home	0.5343*** (0.042)	0.4809 (0.915)	0.0078** (0.003)	-0.0097 (0.015)	0.4657*** (0.042)
State Median Price of a Home	-0.0002 (0.000)	0.1023** (0.046)	-0.0001 (0.000)	0.0011*** (0.000)	0.0002 (0.000)
Observations	2538	2538	2538	2538	2538
R-squared	0.435	0.314	0.090	0.145	0.860

Table 5f

First Stage Results for Ratio of Workers to Non-Workers Regression

Instruments	**Endogenous Variables**			
	Ratio of Workers to Non-Workers	Family Income	Posterior Probability	Smoke
Weight in 1994	0.0006	-0.0007	0.0000	-0.0017***
	(0.000)	(0.020)	(0.000)	(0.000)
Height	0.1913	-5.0938	-0.0194	-0.2788**
	(0.155)	(11.786)	(0.018)	(0.105)
Height Squared	-0.0014	0.0422	0.0001	0.0021***
	(0.001)	(0.087)	(0.000)	(0.001)
Age	0.0048	0.8198**	0.0001	0.0049
	(0.004)	(0.368)	(0.001)	(0.004)
Black	0.0448	-9.4931***	0.0224***	-0.0034
	(0.034)	(1.746)	(0.004)	(0.020)
Hispanic	-0.0418	-2.0249	0.0004	-0.0207
	(0.028)	(2.727)	(0.005)	(0.029)
Married	0.3720***	36.9611***	-0.0269***	-0.1002***
	(0.053)	(2.372)	(0.006)	(0.027)
Divorced/Separated	0.1735*	9.1768***	-0.0161***	0.0141
	(0.066)	(2.917)	(0.005)	(0.029)
Widow	0.4618	10.9609	-0.0307***	0.0977
	(0.306)	(8.039)	(0.009)	(0.108)
College Graduate	-0.0317	55.3368***	-0.0306***	-0.4540***
	(0.053)	(2.531)	(0.007)	(0.032)
Some college	0.0208	24.2754***	-0.0209**	-0.2862***
	(0.058)	(2.258)	(0.008)	(0.029)
High School Graduate	-0.0001	11.5653***	-0.0171**	-0.1806***
	(0.047)	(1.353)	(0.006)	(0.031)
Live in a City	-0.0174	-0.8080	0.0005	-0.0269*
	(0.017)	(1.330)	(0.003)	(0.015)
State cigarette tax (in	0.0039	-0.0070	0.0002	-0.0033
cents), 1988	(0.002)	(0.395)	(0.000)	(0.002)
State cigarette tax (in	-0.0030	-0.2642	0.0001	0.0028
cents), 1989	(0.002)	(0.387)	(0.000)	(0.003)
State cigarette tax (in	-0.0043	-0.1929	0.0004	-0.0002
cents), 1990	(0.003)	(0.383)	(0.000)	(0.003)
State cigarette tax (in	0.0027	0.5943	-0.0010**	-0.0020
cents), 1991	(0.005)	(0.356)	(0.000)	(0.004)
State cigarette tax (in	-0.0028	-0.1291	0.0005	0.0016
cents), 1991	(0.004)	(0.192)	(0.000)	(0.003)
State cigarette tax (in	0.0026	0.0497	0.0004**	-0.0021
cents), 1993	(0.002)	(0.162)	(0.000)	(0.002)
State cigarette tax (in	-0.0015	0.3523**	-0.0000	0.0024*
cents), 1994	(0.002)	(0.146)	(0.000)	(0.001)
State cigarette tax (in	0.0009	-0.4299**	-0.0002	-0.0010
cents), 1996	(0.002)	(0.173)	(0.000)	(0.001)
State cigarette tax (in	-0.0012	0.2699**	-0.0000	0.0017
cents), 1998	(0.001)	(0.123)	(0.000)	(0.001)
State cigarette tax (in	0.0003	-0.0455	0.0000	-0.0003
cents), 2000	(0.001)	(0.077)	(0.000)	(0.001)
State Median	0.0000***	-0.0002	0.0000	-0.0000**
Household Income	(0.000)	(0.000)	(0.000)	(0.000)

Unemployment rate in local labor market, 1988	-0.0076	-0.4671	0.0008	-0.0021
	(0.007)	(0.839)	(0.001)	(0.005)
Unemployment rate in local labor market, 1989	0.0127	-0.8745	-0.0016*	0.0133*
	(0.014)	(1.079)	(0.001)	(0.007)
Unemployment rate in local labor market, 1990	0.0188	-1.5739	0.0004	-0.0147**
	(0.017)	(1.034)	(0.003)	(0.007)
Unemployment rate in local labor market, 1991	-0.0056	-0.1931	0.0028	-0.0040
	(0.012)	(0.918)	(0.002)	(0.007)
Unemployment rate in local labor market, 1992	-0.0048	3.3155***	-0.0020	0.0105
	(0.012)	(1.157)	(0.001)	(0.008)
Unemployment rate in local labor market, 1993	-0.0048	-1.6208	-0.0007	-0.0013
	(0.013)	(1.018)	(0.001)	(0.009)
Unemployment rate in local labor market, 1994	0.0161	-0.2092	-0.0010	-0.0162
	(0.013)	(1.043)	(0.001)	(0.011)
Unemployment rate in local labor market, 1996	-0.0062	-0.0246	0.0020***	0.0027
	(0.007)	(0.479)	(0.001)	(0.005)
Unemployment rate in local labor market, 1998	-0.0184	-1.2168	0.0012	0.0105
	(0.014)	(1.279)	(0.001)	(0.008)
Unemployment rate in local labor market, 2000	0.0102	0.1096	0.0016**	-0.0124**
	(0.010)	(1.182)	(0.001)	(0.006)
State Median Price of a Home	-0.0011	0.1023**	-0.0001	0.0011***
	(0.001)	(0.046)	(0.000)	(0.000)
Number of Adults in the Home	0.2515***	0.4809	0.0078**	-0.0097
	(0.046)	(0.915)	(0.003)	(0.015)
Number of Children in the Home	-0.1011***	-0.6735	-0.0012	-0.0009
	(0.014)	(0.819)	(0.001)	(0.007)
Observations	1697	2538	2538	2538
R-squared	0.196	0.314	0.090	0.145

Table 5g

First Stage Results for Non-Spouse Workers and Non-Workers Regression

Instruments	**Endogenous Variables**				
	Workers Non-Spouse	Non-Workers Non-Spouse	Posterior Probability	Smoke	Family Income
Weight in 1994	0.0004	-0.0011**	0.0000	-0.0017***	-0.0007
	(0.000)	(0.000)	(0.000)	(0.000)	(0.020)
Height	0.2120	-0.2007	-0.0194	-0.2788**	-5.0938
	(0.148)	(0.217)	(0.018)	(0.105)	(11.786)
Height Squared	-0.0015	0.0015	0.0001	0.0021***	0.0422
	(0.001)	(0.002)	(0.000)	(0.001)	(0.087)
Age	0.0133***	-0.0042	0.0001	0.0049	0.8198**
	(0.004)	(0.005)	(0.001)	(0.004)	(0.368)
Black	0.0086	-0.0384	0.0224***	-0.0034	-9.4931***
	(0.027)	(0.039)	(0.004)	(0.020)	(1.746)
Hispanic	-0.0089	0.0177	0.0004	-0.0207	-2.0249
	(0.026)	(0.061)	(0.005)	(0.029)	(2.727)
Married	-0.4396***	-0.8432***	-0.0269***	-0.1002***	36.9611***
	(0.045)	(0.046)	(0.006)	(0.027)	(2.372)
Divorced/Separated	0.0863***	-0.0984***	-0.0161***	0.0141	9.1768***
	(0.023)	(0.025)	(0.005)	(0.029)	(2.917)
Widow	0.1246	-0.1060	-0.0307***	0.0977	10.9609
	(0.163)	(0.177)	(0.009)	(0.108)	(8.039)
College Graduate	-0.0298	-0.1233*	-0.0306***	-0.4540***	55.3368***
	(0.032)	(0.068)	(0.007)	(0.032)	(2.531)
Some college	-0.0026	-0.1330*	-0.0209**	-0.2862***	24.2754***
	(0.043)	(0.067)	(0.008)	(0.029)	(2.258)
High School Graduate	-0.0004	-0.1155**	-0.0171**	-0.1806***	11.5653***
	(0.030)	(0.055)	(0.006)	(0.031)	(1.353)
Live in a City	-0.0119	0.0273	0.0005	-0.0269*	-0.8080
	(0.014)	(0.018)	(0.003)	(0.015)	(1.330)
State cigarette tax (in	0.0002	-0.0074**	0.0002	-0.0033	-0.0070
cents), 1988	(0.002)	(0.004)	(0.000)	(0.002)	(0.395)
State cigarette tax (in	-0.0010	0.0012	0.0001	0.0028	-0.2642
cents), 1989	(0.002)	(0.004)	(0.000)	(0.003)	(0.387)
State cigarette tax (in	-0.0057*	0.0068*	0.0004	-0.0002	-0.1929
cents), 1990	(0.003)	(0.004)	(0.000)	(0.003)	(0.383)
State cigarette tax (in	0.0030	-0.0008	-0.0010**	-0.0020	0.5943
cents), 1991	(0.003)	(0.006)	(0.000)	(0.004)	(0.356)
State cigarette tax (in	0.0002	-0.0018	0.0005	0.0016	-0.1291
cents), 1991	(0.002)	(0.004)	(0.000)	(0.003)	(0.192)
State cigarette tax (in	0.0025	-0.0020	0.0004**	-0.0021	0.0497
cents), 1993	(0.001)	(0.002)	(0.000)	(0.002)	(0.162)
State cigarette tax (in	0.0003	0.0043*	-0.0000	0.0024*	0.3523**
cents), 1994	(0.001)	(0.002)	(0.000)	(0.001)	(0.146)
State cigarette tax (in	-0.0013	-0.0018	-0.0002	-0.0010	-0.4299**
cents), 1996	(0.001)	(0.002)	(0.000)	(0.001)	(0.173)
State cigarette tax (in	0.0006	0.0026*	-0.0000	0.0017	0.2699**
cents), 1998	(0.001)	(0.001)	(0.000)	(0.001)	(0.123)
State cigarette tax (in	-0.0001	-0.0006	0.0000	-0.0003	-0.0455
cents), 2000	(0.001)	(0.001)	(0.000)	(0.001)	(0.077)
Number of Kids	0.0493***	0.9259***	-0.0012	-0.0009	-0.6735
	(0.013)	(0.021)	(0.001)	(0.007)	(0.819)

Median State Household Income	0.0000***	-0.0000***	0.0000	-0.0000**	-0.0002
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Unemployment rate in local labor market, 1988	-0.0072	0.0185	0.0008	-0.0021	-0.4671
	(0.007)	(0.014)	(0.001)	(0.005)	(0.839)
Unemployment rate in local labor market, 1989	0.0155	-0.0333	-0.0016*	0.0133*	-0.8745
	(0.014)	(0.026)	(0.001)	(0.007)	(1.079)
Unemployment rate in local labor market, 1990	0.0061	-0.0206	0.0004	-0.0147**	-1.5739
	(0.013)	(0.024)	(0.003)	(0.007)	(1.034)
Unemployment rate in local labor market, 1991	-0.0090	-0.0043	0.0028	-0.0040	-0.1931
	(0.009)	(0.012)	(0.002)	(0.007)	(0.918)
Unemployment rate in local labor market, 1992	0.0079	0.0101	-0.0020	0.0105	3.3155***
	(0.010)	(0.013)	(0.001)	(0.008)	(1.157)
Unemployment rate in local labor market, 1993	-0.0141	0.0058	-0.0007	-0.0013	-1.6208
	(0.011)	(0.020)	(0.001)	(0.009)	(1.018)
Unemployment rate in local labor market, 1994	0.0130	-0.0093	-0.0010	-0.0162	-0.2092
	(0.010)	(0.017)	(0.001)	(0.011)	(1.043)
Unemployment rate in local labor market, 1996	-0.0073	0.0023	0.0020***	0.0027	-0.0246
	(0.005)	(0.011)	(0.001)	(0.005)	(0.479)
Unemployment rate in local labor market, 1998	-0.0131	0.0276	0.0012	0.0105	-1.2168
	(0.008)	(0.017)	(0.001)	(0.008)	(1.279)
Unemployment rate in local labor market, 2000	0.0085	-0.0177	0.0016**	-0.0124**	0.1096
	(0.006)	(0.014)	(0.001)	(0.006)	(1.182)
Number of Adults in the Home	0.5245***	0.4689***	0.0078**	-0.0097	0.4809
	(0.043)	(0.041)	(0.003)	(0.015)	(0.915)
State Median Price of a Home	-0.0000	0.0008	-0.0001	0.0011***	0.1023**
	(0.000)	(0.001)	(0.000)	(0.000)	(0.046)
Observations	2538	2538	2538	2538	2538
R-squared	0.421	0.706	0.090	0.145	0.314

Table 5h

First Stage Results for Adult Workers and Non-Workers Regression

Instruments	Endogenous Variables				
	Adult Workers	Adult Non-Workers	Family Income	Posterior Probability	Smoke
Weight in 1994	0.0006	0.0035	0.0000	-0.0017***	-0.0017***
	(0.000)	(0.021)	(0.000)	(0.000)	(0.000)
Height	0.0792	-3.8875	-0.0173	-0.2866***	-0.2866***
	(0.140)	(12.308)	(0.018)	(0.106)	(0.106)
Height Squared	-0.0006	0.0334	0.0001	0.0022***	0.0022***
	(0.001)	(0.090)	(0.000)	(0.001)	(0.001)
Age	-0.0009	0.8456**	0.0001	0.0047	0.0047
	(0.004)	(0.371)	(0.001)	(0.004)	(0.004)
Black	0.0219	-10.3445***	0.0197***	-0.0053	-0.0053
	(0.027)	(1.919)	(0.004)	(0.023)	(0.023)
Hispanic	-0.0334	-3.1859	-0.0026	-0.0018	-0.0018
	(0.031)	(2.612)	(0.004)	(0.031)	(0.031)
Married	0.2860***	36.2547***	-0.0278***	-0.1046***	-0.1046***
	(0.034)	(2.090)	(0.006)	(0.024)	(0.024)
Divorced/Separated	0.0928***	9.3912***	-0.0158***	0.0144	0.0144
	(0.021)	(2.794)	(0.005)	(0.030)	(0.030)
Widow	0.0400	11.1048	-0.0303***	0.1120	0.1120
	(0.075)	(9.629)	(0.010)	(0.106)	(0.106)
College Graduate	0.0740	55.0727***	-0.0299***	-0.4450***	-0.4450***
	(0.043)	(2.595)	(0.006)	(0.032)	(0.032)
Some college	0.0814	24.5357***	-0.0215**	-0.2808***	-0.2808***
	(0.043)	(2.186)	(0.008)	(0.029)	(0.029)
High School Graduate	0.0758*	11.8204***	-0.0172**	-0.1780***	-0.1780***
	(0.035)	(1.418)	(0.006)	(0.031)	(0.031)
Live in a City	0.0056	-2.0864	-0.0009	-0.0140	-0.0140
	(0.012)	(1.445)	(0.002)	(0.016)	(0.016)
State cigarette tax (in cents), 1988	0.0045*	0.0614	0.0001	-0.0035	-0.0035
	(0.002)	(0.397)	(0.000)	(0.002)	(0.002)
State cigarette tax (in cents), 1989	-0.0010	-0.2451	0.0004	0.0022	0.0022
	(0.002)	(0.369)	(0.000)	(0.003)	(0.003)
State cigarette tax (in cents), 1990	-0.0079***	-0.2355	0.0003	0.0004	0.0004
	(0.003)	(0.388)	(0.000)	(0.003)	(0.003)
State cigarette tax (in cents), 1991	0.0027	0.5173	-0.0009**	-0.0010	-0.0010
	(0.003)	(0.345)	(0.000)	(0.004)	(0.004)
State cigarette tax (in cents), 1991	0.0025	-0.0829	0.0005	0.0009	0.0009
	(0.002)	(0.191)	(0.000)	(0.003)	(0.003)
State cigarette tax (in cents), 1993	0.0004	0.0484	0.0003*	-0.0016	-0.0016
	(0.001)	(0.168)	(0.000)	(0.002)	(0.002)
State cigarette tax (in cents), 1994	-0.0010	0.3622**	-0.0001	0.0020	0.0020
	(0.001)	(0.156)	(0.000)	(0.001)	(0.001)
State cigarette tax (in cents), 1996	0.0005	-0.4624**	-0.0001	-0.0010	-0.0010
	(0.001)	(0.182)	(0.000)	(0.001)	(0.001)
State cigarette tax (in cents), 1998	-0.0001	0.3172**	-0.0001	0.0011	0.0011
	(0.001)	(0.129)	(0.000)	(0.001)	(0.001)
State cigarette tax (in cents), 2000	-0.0018***	-0.0829	0.0001	0.0003	0.0003
	(0.001)	(0.079)	(0.000)	(0.001)	(0.001)
Median State Household Income	0.0000*	-0.0003	0.0000	-0.0000**	-0.0000**
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)

Unemployment rate in local labor market, 1988	-0.0090	-0.6048	0.0009	-0.0007	-0.0007
	(0.009)	(0.886)	(0.001)	(0.005)	(0.005)
Unemployment rate in local labor market, 1989	0.0316	-0.4967	-0.0015*	0.0095	0.0095
	(0.018)	(1.105)	(0.001)	(0.007)	(0.007)
Unemployment rate in local labor market, 1990	-0.0059	-1.8302	-0.0001	-0.0119*	-0.0119*
	(0.015)	(1.158)	(0.002)	(0.007)	(0.007)
Unemployment rate in local labor market, 1991	-0.0077	0.2048	0.0028	-0.0062	-0.0062
	(0.009)	(0.978)	(0.002)	(0.007)	(0.007)
Unemployment rate in local labor market, 1992	0.0063	3.2710***	-0.0020	0.0113	0.0113
	(0.007)	(1.209)	(0.001)	(0.008)	(0.008)
Unemployment rate in local labor market, 1993	-0.0003	-1.6330	-0.0005	-0.0055	-0.0055
	(0.010)	(1.038)	(0.001)	(0.010)	(0.010)
Unemployment rate in local labor market, 1994	0.0049	-0.2644	-0.0011	-0.0124	-0.0124
	(0.009)	(1.110)	(0.001)	(0.012)	(0.012)
Unemployment rate in local labor market, 1996	-0.0051	-0.2342	0.0019**	0.0071	0.0071
	(0.005)	(0.542)	(0.001)	(0.005)	(0.005)
Unemployment rate in local labor market, 1998	-0.0171	-1.0667	0.0010	0.0122	0.0122
	(0.009)	(1.246)	(0.001)	(0.008)	(0.008)
Unemployment rate in local labor market, 2000	0.0132	-0.2488	0.0016*	-0.0150**	-0.0150**
	(0.007)	(1.133)	(0.001)	(0.006)	(0.006)
Percent of Whites in County	-0.3696	-55.4331	0.1071***	-0.0516	-0.0516
	(0.391)	(35.694)	(0.040)	(0.271)	(0.271)
Percent of Blacks in County	-0.4098	-48.2643	0.1332***	-0.0181	-0.0181
	(0.405)	(33.737)	(0.043)	(0.244)	(0.244)
Percent of Indians in County	0.3789	-107.0334*	0.0172	0.5795	0.5795
	(0.694)	(55.731)	(0.054)	(0.709)	(0.709)
Percent of Asians in County	0.3079	5.7783	-0.0319	-0.9599**	-0.9599**
	(0.373)	(50.285)	(0.074)	(0.377)	(0.377)
Percent of Hispanics in County	-0.0280	-8.3273	0.0629***	-0.2088**	-0.2088**
	(0.107)	(20.357)	(0.016)	(0.078)	(0.078)
Number of Adults in the Home	0.5204***	0.2597	0.0075**	-0.0079	-0.0079
	(0.038)	(0.986)	(0.003)	(0.014)	(0.014)
State Median Price of a Home	0.0007	0.0826*	-0.0001	0.0013***	0.0013***
	(0.000)	(0.046)	(0.000)	(0.000)	(0.000)
Observations	2529	2529	2529	2529	2529
R-squared	0.478	0.316	0.095	0.148	0.148

Table 5i

First Stage Results for Adult Workers, Non-Workers and Children Regression

Instruments	**Endogenous Variables**				
	Workers	Adult Non-Workers	Posterior Probability	Smoke	Family Income
Weight in 1994	0.0008*	-0.0006	0.0000	-0.0017***	0.0035
	(0.000)	(0.000)	(0.000)	(0.000)	(0.021)
Height	0.1709	-0.0792	-0.0173	-0.2866***	-3.8875
	(0.164)	(0.140)	(0.018)	(0.106)	(12.308)
Height Squared	-0.0012	0.0006	0.0001	0.0022***	0.0334
	(0.001)	(0.001)	(0.000)	(0.001)	(0.090)
Age	0.0093*	0.0009	0.0001	0.0047	0.8456**
	(0.004)	(0.004)	(0.001)	(0.004)	(0.371)
Black	0.0316	-0.0219	0.0197***	-0.0053	-10.3445***
	(0.031)	(0.027)	(0.004)	(0.023)	(1.919)
Hispanic	-0.0152	0.0334	-0.0026	-0.0018	-3.1859
	(0.034)	(0.031)	(0.004)	(0.031)	(2.612)
Married	0.3505***	-0.2860***	-0.0278***	-0.1046***	36.2547***
	(0.035)	(0.034)	(0.006)	(0.024)	(2.090)
Divorced/Separated	0.0992***	-0.0928***	-0.0158***	0.0144	9.3912***
	(0.023)	(0.021)	(0.005)	(0.030)	(2.794)
Widow	0.0935	-0.0400	-0.0303***	0.1120	11.1048
	(0.156)	(0.075)	(0.010)	(0.106)	(9.629)
College Graduate	0.0330	-0.0740*	-0.0299***	-0.4450***	55.0727***
	(0.047)	(0.043)	(0.006)	(0.032)	(2.595)
Some college	0.0522	-0.0814*	-0.0215**	-0.2808***	24.5357***
	(0.048)	(0.043)	(0.008)	(0.029)	(2.186)
High School Graduate	0.0557	-0.0758**	-0.0172**	-0.1780***	11.8204***
	(0.038)	(0.035)	(0.006)	(0.031)	(1.418)
Live in a City	-0.0047	-0.0056	-0.0009	-0.0140	-2.0864
	(0.016)	(0.012)	(0.002)	(0.016)	(1.445)
State cigarette tax (in	0.0038	-0.0045**	0.0001	-0.0035	0.0614
cents), 1988	(0.002)	(0.002)	(0.000)	(0.002)	(0.397)
State cigarette tax (in	-0.0011	0.0010	0.0004	0.0022	-0.2451
cents), 1989	(0.002)	(0.002)	(0.000)	(0.003)	(0.369)
State cigarette tax (in	-0.0076*	0.0079***	0.0003	0.0004	-0.2355
cents), 1990	(0.003)	(0.003)	(0.000)	(0.003)	(0.388)
State cigarette tax (in	0.0013	-0.0027	-0.0009**	-0.0010	0.5173
cents), 1991	(0.004)	(0.003)	(0.000)	(0.004)	(0.345)
State cigarette tax (in	0.0013	-0.0025	0.0005	0.0009	-0.0829
cents), 1991	(0.002)	(0.002)	(0.000)	(0.003)	(0.191)
State cigarette tax (in	0.0027	-0.0004	0.0003*	-0.0016	0.0484
cents), 1993	(0.002)	(0.001)	(0.000)	(0.002)	(0.168)
State cigarette tax (in	-0.0011	0.0010	-0.0001	0.0020	0.3622**
cents), 1994	(0.001)	(0.001)	(0.000)	(0.001)	(0.156)
State cigarette tax (in	-0.0001	-0.0005	-0.0001	-0.0010	-0.4624**
cents), 1996	(0.001)	(0.001)	(0.000)	(0.001)	(0.182)
State cigarette tax (in	-0.0005	0.0001	-0.0001	0.0011	0.3172**
cents), 1998	(0.001)	(0.001)	(0.000)	(0.001)	(0.129)
State cigarette tax (in	-0.0009	0.0018***	0.0001	0.0003	-0.0829
cents), 2000	(0.001)	(0.001)	(0.000)	(0.001)	(0.079)
Median State	0.0000***	-0.0000**	0.0000	-0.0000**	-0.0003
Household Income	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)

Unemployment rate in local labor market, 1988	-0.0136	0.0090	0.0009	-0.0007	-0.6048
	(0.010)	(0.009)	(0.001)	(0.005)	(0.886)
Unemployment rate in local labor market, 1989	0.0264	-0.0316*	-0.0015*	0.0095	-0.4967
	(0.018)	(0.018)	(0.001)	(0.007)	(1.105)
Unemployment rate in local labor market, 1990	0.0089	0.0059	-0.0001	-0.0119*	-1.8302
	(0.017)	(0.015)	(0.002)	(0.007)	(1.158)
Unemployment rate in local labor market, 1991	-0.0052	0.0077	0.0028	-0.0062	0.2048
	(0.010)	(0.009)	(0.002)	(0.007)	(0.978)
Unemployment rate in local labor market, 1992	0.0055	-0.0063	-0.0020	0.0113	3.2710***
	(0.011)	(0.007)	(0.001)	(0.008)	(1.209)
Unemployment rate in local labor market, 1993	-0.0089	0.0003	-0.0005	-0.0055	-1.6330
	(0.015)	(0.010)	(0.001)	(0.010)	(1.038)
Unemployment rate in local labor market, 1994	0.0090	-0.0049	-0.0011	-0.0124	-0.2644
	(0.012)	(0.009)	(0.001)	(0.012)	(1.110)
Unemployment rate in local labor market, 1996	-0.0054	0.0051	0.0019**	0.0071	-0.2342
	(0.007)	(0.005)	(0.001)	(0.005)	(0.542)
Unemployment rate in local labor market, 1998	-0.0234*	0.0171*	0.0010	0.0122	-1.0667
	(0.011)	(0.009)	(0.001)	(0.008)	(1.246)
Unemployment rate in local labor market, 2000	0.0177*	-0.0132*	0.0016*	-0.0150**	-0.2488
	(0.008)	(0.007)	(0.001)	(0.006)	(1.133)
Percent of Whites in County	-0.3271	0.3696	0.1071***	-0.0516	-55.4331
	(0.420)	(0.391)	(0.040)	(0.271)	(35.694)
Percent of Blacks in County	-0.5026	0.4098	0.1332***	-0.0181	-48.2643
	(0.434)	(0.405)	(0.043)	(0.244)	(33.737)
Percent of Indians in County	0.4346	-0.3789	0.0172	0.5795	-107.0334*
	(0.855)	(0.694)	(0.054)	(0.709)	(55.731)
Percent of Asians in County	0.3044	-0.3079	-0.0319	-0.9599**	5.7783
	(0.454)	(0.373)	(0.074)	(0.377)	(50.285)
Percent of Hispanics in County	-0.0618	0.0280	0.0629***	-0.2088**	-8.3273
	(0.111)	(0.107)	(0.016)	(0.078)	(20.357)
Number of Adults in the Home	0.5346***	0.4796***	0.0075**	-0.0079	0.2597
	(0.042)	(0.038)	(0.003)	(0.014)	(0.986)
State Median Price of a Home	-0.0001	-0.0007*	-0.0001	0.0013***	0.0826*
	(0.000)	(0.000)	(0.000)	(0.000)	(0.046)
Observations	2529	2529	2529	2529	2529
R-squared	0.434	0.365	0.095	0.148	0.316

Table 5j

First Stage Results for Ratio of Workers to Adult Non-Workers Regression

Instruments	**Endogenous Variables**			
	Ratio of Workers to Adult Non-Workers	Posterior Probability	Smoke	Family Income
Weight in 1994	0.0002	0.0000	-0.0017***	0.0035
	(0.000)	(0.000)	(0.000)	(0.021)
Height	-0.0267	-0.0173	-0.2866***	-3.8875
	(0.060)	(0.018)	(0.106)	(12.308)
Height Squared	0.0002	0.0001	0.0022***	0.0334
	(0.000)	(0.000)	(0.001)	(0.090)
Age	-0.0019	0.0001	0.0047	0.8456**
	(0.001)	(0.001)	(0.004)	(0.371)
Black	0.0113	0.0197***	-0.0053	-10.3445***
	(0.011)	(0.004)	(0.023)	(1.919)
Hispanic	-0.0169	-0.0026	-0.0018	-3.1859
	(0.014)	(0.004)	(0.031)	(2.612)
Married	0.1883***	-0.0278***	-0.1046***	36.2547***
	(0.012)	(0.006)	(0.024)	(2.090)
Divorced/Separated	0.0220*	-0.0158***	0.0144	9.3912***
	(0.009)	(0.005)	(0.030)	(2.794)
Widow	-0.0245	-0.0303***	0.1120	11.1048
	(0.047)	(0.010)	(0.106)	(9.629)
College Graduate	0.0429*	-0.0299***	-0.4450***	55.0727***
	(0.018)	(0.006)	(0.032)	(2.595)
Some college	0.0404*	-0.0215**	-0.2808***	24.5357***
	(0.016)	(0.008)	(0.029)	(2.186)
High School Graduate	0.0432***	-0.0172**	-0.1780***	11.8204***
	(0.013)	(0.006)	(0.031)	(1.418)
Live in a City	0.0021	-0.0009	-0.0140	-2.0864
	(0.006)	(0.002)	(0.016)	(1.445)
State cigarette tax (in	0.0020*	0.0001	-0.0035	0.0614
cents), 1988	(0.001)	(0.000)	(0.002)	(0.397)
State cigarette tax (in	-0.0005	0.0004	0.0022	-0.2451
cents), 1989	(0.001)	(0.000)	(0.003)	(0.369)
State cigarette tax (in	-0.0028*	0.0003	0.0004	-0.2355
cents), 1990	(0.001)	(0.000)	(0.003)	(0.388)
State cigarette tax (in	0.0011	-0.0009**	-0.0010	0.5173
cents), 1991	(0.002)	(0.000)	(0.004)	(0.345)
State cigarette tax (in	0.0009	0.0005	0.0009	-0.0829
cents), 1991	(0.001)	(0.000)	(0.003)	(0.191)
State cigarette tax (in	-0.0001	0.0003*	-0.0016	0.0484
cents), 1993	(0.001)	(0.000)	(0.002)	(0.168)
State cigarette tax (in	-0.0000	-0.0001	0.0020	0.3622**
cents), 1994	(0.001)	(0.000)	(0.001)	(0.156)
State cigarette tax (in	0.0000	-0.0001	-0.0010	-0.4624**
cents), 1996	(0.001)	(0.000)	(0.001)	(0.182)
State cigarette tax (in	-0.0002	-0.0001	0.0011	0.3172**
cents), 1998	(0.000)	(0.000)	(0.001)	(0.129)
State cigarette tax (in	-0.0007*	0.0001	0.0003	-0.0829
cents), 2000	(0.000)	(0.000)	(0.001)	(0.079)
State Median	0.0000*	0.0000	-0.0000**	-0.0003
Household Income	(0.000)	(0.000)	(0.000)	(0.000)

Unemployment rate in	-0.0038	0.0010	-0.0012	-0.6653
local labor market, 1988	(0.004)	(0.001)	(0.005)	(0.830)
Unemployment rate in	0.0098	-0.0021**	0.0102	-0.3938
local labor market, 1989	(0.006)	(0.001)	(0.008)	(1.133)
Unemployment rate in	-0.0038	0.0008	-0.0144*	-1.6833
local labor market, 1990	(0.006)	(0.002)	(0.007)	(1.178)
Unemployment rate in	-0.0011	0.0026	-0.0062	0.0066
local labor market, 1991	(0.003)	(0.002)	(0.007)	(0.954)
Unemployment rate in	0.0028	-0.0023	0.0115	3.3529***
local labor market, 1992	(0.003)	(0.001)	(0.008)	(1.214)
Unemployment rate in	0.0024	-0.0006	0.0002	-1.7687
local labor market, 1993	(0.005)	(0.001)	(0.009)	(1.067)
Unemployment rate in	0.0006	-0.0009	-0.0171	-0.3939
local labor market, 1994	(0.004)	(0.001)	(0.011)	(1.040)
Unemployment rate in	-0.0012	0.0022***	0.0058	-0.2182
local labor market, 1996	(0.002)	(0.001)	(0.005)	(0.498)
Unemployment rate in	-0.0064	0.0011	0.0106	-0.9765
local labor market, 1998	(0.004)	(0.001)	(0.008)	(1.276)
Unemployment rate in	0.0047	0.0009	-0.0161**	0.3439
local labor market, 2000	(0.004)	(0.001)	(0.006)	(1.135)
Percent of Whites in	-0.0437	0.1071***	-0.0516	-55.4331
County	(0.153)	(0.040)	(0.271)	(35.694)
Percent of Blacks in	-0.0689	0.1332***	-0.0181	-48.2643
County	(0.152)	(0.043)	(0.244)	(33.737)
Percent of Indians in	0.2622	0.0172	0.5795	-107.0334*
County	(0.318)	(0.054)	(0.709)	(55.731)
Percent of Asians in	0.2732	-0.0319	-0.9599**	5.7783
County	(0.157)	(0.074)	(0.377)	(50.285)
Percent of Hispanics in	0.0196	0.0629***	-0.2088**	-8.3273
County	(0.157)	(0.074)	(0.377)	(50.285)
State Median Price of	0.0002	-0.0001	0.0013***	0.0826*
a Home	(0.000)	(0.000)	(0.000)	(0.046)
Number of Adults in the	0.1218***	0.0075**	-0.0079	0.2597
Home	(0.010)	(0.003)	(0.014)	(0.986)
Observations	2529	2529	2529	2529
R-squared	0.348	0.095	0.148	0.316